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The Journal of CETACEAN RESEARCH AND MANAGEMENT

Editorial

Welcome to this the supplement to the nineteenth volume of the *Journal of Cetacean Research and Management*.

This supplement to the Journal contains the Report of the IWC Scientific Committee from its Annual Meeting held from 9-21 May 2017 in Bled, Slovenia. The meeting was attended by over 210 participants, including 85 invited participants; 31 member nations were represented. It also contains the reports of nine intersessional meetings:

(1) the Report of the Expert Panel Workshop on the Proposed Research Plan for the New Scientific Whale Research Programme in the Western North Pacific (NEWREP-NP), held in January-February 2017 in Tokyo, Japan;
(2) the Report of the Planning Meeting for the 2017 IWC-POWER Cruise in the North Pacific with Initial Discussion for the 2018 and 2019 Cruises, held in September 2016 in Tokyo, Japan;
(3) the Report of the Workshop on Southern Hemisphere Blue, Fin and Humpback Whale Photo-Identification Catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula, held in December 2016 in Valparaiso, Chile;
(4) the Report of the Fourth Rangewide Workshop on the Status of North Pacific Gray Whales, held in April 2017 in La Jolla, CA, USA;
(5) the Report of the Third Intersessional Workshop on the *Implementation Review* for North Atlantic Common Minke Whales, held in December 2016 in Copenhagen, Denmark;
(6) the Report of the 2016 AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS, held in December 2016 in Copenhagen, Denmark;
(7) the Report of the Workshop on the *Implementation Review* of Western North Pacific Bryde's Whales, held in March 2017 in Tokyo, Japan;
(8) the Chair's Summary Report of the First IWC Workshop on the Comprehensive Assessment of North Pacific Humpback Whales, held in April 2017 in Seattle, WA, USA; and
(9) the Report of the Workshop on Harmful Algal Blooms (HABs) and Associated Toxins, held in May 2017 in Bled, Slovenia.

The Commission meeting associated with this Scientific Committee meeting will be held in September 2018 in Florianopolis, Brazil and will be numbered IWC/67. This report and the report of the previous Scientific Committee meeting (SC/67a, which was held in 2016) will both be presented at the 2018 Commission meeting.

This year the Scientific Committee report continues with a new format which shows recommendations and agreements more clearly. Since the last Commission meeting in 2014, there has been discussion on the adoption of a better way to deliver Scientific Committee advice. The Scientific Committee Chair, Vice-Chair and Head of Science have therefore developed a consistent template for recommendations which means that they should be understandable even if read alone. An example and explanation is given below.

Attention: SC, C-A

The Committee ***agrees*** *that after the meeting and before the Scientific Committee report is published on the IWC website, the Chair and Head of Science should develop a template to highlight advice, agreements and recommendations and identify, in their judgement, the primary intended recipients (of course it is recognised that in a general sense, the whole report provides advice to the Commission). The template is as follows:*

(a) important action items, agreements and recommendations are highlighted by placing them between lines; and
(b) the header of the paragraph provides information on the primary intended recipients in the judgement of the Chair and Head of Science, using the following codes: S=Secretariat; SC=internal to the Scientific Committee, G=general scientific recommendation; C-A=advice to the Commission; C-R= recommendation to the Commission; CC=relevant to the Commission's Conservation Committee; AWS=relevant to the Commission's Aboriginal Subsistence Whaling sub-committee; CG-A=advice to a Contracting Government or Governments; CG-R=recommendations to a Contracting Government or Governments.

A large number of topics were discussed in Bled of which only a very brief summary is given below. Full details of the large amount of work undertaken can be found in the Report of the Scientific Committee and its many sub-groups in this supplement.

The Committee continued its work on matters related to the Revised Management Procedure (RMP). The RMP was developed to establish a precautionary way to evaluate anthropogenic removals in the light of potential future commercial catches (there is a moratorium on commercial catching of whales in force). The objectives for commercial catches were established by the Commission with the highest priority being to ensure that no catches would be allowed if there was a possibility that the populations subject to exploitation were below 10% of the level at which maximum sustainable yield might be obtained (i.e. 54% of the unexploited population size). There is a focus on fully taking into account scientific uncertainty when providing advice. In 2017 the Committee is pleased to report it has completed the *Implementation Review* for North Atlantic common minke whales. The *Implementation Review* for Western North Pacific Bryde's whales has now begun with a Workshop and discussions at this meeting, and is expected to be completed in 2018.

'Aboriginal subsistence whaling' is regulated by the IWC in several parts of the world. This year, work continued on the development of advice on safe hunting limits and *SLA*s (*Strike Limit Algorithms*) for the hunts off Greenland. Completing this complex work is a high priority for the Scientific Committee. This year the focus was on outstanding aspects of an Aboriginal Whaling Management Scheme (AWS), including how to handle 'carryover' of unused strikes. The Committee needs to have this work finished by 2018 as this is when the quotas are due to be discussed by the Commission. The Committee as usual provided advice on whether proposed strike limits for subsistence hunts by subsistence whaling countries were sustainable.

The Committee gave advice to the Commission on the management of several whale stocks which are subject to aboriginal hunts, including North Pacific gray whales, Bering-Chukchi-Beaufort (B-C-B) Seas bowhead whales, common minke whales and fin whales off West and East Greenland, humpback and bowhead whales off West Greenland, and humpback whales off St Vincent and The Grenadines. An *Implementation Review* for B-C-B bowhead whales is due to begin in 2018.

A Comprehensive Assessment of North Pacific humpback whales was begun this year. This is a large topic with a lot of material to review both during intersessional workshops and this meeting. There are also two ongoing In-Depth Assessments, of North Pacific sei whales and Indo-Pacific Antarctic minke whales, in progress.

The Committee continued work on assessments of other Southern Hemisphere species including Antarctic minke whales, humpback whales and right whales. There has been good progress on the assessment of Southern Hemisphere blue whales, including the use of song and acoustic data from several areas. There has also been much collaboration between the IWC and the various holders of photo-identification database around the world, with a view to using these datasets in future Assessments.

Conservation Management Plans (CMPs) are becoming more of a focus for the Committee and new biological information and progress with existing CMPs were discussed (southeast Pacific southern right whales, southwest Atlantic southern right whales, North Pacific gray whales and franciscana). The possible development of a new CMP for Arabian Sea humpback whales was discussed and the importance of agreement from range states reiterated.

The two issues of stock definition and DNA testing have now been combined into one sub-group. The group discussed developments in DNA databases and several other issues including determining stock structure in the North Pacific Bryde's whale.

It has been agreed that all abundance estimates submitted to the Committee will be reviewed by a dedicated Working Group; this will include a review of past estimates in some cases. The objective of the group will be to produce a table with the latest agreed abundance estimates and the uses to which they can be put in the Committee's work that will be updated at each meeting.

The issues of non-deliberate human-induced mortality (e.g. bycatches of whales in fishing gear and collisions with ships) are important at a number of levels including animal welfare and may have conservation implications for certain populations. The Scientific Committee has been working on these issues for several years. This year, discussions focussed on entanglement of large whales in fishing gear and mitigation of entanglements, including prevention by various means, how to deal with the important issue of small cetacean bycatch, and reviewing estimates of ship strikes and mitigation of collisions in high-risk areas.

As usual, the Committee examined a number of topics related to the environment and cetaceans. These included progress on: chemical pollution via the POLLUTION 2020+ research programme; the impacts of oil spills on cetaceans; cetacean disease and unexplained mortality events; the effects of anthropogenic sound on cetaceans; and the effects of climate change on cetaceans. A pre-meeting Workshop on harmful algal blooms (HABs) was very productive. The regular State of the Cetacean Environment (SOCER) report this year focused on the Indian Ocean.

The Committee's main focus for small cetaceans was a review of taxonomy and population structure of bottlenose dolphins in the East Pacific and western North Pacific. This is the second half of a large review of *Tursiops* which began last year. Progress on previous recommendations on endangered populations of Hector's dolphins, Amazon river dolphins and others were discussed, as well as direct and accidental takes of small cetaceans. The case of the critically endangered vaquita received special attention, and a strong statement was made by the Committee on the importance of stopping the illegal totoaba fishery in the Gulf of Mexico.

Whale watching issues were discussed and the impacts of whale watching on different cetacean populations continues to be monitored, and there will be a workshop on this in 2018 (MAWI).

There was considerable discussion of Special Permits. The Committee is working on improving the process for evaluating special permit proposals (the 'Annex P' process). They also reviewed ongoing work from the NEWREP-A and JARPN II research programs.

There was a new group formed this year to review the database and catalogue work undertaken by the Committee, which is extensive. Photo-identification databases can be used in population assessments, and several are in use already including the Antarctic Humpback Whale Catalogue and the Southern Hemisphere Blue Whale Catalogue. This group will also work on the progress report database and is looking at possible future databases including one for bycatch recording.

The Committee received reports from several international research cruises, including the ongoing IWC-POWER which is undertaking a systematic set of surveys of the North Pacific.

The Chair of the Scientific Committee, Caterina Fortuna (Italy), has completed her second year in office and at the end of the meeting the Committee thanked her for her dedicated and effective work so far. She will continue in the role of Chair and Robert Suydam (USA) continues as Vice-Chair.

The IWC website (*http://www.iwc.int*) has been used for all document distribution now for several years. All Scientific Committee, Commission and intersessional documents are now submitted using the online Portal system which has made a substantial saving on paper and printing costs. These systems will be further developed to improve the user experience. In addition, papers for the Journal are now submitted, reviewed and, if accepted, published exclusively online and open-access (*https://iwc.int/jcrm*). The Journal now has a new team of associate editors in place to increase efficiency and streamline the publication process.

While all new documents are now available online, an electronic archive of all past Scientific Committee and Commission documents and publications was underway but has stalled due to lack of funds. This is a major undertaking. Many of the earlier papers have been scanned and will be uploaded to the website in due course. In the meantime they are available to Committee members on request. All past Journal papers and Supplements are now available online, as are the Annual Reports and the older Reports of the IWC.

Greg Donovan
Editor
Cambridge, 28 February 2018

Supplement Contents

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*Detailed contents for the Plenary Section (pp.1-101) are given on the next page.

PLENARY SECTION: CONTENTS

Report of the Scientific Committee

Codes for highlighted action items: S=Secretariat; SC=internal to the Scientific Committee; G=general scientific recommendations; C-A=advice to the Commission; C-R=recommendation to the Commission; CC=relevant to the Commission's Conservation Committee; AWS=relevant to the Commission's Aboriginal Subsistence Whaling sub-committee; CG-A=advice to a Contracting Government or Governments; and CG-R=recommendations to a Contracting Government or Governments.

The meeting (SC/67a) was held at the Golf Hotel, Bled, Slovenia, from 9-21 May 2017 and was chaired by Caterina Fortuna. The next meeting of the Commission (IWC/67) will take place in late 2018. The list of participants is given as Annex A (only 35% of the Contracting Governments were represented by delegates).

1. INTRODUCTORY ITEMS

1.1 Chair's welcome and opening remarks

Fortuna welcomed the participants to the meeting. On behalf of the Scientific Committee she thanked the Government of Slovenia and the City of Bled, especially her Slovenian colleagues Commissioner Andrej Bibič and Mateja Legat, for inviting it back to such a beautiful place. She thanked the IWC Secretariat staff for their hard work during the intersessional period along with Greg Donovan (Head of Science), vice-Chair Robert Suydam and the convenors and all Committee members.

Andrej Bibič, IWC Commissioner for Slovenia, welcomed participants to Bled and hoped that everyone would enjoy their time there. He noted that most commodities come from natural resources and therefore conservation of nature and sustainable management are tasks of strategic importance. He acknowledged that scientific knowledge is crucial in implementing effective conservation and management strategies and he wished participants every success during the 2017 Scientific Committee meeting.

Thomaž Lovrenčič, Ambassador at the Ministry of Foreign affairs, also welcomed participants to Bled whose beautiful green setting provides an excellent setting for the demanding work of the Committee. The Committee's work contributes to Government Policy and the Slovenian Government strongly agrees with the principles contained in the IWC Convention, that is finding a balance between conservation of whale stocks and the orderly development of the whaling industry. Humans have a responsibility to work together to find sustainable long-term solutions in the maritime environment, both now and for future generations. He hoped that the meeting would be a great success.

Brockington, the IWC Executive Secretary, thanked the representatives of Slovenia for their warm welcome. The IWC has been remarkably productive over the last three years, has organised a specialist event or workshop on cetaceans at the rate of approximately once per month on many aspects of cetacean conservation and management. He highlighted some of the ways that the Commission has been receiving and acting upon recommendations of the Scientific Committee. He acknowledged the implementation of the new format for Scientific Committee report recommendations and referred to the database of recommendations that the 'Scientific Committee-Conservation Committee joint working group' is working on that will record and track progress. He thanked Fortuna for her initiative in increasing focus for the Committee and improving its alignment with Commission priorities. Access to the advice of the Committee allied with the commitment of Governments and increased co-operation with inter-governmental organisations and observers provides an increasingly powerful model for addressing urgent conservation and management needs.

The Committee was saddened to learn of the death of Carole Carlson. Carlson was involved with the Scientific Committee for over two decades, attending her first meeting in Puerto Vallarta, Mexico in 1994. She will be remembered for her great contribution to the work of the then newly formed sub-committee on whalewatching, acting as wise rapporteur. She helped to steer the Committee's scientific discussions on sustainable whalewatching and championed the effective contribution that data collected carefully from platforms of opportunity can make to science and conservation. One of her major contributions was the development and maintenance of the IWC Compilation of Worldwide Whalewatching Regulations. She also made major contributions to the development of good practice guidelines for new whalewatching operations in many parts of the world. Her work on humpback whale photo-identification catalogues, initially in the North Atlantic and later in the Antarctic, greatly contributed to the comprehensive assessment of those species in both areas. Apart from her important scientific contributions, Carole will be especially remembered for her unfailing cheerfulness, her desire to help colleagues from all countries and her encouragement to young scientists and 'IWC beginners'. Her generosity of spirit will be greatly missed. The Scientific Committee gave a celebratory round of applause in her memory.

1.2 Appointment of rapporteurs

Donovan was appointed rapporteur with assistance from various members of the Committee as appropriate. Chairs of sub-committees and Working Groups appointed rapporteurs for their individual meetings.

1.3 Meeting procedures and time schedule

The Committee agreed to the meeting procedures and time schedule outlined by the Chair.

1.4 Establishment of sub-committees and Working Groups

The following pre-meetings were held:

(1) the Standing Working Group on Environmental Concerns held a pre-meeting Workshop on 'Harmful Algal Blooms and their Toxins' from 7-8 May;
(2) the Working Group on Ecosystem Modelling held a pre-meeting on 'Spatial-Modelling-Based Abundance Estimates' from 7-8 May; and
(3) the SORP Antarctic Blue and Fin Whale Acoustic Trends Working Group (ATWG) met from 5-8 May.

Several sub-committees and Working Groups were established. Their reports were either made Annexes (see below) or subsumed into this report.

Annex D – Sub-Committee on the Revised Management Procedure;

Annex E – Standing Working Group on an Aboriginal Whaling Management Procedure;

Annex F – Sub-Committee on In-Depth Assessments;

Annex G – Sub-Committee on Other Northern Hemisphere Whale Stocks;

Annex H – Sub-Committee on Other Southern Hemisphere Whale Stocks;

Annex I – Working Group on Stock Definition and DNA testing;

Annex J – Working Group on Non-Deliberate Human-Induced Mortality of Cetaceans;

Annex K – Standing Working Group on Environmental Concerns;

Annex L – Working Group on Ecosystem Modelling;

Annex M – Sub-Committee on Small Cetaceans;

Annex N – Sub-Committee on Whalewatching;

Annex O – Sub-Committee on Conservation Management Plans;

Annex P – Matters Related to Special Permit Discussions;

Annex Q – *Ad hoc* Working Group on Abundance Estimates, Stock Status and International Cruises;

Annex R – *Ad hoc* Working Group on IWC Global Data Repositories and National Reports;

Annex S – *Ad hoc* Working Group on Photo-Identification;

Annex T - *Ad hoc* Working Group on Interactions between Scientific and Conservation Committees;

Annex U – Statements on the Agenda;

Annex V – Matters Related to Working Methods; and

Annex W – Intersessional Email Correspondence Groups.

1.5 Computing arrangements

Allison outlined the computing and printing facilities available for delegate use.

2. ADOPTION OF AGENDA

The adopted Agenda is given as Annex B. Statements on the Agenda are given as Annex U.

3. REVIEW OF AVAILABLE DATA, DOCUMENTS AND REPORTS

3.1 Documents submitted

The documents available are listed in Annex C. As agreed at the 2012 Annual Meeting, primary papers were only available at the meeting in electronic format (IWC, 2013a, pp.78-79).

3.2 National Progress Reports on research

The National Progress Reports have their origin in Article VIII, Paragraph 3 of the Convention. All member nations are urged by the Commission to provide Progress Reports to the Scientific Committee following the most recent guidelines developed by the Scientific Committee and adopted by the Commission. The report is intended as a concise summary of information available in member countries and where to find more detailed information if required. In addition, the IWC holds several specialist databases (including catches, sightings, ship strikes, images – see Item 22).

As agreed at the 2013 Annual Meeting (IWC, 2014a), all National Progress Reports were submitted electronically through the IWC National Progress Reports data portal. This year 12 countries provided National Progress Reports including data on bycatch, entanglement, ship strikes, direct and indirect takes, sampling, sightings and tracking studies. These countries were: Australia, Croatia, Denmark, Germany, Iceland, Italy, Japan, Korea, New Zealand, Spain, United Kingdom and the USA.

Attention: C-A

The Committee again ***recommends*** *that all member states submit National Progress Reports to the IWC through the IWC data portal (*http://portal.iwc.int*); the present contributions represent only 14% of member nations – see also the recommendations under Item 13.2 and 23.3.2.*

3.3 Data collection, storage and manipulation

3.3.1 Catch data and other statistical material

Table 1 lists data received by the Secretariat since the 2016 meeting.

3.3.2 Progress of data coding projects and computing tasks

Allison reported that Version 6.1 of the catch databases was released in July 2016 and is available on request. She requested information on any sources of data missing from the databases. Work has continued on the entry of catch data into both the IWC individual and summary catch databases, including data received from the 2015 and 2016 seasons.

Data from Gilmore's files held at the NMML in Seattle for Japanese coastal catches by one company in the years 1938-42 has been coded and added to the database. These catches represent ~30-40% of the Japanese coastal catches each year over this period.

Data from the Japanese North Pacific sei and Bryde's whale marking programme has been entered and validated; data for the other species is being entered.

Data from the 2013 and 2014 POWER cruises has been validated, as was reported last year. Some queries have been sorted out and the process documented. Data from the 2015 cruise has been validated but await clarification of some points. This and the DESS database is discussed under Item 11.3.1.

Programming work has concentrated on development, conditioning and running of the *Implementation* trials for North Atlantic common minke whales and initial work on North Pacific Bryde's whale trials (see Items 6.2 and 6.3). This and other work is described under the relevant sub-committee items.

4. CO-OPERATION WITH OTHER ORGANISATIONS

Attention: C-A

The Committee ***stresses*** *the value of co-operation with other organisations when addressing the range of issues affecting cetacean conservation and management. In addition to the summaries below, co-operation is also discussed where relevant elsewhere in the agenda.*

4.1 African States Bordering the Atlantic Ocean (ATLAFCO)

There was no meeting of the Ministerial Conference of ATLAFCO during the intersessional period.

4.2 Arctic Council

4.2.1 PAME (Protection of the Arctic Marine Environment)

The PAME I-2017 meeting was held in Copenhagen, Denmark from 29 January-1 February 2017. No IWC observer attended

Table 1

List of data and programs received by the IWC Secretariat since the 2015 meeting.

Date	Contact	Code	Notes
Catch data from the 2016 and 2016/17 season			
18/04/17	Russia: V. Ilyashenko	E128 Cat2016	Individual data from Russian aboriginal hunt 2016.
19/04/17	Japan: H.Kumakiri	E128 Cat2016	Individual data for Japan's catch in 2016 in the North Pacific (JARPN II) and 2016/17 in the Antarctic (NEWREP-A) (Excel and pdf format).
25/04/17	USA: R. Suydam	E128 Cat2016	Individual records from USA Alaska aboriginal bowhead hunt 2016.
26/04/17	Norway: N. Øien	E128 Cat2016	Individual minke records from the Norwegian 2016 commercial catch. Access restricted (specified 14/11/00).
03/05/17	Iceland: G. Víkingsson	E128 Cat2016	Individual records of minke whales caught by Iceland 2016 [there was no fin whale catch].
18/05/17	St Vincent and The Grenadines: J. Cruickshank-Howard	E128 Cat2016	Information from St Vincent and The Grenadines aboriginal hunt 2016-17.
08/05/17	Canada: L. Vuckovic	E128 Cat2016	Details of the Canadian bowhead harvest for the 2016 season and notification of the 2017 quota.
25/04/17	USA: R. Suydam	E128 Cat2016	Reported landed harvest of beluga whales from western and northern Alaska, 2007-16, compiled by the Alaska Beluga Whale Committee.
Catch data from previous seasons			
22/10/16	Greenland: N. Levermann	E125 Cat2015	Individual catch data from the Greenland aboriginal hunt (all species) in 2015.
18/03-11/2016	S. Mizroch, S. Kromann and Y. Ivashchenko	E127 C	Individual catch data from Gilmore's files held at the NMML, Seattle, for Japan coastal catches by Taiyo Gyogyo in 1938-42.
13/12/16	Y. Hideyoshi	E127 C	Information on 90 Bryde's whales caught 1954-67 (which were formerly reported as 'sei' whales in records which did not distinguish sei and Bryde's whales.
07/04/17	S. Mizroch	E127	USA whale marking program data (1962-69).
07/07/17	R.L. Brownell	CD102	Catch data from Japanese factories operating in the Antarctic in 1946/47 and 1947/48. The data relate to a blue and fin whale baleen collection held at the Smithsonian Institute (reported to Scientific Committee 2015).
Sightings			
07/04/17	Japan: K. Matsuoka	E129	Data from the 2016 JARPNII dedicated sighting survey.
12/04/17	Japan: K. Matsuoka	CD101 E129	Data from the 2016 POWER sightings cruise plus CD received 20/04/17.
30/04/17	Japan: K. Matsuoka	E129	Data from the 2016-17 NEWREP-A dedicated sighting survey.

the meeting. The Committee agrees that if possible an IWC observer should attend the next meeting of PAME.

4.3 Convention on Biological Diversity (CBD)
The Conference of Parties met 4-17 December 2016 in Cancun, Mexico. No IWC observer attended the meeting.

4.4 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
The 35th Meeting of the CCAMLR Scientific Committee was held 17-21 October 2016 in Hobart, Australia. Although no IWC observer attended the meeting, co-operation with CCAMLR remains an important component of the IWC's work and is discussed further under Item 16.1.2.

4.5 Convention on the Conservation of Migratory Species (CMS)
4.5.1 Scientific Council

The First Meeting of the Sessional Committee of the Scientific Council (ScC-SC1) was held 18-21 April 2016 in Bonn, Germany. No IWC observer attended the meeting.

4.5.2 Conference of Parties

There was no meeting of the Conference of Parties during the intersessional period. The next meeting will take place 22-28 October 2017 in Manila, Philippines.

4.5.3 Agreement on Small Cetaceans of the Baltic and North Seas (ASCOBANS)

The report of the observers at the 8th Meeting of Parties to ASCOBANS[1] held in Helsinki, Finland from 30 August to 1 September 2016 is given as SC/67a/02G. There was no meeting of the Advisory Committee (AC) during the intersessional period.

Thirteen resolutions were passed after they had been prepared during the last AC meeting. Those of relevance to the IWC are summarised below.

(1) The harbour porpoise population of the Baltic Proper continues to be endangered, with an IUCN status of 'endangered by extinction'. The resolution reiterates the importance of the Jastarnia plan and furthermore specifies the aim to reduce bycatch to zero.
(2) Common dolphins have a bycatch which is thought to be unsustainable. ASCOBANS will continue to work towards a comprehensive conservation plan for the common dolphin in the eastern North Atlantic.
(3) Mitigation of bycatch, with the aim to reduce bycatch of cetaceans to zero, with the intermediate precautionary aim to reduce bycatch to less than 1% of the best available population estimate; and to focus on monitoring programmes for robust estimation of cetacean bycatch, as well as the development, implementation and evaluation of mitigation measures.
(4) Ocean energy can potentially have an impact on cetaceans due to noise or collision.
(5) Impacts of polychlorinated biphenyls (PCBs). Several actions are proposed, in particular to monitor PCB exposure in small cetacean species across the ASCOBANS range, with particular emphasis on species considered to be at high risk, such as killer whales, bottlenose dolphins and harbour porpoises.
(6) Addressing the threats from underwater unexploded ordnance, which are on the one hand the toxic substances they can release into the marine environment and on the other hand the potential for injury during explosions.

[1] *http://www.ascobans.org/sites/default/files/document/ASCOBANS_MOP8_Report.pdf.*

(7) Cumulative effects are an emerging issue, which can only be addressed in conjunction with partners, and by thinking strategically when dealing with transboundary issues.
(8) CMS family guidelines on environmental impact assessments for marine noise-generating activities signal that underwater noise is a serious issue that affects a whole range of species. These draft guidelines address issues on assessing, mitigating and minimising the negative effects of sound on marine species.

The Committee thanked Geelhoed and Scheidat for their report and **agrees** that they should represent the Committee as observers at the next ASCOBANS meeting.

4.5.4 Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)

4.5.4.1 MEETING OF PARTIES

The 6th Meeting of the Parties (MoP) to ACCOBAMS met from 22-25 November 2016 in Monaco. The report of that meeting, which also celebrated the 20th anniversary of ACCOBAMS, can be found on the ACCOBAMS website[2]. IWC/ACCOBAMS cooperation has been high throughout the period and continues to remain strong. The MoP adopted several resolutions relevant to the work of the IWC including:

(1) Resolution 6.7 on the ACCOBAMS Scientific Committee;
(2) Resolution 6.13 on ACCOBAMS Survey Initiative (this project has previously been endorsed by the IWC Scientific Committee);
(3) Resolution 6.14 on Population Structure Studies;
(4) Resolution 6.15 on Assessment of IUCN Conservation Status of Cetaceans in the ACCOBAMS Area;
(5) Resolution 6.16 on Interactions between Fisheries and Cetaceans;
(6) Resolution 6.17 on Anthropogenic Noise;
(7) Resolution 6.18 on Implementation of an ACCOBAMS Certification for Highly Qualified Marine Mammals Observers;
(8) Resolution 6.19 on Ship Strikes on Cetaceans in the Mediterranean Sea;
(9) Resolution 6.20 on Commercial Cetacean Watching Activities in the ACCOBAMS Area;
(10) Resolution 6.21 on Species Conservation Management Plans;
(11) Resolution 6.22 on Cetacean Live Strandings; and
(12) Resolution 6.24 on New Areas of Conservation of Cetacean Habitats.

The willingness of the IWC to contribute on areas of common interest was stressed and ACCOBAMS welcomed collaboration with the IWC. The Committee thanked Donovan for acting as the IWC Observer at the MoP. The next MoP will be in three years.

4.5.4.2 SCIENTIFIC COMMITTEE

ACCOBAMS Scientific Committee met from 7-9 February 2017 in Monaco and the report can be downloaded from the ACCOBAMS website[3]. The primary objective of the meeting was to agree a workplan to implement the scientific components of the resolutions adopted during the MoP referred to above. Again, the willingness of the IWC to cooperate on matters of mutual interest was stressed. The next ACCOBAMS Scientific Committee meeting will take place in autumn 2018. The Committee thanked Donovan for acting as the IWC representative at the ACCOBAMS Scientific Committee meeting and **agrees** that he should continue to do so.

[2]*http://www.accobams.org/.*
[3]*http://www.accobams.org/.*

4.6 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

The 17th meeting of the Conference of the Parties took place from 24 September-5 October 2016 in Johannesburg, South Africa. No IWC observer attended the meeting.

4.7 Food and Agriculture Organisation of the United Nations (FAO)

The Committee on Fisheries (COFI) met 11-15 July 2016 in Rome, Italy. No observer attended FAO related meetings in the intersessional period.

4.8 Inter-American Tropical Tuna Commission (IATTC)

The 91st (extraordinary) meeting of the Inter-American Tropical Tuna Commission (IATTC) was held in California, USA, 7-10 February 2017. No observer attended IATTC meetings in the intersessional period.

4.8.1 Agreement on the International Dolphin Conservation Program (AIDCP)

No observer attended IADCP meetings in the intersessional period.

4.9 International Committee on Marine Mammal Protected Areas (ICMMPA)

The report of the observer is given as SC/67a/02H. Over 90 Marine Mammal Protected Area (MMPA) researchers and managers, as well as government and conservation group representatives from 19 countries, met in Puerto Vallarta, México, from 13-17 November 2016 for the Fourth International Conference on Marine Mammal Protected Areas (ICMMPA4). A primary focus of the conference was to explore the role of effective partnerships and planning strategies for managing and monitoring protected areas with marine mammals. For further information visit the ICMMPA website[4].

A trilateral workshop began during ICMMPA4 and continued for a few days after the conference concluded. The aim of the workshop was to develop working agreements to aid cooperation when dealing with entangled whales across national boundaries. The primary outcome of the workshop has been increased communication and cooperation between the three countries (Canada, the USA and Mexico). This has already led to the US gear experts identifying US crab gear that was removed by teams from Mexico (RABEN) from whales in Mexico this winter.

The Committee thanked Rojas-Bracho for his report and **agrees** he should represent the Committee at the ICMMPA Task force meeting.

4.10 International Council for the Exploration of the Sea (ICES)

The report of the IWC observer documenting the 2014 activities of ICES is given as SC/67a/02A. During the year, the ICES Working Group on Marine Mammal Ecology (WGMME) met 8-11 February 2016 in Madrid, Spain.

One OSPAR request involved collation of data and assessment of status for cetaceans in the OSPAR areas of the Northeast Atlantic. In relation to coastal bottlenose dolphins and killer whales, most time-series of abundance

[4]*http://icmmpa.org/conference/fourthconference.*

data are rather short in relation to the generation time of these long-lived animals. Assessment was only possible for five populations, with an indicative assessment provided for another one. In many locations, coastal bottlenose dolphin populations declined or disappeared before or during the 20th century, but most of the current populations seem to be stable. The relationships between coastal bottlenose dolphins and wider ranging offshore populations remain unclear. For most other cetacean species, there is only one robust estimate of abundance. For those species for which there are multiple estimates of abundance, the time-series are short relative to the life cycle of the species and the precision of the estimates is generally low leading to poor power to detect trends from these data. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. However, there has been a clear shift in harbour porpoise distribution from north to south in the North Sea. Notwithstanding the inability to detect trends, recent estimates of abundance are either similar to or larger than comparable earlier estimates. There is currently no evidence of an impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II (Greater North Sea), III (Celtic Seas) and IV (Bay of Biscay and Iberian Coast). More data are needed to make an informed assessment; results from a large-scale survey in summer 2016 will aid this process.

In addition, the WGMME reviewed and reported on: (1) new information on population abundance, population/stock structure and management frameworks for marine mammals; and (2) information on negative and positive ecological interactions between grey seal and other marine mammals. In relation to the latter topic, a workshop is proposed for 2017.

The ICES Working Group on Bycatch of Protected Species (WGBYC) met in Copenhagen from 1-5 February 2016. Since the commencement of WGBYC in 2009 it has been collating, storing and summarising annual data reported by European member states concerned by Regulation 812/2004. This has resulted in the development of a WGBYC database that currently stores nine years (2006-14) of data on fishing effort, dedicated monitoring effort and observed bycatch of cetaceans (and increasingly of other protected species). However, WGBYCs ability to evaluate the magnitude of bycatch mortality of cetaceans and other protected species or species of possible concern continues to be hampered by limited availability of accurate total fishing effort from relevant European waters for gear types covered by this regulation. WGBYC continues to highlight the inconsistent submission and content of annual reports provided by some member states and the shortcomings of the regulation to accurately reflect the magnitude of cetacean bycatch in European fisheries.

The following have been achieved by the WGBYC.

(1) WGBYC now has a framework for automatic data uploading and storage jointly managed with the ICES Data Centre.
(2) WGBYC data continues to demonstrate weaknesses in the current Data Collection Framework (DCF) to adequately capture bycatch incidences of rare event species.
(3) WGCATCH now formally recognises the need to address sampling protocol deficiencies for rare event species in the DCF by incorporating an explicit Term of Reference to address this issue at their annual meetings and they have expanded their membership to include WGBYC.
(4) WGBYC continues to advance overall understanding of protected species bycatch levels by using its database to: (a) now include a summary table of bycatch rates for seabird species in addition to small cetaceans; and (b) undertake bycatch risk assessments for harbour porpoise and a new addition in 2016 - common dolphins.
(5) Several member states continue with mitigation research projects highlighting the importance of continuing to work toward solutions to difficult bycatch management and conservation issues in the face of challenging data and limited resources.

More information is available from the ICES website *http://www.ices.dk.*

The Committee thanked Haug for his report and **agrees** that he should represent the Committee as an observer at the next ICES meetings.

4.11 International Maritime Organisation (IMO)

The report of the observer is given as SC/67a/02E. At IWC/66, the Commission endorsed recommendations of the Conservation Committee and Scientific Committee for continued engagement with the IMO. This included recommendations related to ship strikes and to submit a paper to the IMO Marine Environment Protection Committee providing an update of recent information related to the extent and impacts of underwater noise from shipping.

There have been several recent discussions at the IMO relevant to the IWC recommendations. Costa Rica submitted two proposals to the IMO Navigational Communications and Search and Rescue (NCSR) subcommittee in March 2017 related to reducing ship strike risks to humpback whales. These were ‘Establishment of a new area to be avoided (ATBA) off the Pacific coast of Costa Rica’ (NCSR/4/3/2) and ‘Establishment of a recommendatory two-way route in Golfo Dulce, off the Pacific coast of Costa Rica’ (NCSR/4/3/3). The proposal for the area to be avoided was recommended by NCSR and will be considered by the Maritime Safety Committee (MSC 98) which will meet 7-16 June 2017. The NCSR invited Costa Rica to consider the establishment of national ships’ routeing measures within the Golfo Dulce after the implementation of the ATBA, if deemed necessary. The NCSR also suggested that proposed routeing measures which were primarily related to environmental protection should first be considered by the Marine Environmental Protection Committee (MEPC). The next MEPC meeting (MEPC 71) is scheduled for 3-7 July 2017.

The IMO International Code for Ships Operating in Polar Waters (Polar Code) came into force on 1 January 2017. This applies to passenger and cargo ships covered by SOLAS and includes environmental provisions for the prevention of pollution by oil, noxious liquid substances, sewage, and garbage. Section 11.3.6 of Chapter 11 on Voyage Planning includes the requirement that in considering routes through polar waters, masters shall take into account ‘current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas’ and ‘current information on relevant ships’ routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas’. Provisions relating to non-SOLAS ships, including fishing vessels and pleasure craft will be discussed in the future.

The Committee thanked Ferris and Leaper for their report and **agrees** that they should represent the Committee at the next IMO meeting.

4.12 International Union for the Conservation of Nature (IUCN)

The 6th World Conservation Congress (IUCN's 4-yearly general meeting) was held in Hawai'i in September 2016. Workshops relevant to cetaceans covered the role of Important Marine Mammal Areas (IMMAs) in cetacean conservation; the management of marine traffic, including the use of IMO measures in IMMAs; the South Atlantic Whale Sanctuary; and balancing whale conservation with oil and gas development, which included a presentation of the Western Gray Whale Advisory Panel (WGWAP) work. Three cetacean-related resolutions were adopted: (i) an action to avert the extinction of the vaquita; (ii) a recommendation for the lethal component of the whale research programmes in the Antarctic and North Pacific to be cancelled; and (iii) one supporting the adoption of the South Atlantic Whale Sanctuary and the implementation of its management plan.

IUCN's joint Task Force on MMPA's, drew up a series of regional workshops to propose candidate Important Marine Mammal Areas. The first workshop, for the Mediterranean, was held in Greece in October 2016 and the second, for the South Pacific, in Samoa in March 2017. The programme is discussed further in Annex J.

The WGWAP met in November 2016 in Moscow, and its Noise Task Force met at IUCN in April 2017, where it reviewed *inter alia* a simulation study on the efficacy of mitigation measures for reducing the sonic exposure of whales during seismic surveys. The next meetings of WGWAP and of the Task Force are scheduled for November 2017 in Moscow. A report of WGWAP activities is contained in Annex O, Appendix 5.

Updated Red List assessments for all cetacean species and selected subpopulations are underway and are expected to be completed this year. Two on-line workshops were held, with several Committee members participating. The new assessments will be posted on *http://www.redlist.org* when they have been reviewed by external experts and approved by the Red List Authority. Updates of other projects in which Cetacean Specialist Group members are involved are posted on the Group's web site[5]. The Committee thanked Cooke and Reeves for their report and **agrees** that they should continue to act as observers to IUCN for the IWC.

4.13 North Atlantic Marine Mammal Commission (NAMMCO)

4.13.1 Scientific Committee

The report of the IWC observer at the 23rd meeting of the NAMMCO Scientific Committee (SC) held in Nuuk, Greenland from 4-7 November 2016 is given as SC/67a/02B.

4.13.1.1 BYCATCH

A permanent NAMMCO Bycatch Working Group (Bycatch WG) met for the first time in Reykjavik in 2016. They reviewed the status of bycatch reporting systems, types of fisheries and assumed bycatch risks as well as required and existing bycatch related data. The Bycatch WG will meet every 1-2 years.

4.13.1.2 IMPACTS OF HUMAN DISTURBANCE IN THE ARCTIC

A Symposium on 'Impacts of Human Disturbance on Arctic Marine Mammals' was held 13-15 October 2015. Impact assessments on migrating species/stocks, industrial activities and the difficulties in separating the impacts of human activities from climate change were all discussed.

4.13.1.3 FIN WHALES

The SC accepted a new estimate of 40,788 for fin whales from the Icelandic/Faroe Islands shipboard survey in 2015 (NASS2015) as the most appropriate to use in future assessments. Furthermore, the SC accepted the new estimates corrected for perception bias of 465 in West Greenland and 1,932 in East Greenland. It should be possible to produce a combined estimate for North Atlantic fin whales, including estimates from NASS2015 and the additional Norwegian surveys in 2015.

4.13.1.4 HUMPBACK WHALES

The SC accepted the new abundance estimates of 1,321 in West Greenland and 4,012 in East Greenland from the NASS2015 surveys. Work on abundance estimates from the Icelandic, Faroe Islands, and Norwegian surveys in 2015 are still in progress.

4.13.1.5 COMMON MINKE WHALES

The SC accepted a new total common minke whale estimate (from the NASS2015 survey) of 36,185 for the entire central north Atlantic, and an estimate for Icelandic coastal waters (IC or CIC in RMP terms) of 12,710 for generating management advice. A new abundance estimate from the Icelandic coastal aerial survey conducted in 2016 will be finalised in 2017. Fully corrected abundance estimates of 4,204 whales in West Greenland and 2,681 whales in East Greenland from the NASS2015 survey were also accepted.

The combined results from the 2014-16 data in the present Norwegian survey cycle indicate large shifts in distribution. Preliminary estimates of common minke whale abundance show a considerable decrease in the Svalbard area (2014), a relative stable situation in the Norwegian Sea (2015) and a considerable increase in the Jan Mayen area (2015 and 2016).

4.13.1.6 BLUE WHALES

There were some blue whale sightings during the NASS2015, mostly on the East Greenland shelf break. It is unlikely that an abundance estimate will be developed. There was one sighting in East Greenland and none in West Greenland.

Biopsies are being collected from whales around Svalbard for diet (fatty acids and stable isotopes), ecotoxicology studies and genetics. Also, whales are tagged to look at migration movements. Photos are being collected around Svalbard and Iceland, for a photo-identification study in the North Atlantic.

4.13.1.7 PILOT WHALES

Abundance estimates for pilot whales from the Greenland NASSS2015 surveys of 11,993# in West Greenland, and 338 in East Greenland, were accepted by the SC. The SC concluded that this survey was not designed to provide a complete coverage of the stock area in Baffin Bay and that the abundance estimates from West Greenland must therefore be considered a minimum estimate. Work on the estimate from the Iceland/Faroe Islands parts of NASS2015 shipboard survey is still in progress.

4.13.1.8 HARBOUR PORPOISES

An increased research effort on harbour porpoises in Norway is being driven by the concerns regarding bycatch. The Norwegian coast from 62°N to Lofoten was covered by aerial surveys as part of the SCANS-III survey in 2016, and abundance estimates are expected in spring 2017.

Over 1,300 Icelandic harbour porpoises have been genotyped at 11 microsatellite loci.

Porpoises tagged with satellite transmitters in central West Greenland in July-October made large scale movements in the North Atlantic, after leaving the Greenland shelf area.

[5]*http://www.iucn-csg.org*.

It is believed that they feed on mesopelagic fish species at depths between 100 and 300m. The return to the coastal areas took place in June and most porpoises showed site fidelity to the tagging area, except for two animals, that chose East Greenland as their summering ground the year after they were tagged.

Abundance estimates were developed for harbour porpoises from the 2015 Greenland aerial surveys. The SC accepted the estimates of 83,321 harbour porpoises in West Greenland and 1,642 harbour porpoises in East Greenland. This is an increase in West Greenland from the 2007 estimate.

4.13.1.9 NASS2015

NAMMCOs whale sighting surveys in the Northeast Atlantic in 2015 (NASS2015) included an intensive survey with the purpose of estimating the abundance of pilot whales around the Faroe Isles, an aerial survey of the coastal waters in East Greenland and a ship-based survey around Jan Mayen following methods developed for the Norwegian minke whale surveys. The SC remarked that NASS2015 was successful. Norway and Iceland will likely continue to aim at surveying every six years. This would set the timing of a next NASS survey in about 2021. Cooperation with Canada and USA would be desirable for a future NASS.

The Committee thanked Haug for his report and **agrees** that he should represent the Committee as an observer at the next NAMMCO Scientific Committee meeting.

4.13.2 Council

The report of the IWC observer at the 25th Annual Council meeting of NAMMCO held in Nuuk, Greenland, 5-6 April 2017 is given as SC/67a/02C. The following relevant items were discussed.

(1) *Outreach strategies*. The new website contains information on the conservation and management status of all marine mammal population, as well as matters related to marine mammals in a broader sense.
(2) *A performance review* of the organisation by external experts will be carried out in 2017-18. IWC and NAFO have both been asked and accepted to nominate one expert to the panel.
(3) *Inspection and Observation*. The observer scheme monitors whether national legislation and advice given by the Commission are respected. In 2016, two observers were onboard two Norwegian minke whalers and no infraction was reported. The scope for 2017 is minke whaling in Iceland.
(4) *Surveys*. At NAMMCO-25, new abundance estimates based on the data collected during NAMMCO surveys were presented for fin, humpback, common minke and pilot whales, harbour porpoises, and dolphins.
(5) *Quota advice*. New quota advice was given for fin whales and minke whales off Iceland.
(6) *Scientific Advice*. During 2017 topics to be dealt with include: (a) stock assessments of fin, humpback and common minke whales, as well as narwhals and white whales; (b) a global circumpolar review of the conservation status of white whale and narwhal stocks; (c) review of bycatch of marine mammals by NAMMCO countries; and (d) a workshop to gain a wider perspective on cetacean distribution and abundance in the whole North Atlantic. The Scientific Committee was also tasked to advise on the best process to investigate the effects of non-hunting related anthropogenic impacts on marine mammals.

The parties of NAMMCO agreed on the 'Nuuk Declaration' reaffirming their will in ensuring the sustainable and responsible use of marine mammals.

The Committee thanked Moronuki for his report and **agrees** that he should represent the Committee at the next NAMMCO Council.

4.14 North Pacific Marine Science Organisation (PICES)

The report of the IWC observer at the annual meeting of PICES held in San Diego, USA, 2-13 November 2016 is given as SC/67a/02I.

In 2016, the marine birds and mammals section (S-MBM) focussed on 'the consumption of North Pacific forage species by marine birds and mammals'. It synthesised new dietary information and estimated food consumption using a new generation of bioenergetic models. These efforts were useful for understanding: (1) top-down pressures on fish communities and fisheries; (2) spatial shifts in lower trophic levels and, in turn, top predators; and (3) climate effects on top predators. A 5-year plan has been developed and has been separated into two phases. The first phase will focus on top-down effects (2016-17), second phase on bottom-up effects (2018-19). The following items will be covered:

(1) influence of climate variability and change on trophic linkages and MBM distribution and abundance;
(2) synthesis of diets and estimate consumption by MBMs (and perhaps other top predators) for use in ecosystem models;
(3) synthesis of information on prey quantity, quality, composition and distribution to understand and predict impacts from climate variability and change on MBMs; and
(4) activity plan in 2017 for S-MBM.

The 2017 annual meeting of the PICES will be held at Vladivostok, Russia from 20 September-1 October. The Section-MBM meeting will be held on 22 September 2017.

The Committee thanked Tamura for attending on its behalf and **agrees** that he should represent the Committee as an observer at the next PICES meeting.

4.15 Protocol on Specially Protected Areas and Wildlife (SPAW) of the Cartagena Convention for the Wider Caribbean

The report of the observer documenting the activities of SPAW is given as SC/67a/02F.

Neither the Secretariat nor the Scientific Committee's observer were able to attend any SPAW meetings over the past year. However the IWC Secretariat is continuing to work on a draft MOU with CEP-SPAW and future capacity building is planned for the region.

The Committee thanked Mattila for his report. A new observer will be identified during the intersessional period.

4.16 Pacific Region Environment Programme (SPREP)

The report of the observer documenting the activities of SPREP is given as SC/67a/02D. After IWC/66, the IWC Secretariat continued to be actively engaged with the SPREP Secretariat. In particular, after the 'Year of the Whale' had been officially endorsed by SPREP's members, work focused on cooperative activities in support of that initiative. This included providing technical expertise and representation at the IUCN workshop on identifying Important Marine Mammal Areas (IMMAs) in the SPREP Region (March, Apia Samoa), and representation at the 'Whales in a Changing World' conference (April, Nuku'alofa, Tonga). Two presentations were given: one about the IWC focusing on its Science and Conservation work; and the other about the impacts of entanglement and bycatch, and the IWC's initiatives to mitigate these impacts. As a result, several Pacific Island Countries expressed interest in the IWC's capacity building with regard to entanglement. While the IWC was not able to send a representative to last year's annual meeting of SPREP's members, it is anticipated that the Secretariat will be able to attend this year's meeting (September 2017) in Apia, Samoa. An entanglement response training for Samoa may be held in conjunction with the SPREP annual meeting.

The Committee **agrees** that Nelson should be requested to represent the Committee at future SPREP activities.

5. GENERAL ASSESSMENT ISSUES WITH A FOCUS ON THOSE RELATED TO THE REVISED MANAGEMENT PROCEDURE

There are several common assessment topics that apply to the Scientific Committee work as whole, not only to the Revised Management Procedure (RMP). This item includes, but is not restricted to, assessment issues generated from the RMP discussions. It includes issues such as: (1) the relationship between $MSYR_{mat}$ and $MSYR_{1+}$; (2) text for the 'requirements and guidelines for conducting surveys' e.g. wrt model based abundance estimates; (3) implications of RMP and AWMP simulation trials for consideration of 'status'; and (4) matters of relevance to special permits that involve RMP considerations including effects of catches upon stocks.

5.1 Evaluate the energetics based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$

MSYR is a key parameter in the *Implementation Simulation Trials* used to evaluate the conservation and catch performance of alternative RMP variants for specific species and Regions. The Committee has previously adopted a pragmatic and precautionary lower bound for $MSYR_{1+}$=1% for use in trials. However, much remains to be learnt regarding MSYR. One issue is the relationship between $MSYR_{1+}$ and $MSYR_{mat}$. The Committee has been reviewing progress on using an individual based energetics model (IBEM) to provide insights into this relationship. SC/67a/RMP02 illustrated some improvements in the parameterisation of the IBEM for humpback whales and summarised initial work developing a simpler model that can emulate the IBEM. Such an emulator model may form the basis for future *Implementation Simulation Trials* once it is fully developed, and allow the Committee to replace the current deterministic model used as the basis for the operating models used in *Implementation Simulation Trials* by a stochastic model. The current emulator model is based on a stage-structured population dynamics model so would be unable to use age data for conditioning, which will limit its use in trials.

Attention: SC

The Committee ***recommends*** *that the author of SC/67a/RMP02 continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model; compare the yield curves from the IEBM with those from the emulator model; and develop guidelines for how to use an emulator model as the basis for a multi-stock, multi-area population dynamics model and how such a model could be conditioned given available data.*

5.2 Implications of *IST*s for consideration of 'status'

This matter is considered under Item 12.3.

5.3 General consideration of how to evaluate the effect of special permit catches on stocks

Evaluation of the effects of catches on stocks should be based on the best available information regarding the status and productivity of the stock or stocks in the area in which scientific permit catches are to occur. Conducting projections to evaluate the effects of catches will rely on a well-specified sampling plan that includes details on where within the study area and when catches are expected to occur. Should this information be uncertain, it will be necessary to consider sensitivity to alternative plausible outcomes of the sampling plan.

Where possible, evaluation of scientific permit catches should be based on existing models and methods developed by the Committee. The Committee developed guidelines (Annex D, Appendix 2) for three situations:

(1) where either an AWMP or RMP *Implementation* has been completed for the species/region concerned;
(2) where an in-depth assessment has been completed; and
(3) other cases (i.e. where neither (1) nor (2) apply).

The Committee notes that in all cases, projections should be conducted that consider a set of scenarios that aim to cover the core uncertainties for the region and species (although, not at the level of detail one would expect for an RMP/AWMP *Implementation*). In some cases, the amount of modelling work could be minimal if it is clear that the effects of the catches will be minimal.

Attention: SC

The Committee ***recommends*** *that the guidelines provided in Annex D, Appendix 2 are followed when reporting (or reviewing evaluations of) the effects of special permit catches on stocks.*

5.4 Work plan

Details of work to be undertaken both before and during the 2018 Annual Meeting are given in Table 2. Intersessional groups are provided in Annex W.

6. RMP – *IMPLEMENTATION*-RELATED MATTERS

This agenda item includes: (1) ongoing *Implementation Reviews*; and (2) preparation of new *Implementation Reviews*. For discussions related to the stock structure and abundance of these stocks see also Items 10 and 11.

6.1 North Atlantic common minke whales

6.1.1 Report of the intersessional Workshop

The *Implementation Review* process for North Atlantic common minke whales began with a joint AWMP/RMP Workshop in 2014, followed by a pre-meeting in 2014, intersessional Workshops in 2015 and 2016, and discussions at the 2016 and 2017 Annual Meetings (IWC, 2016e; 2017b). Last year, the Committee concluded that although it was unable to complete the *Implementation Review*, it could do so if an intersessional Workshop was held.

Donovan reported on outcomes of the third RMP intersessional Workshop on the *Implementation Review* for North Atlantic common minke whales held 16-18 December 2016 in Copenhagen, Denmark (SC/67a/Rep05), which aimed to finalise the trial specifications, confirm the trials to be conducted and their plausibility rankings, agree those

Table 2

Work plan for general assessment matters with a focus on the RMP.

Item	Intersessional period	During SC/67b
Conduct work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$.	(a) Parameterise the individual-based model for 'minke-like' whales (de la Mare); (b) further develop emulator models (de la Mare); and (c) conduct simulations of the *CLA* for the energetics-based model (de la Mare).	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$.
Implications of *IST*s, for consideration of status.	(a) Update the Guidelines for *Implementations* and *Implementation Reviews* to reflect decisions on evaluation status of stocks (Donovan); and (b) modify the control programs used for *Implementation Simulation Trials* to report the three measures of status (Allison).	Review proposed guidelines.
Improvements in management performance (in relation to RMP and SCAA) by improved precision in biological parameters.	Develop documents on guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits.	Review any proposals on guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits.

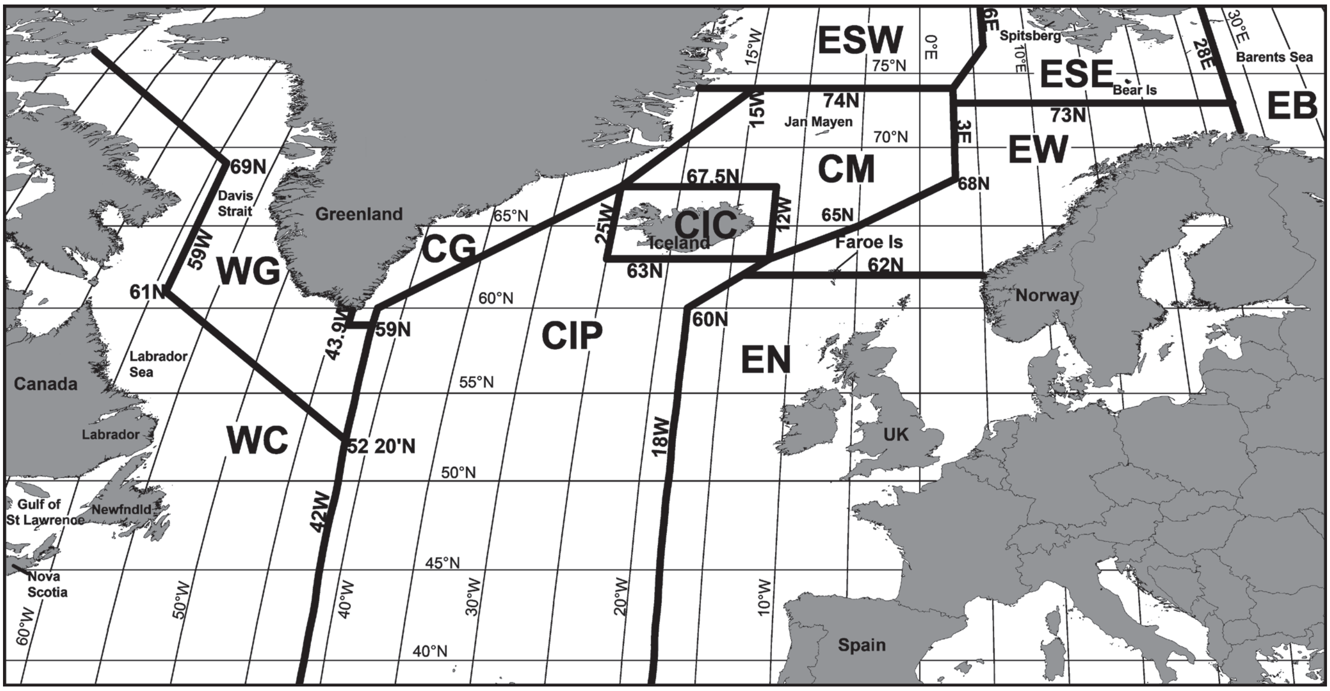

Fig.1. Sub-areas used in the *Implementation Review* for the North Atlantic common minke whales

trials that needed reconditioning, and identify a workplan for the completion of the *Implementation Review*. The final trial specifications reflect the outcomes of the extensive deliberations during the Workshop. These trials consider four stock structure hypotheses covering the range a single stock to a hypothesis in which there are three stocks, two of which consist of two sub-stocks each. Figs 1 and 2 show the sub-areas and stock hypotheses referred to in the text.

Attention: SC
The Committee ***endorses*** *the report of the Workshop on the* Implementation Review *of North Atlantic common minke whales (SC/67a/Rep05),* ***thanks*** *Donovan for chairing it and the participants for their work during it and subsequently.*

6.1.2 Completion of Implementation Review

6.1.2.1 FINALISE TRIAL SPECIFICATIONS AND CONDITIONING

The Committee received a summary of the modifications to the trials since the last meeting (Annex D, item 3.1.2.1.2).

The Committee reviewed the results of the final conditioning using tabular and graphical summaries developed for previous *Implementatio*n and *Implementation Reviews* (Annex D, table 3). The Committee noted that two of the trials (NM09-1 and NM09-4) led to unrealistic outcomes for one of the sub-stocks (E-2). This sub-stock is found in sub-areas CM, EN and EW (Fig. 1). Unlike the C stock and the E-1 sub-stock, there is no sub-area in which only the E-2 sub-stock is found. Thus, there are no data that directly inform on the minimum value for the unexploited abundance of the E-2 sub-stock. To address this, the trials based on stock hypotheses I and II (Fig. 2) arbitrarily specify that 50% of the whales in the EN sub-area at equilibrium are from the E-2 sub-stock, with the entries in the mixing matrices for females in the E-2 sub-stock being pre-specified. However, results of the conditioning show the size of the E-2 sub-stock to be much smaller than those of the nearby E-1 sub-stock. In addition, there is no stochastic mixing prior to the start of the projection period. The results of projections of the size of the E-2 sub-stock will be impacted by stochastic mixing. For years in which few C and E-1 whales are in sub-area EN, the exploitation rate on the E-2 sub-stock will be high, which is exacerbated for trial NM09-1. The operating model assumes that the allocated catch limits are taken exactly, irrespective of how few whales there are in the EN sub-area. This is unreasonable.

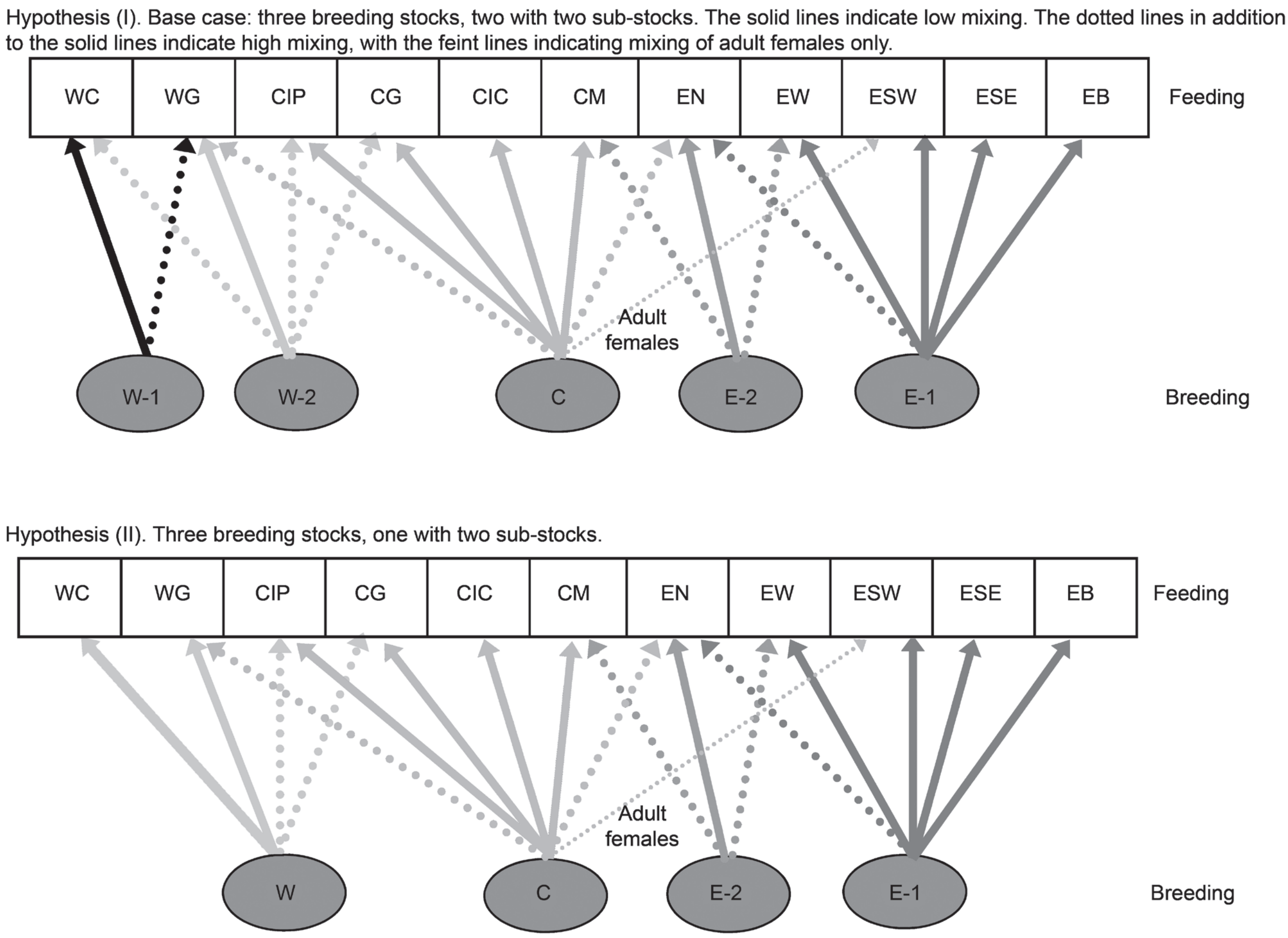

Fig. 2. Stock structure hypotheses for common minke whales in the North Atlantic referred to in the text

Table 3

The *Implementation Simulation Trials* for North Atlantic minke whales.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Trial weight	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	M	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	H	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	M	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	H	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	M	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	M	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	M	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	M	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	2002-07	M	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	2002-07	M	Alternative years to adjust selectivity-at-age
NM10-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM10-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM12-1	I	1%[1]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM12-4	I	4%[2]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM13-1	II	1%[1]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM13-4	II	4%[2]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM01-1v	I	1%[1]	3	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM01-4v	I	4%[2]	3	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM02-1v	II	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM02-4v	II	4%[2]	2	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM03-1v	III	1%[1]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM03-4v	III	4%[2]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-1v	IV	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-4v	IV	4%[2]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value

[1]1+; [2]mature.

The Committee noted that evidence for sub-stocks within the E stock was weak and that the support for retaining the EN sub-stock as a possibility was because of some differences in chemical concentrations in blubber (IWC, 2015c). Given the unexpected results in terms of unexploited size of the EN sub-stock and the weak evidence for existence of this sub-stock, the Committee assigned trials NM09-1 and NM09-4 low plausibility.

Attention: SC
The Committee ***endorses*** *these changes to the trials specifications for the North Atlantic common minke whale* Implementation Review *(see Annex D, Appendix 6 for the final trial specifications) and Annex W2 for the list of trials. The Committee* ***agrees*** *that the remaining trials have been satisfactorily conditioned.*

6.1.2.2 REVIEW TRIAL RESULTS

The four-step procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance first agreed by the Committee (IWC, 2008a, p. 6) and encapsulated in the most recent version of the Committee's Requirements and Guidelines (IWC, 2012c) is detailed in Annex D, item 3.1.2.2 together with a flow chart summarising the decision process to be followed (Annex D, fig. 4).

The Committee reviewed the results of the *Implementation Simulation Trials* following the 'Requirements and Guidelines' as had been the case during recent *Implementations* and *Implementation Reviews*. The tables and plots used to evaluate the performance statistics for each trial and RMP variant are detailed in Annex D, item 3.1.2.2.

The master set of plots and tables is archived by the Secretariat and is available to members of the Committee on request. The five management variants to be considered are listed in Annex D, item 3.1.2.3. The catch limits for minke whales by Norway are based on the 0.62 tuning of *CLA* and an RMP variant in which sub-areas EN, ESW+ESE, EB, and EW are treated as *Small Areas* with catch cascading based on the E *Combination Area*. Table 5 in Annex D summarises the application of the rules for evaluating conservation performance.

Attention: SC
After reviewing the results of the Implementation Simulation Trials *(Annex D, item 3.1.2.2), the Committee* ***agrees*** *that variants 1,3,4 and 5 are acceptable in terms of conservation performance for North Atlantic common minke whales (see Fig. 1 for the sub-areas):*

(1) *Sub-areas CIC, CM, CG, CIP, EN, EB, ESW+ESE and EW are* Small Areas, *with the catch limits for these* Small Areas *based on catch cascading from the C and E* Combination Areas. *The catch from the ESW+ESE* Small Area *is all taken in sub-area ESE. The catch limits set for the CM, CG and CIP* Small Areas *are not taken (except that the aboriginal catch is taken from CG);*
(2) *Sub-areas CIC, CM, CG, CIP, EN, ESW+ESE, and EB+EW are Small Areas, with the catch limits for these* Small Areas *based on catch cascading from the C and E* Combination Areas. *The catch from the EB+ EW* Small Area *is all taken in sub-area EW and the catch from the ESW+ESE* Small Area *is taken in the ESE sub-area. The catch limits set for the CM, CG and CIP* Small Areas *are not taken (except that the aboriginal catch is taken from CG);*
(3) *As for variant 1, except that sub-areas CIC+CIP+CM are a single* Small Area *and all of the catches from this* Small Area *are taken in sub-area CIC. The catch limits set for the CG* Small Area *are not taken (except that the aboriginal catch is taken); and*
(4) *Sub-areas CIP+CIC+CG+CM, EN, EB, ESW+ESE and EW are* Small Areas, *with the catch limits for the E* Small Areas *based on catch cascading from the E* Combination Area. *All the catches from CIP+CIC+CG+CM* Small Area *are taken in sub-area CIC (after taking the Aboriginal catch from CG) and those for the ESW+ESE* Small Area *are taken in sub-area ESE.*

Of these, variant 5 has the best catch performance.

6.1.3 Conclusions and recommendations

The Committee is pleased to have completed the *Implementation Review* of North Atlantic common minke whales. The next review will be expected to occur around 2022.

Attention SC, C-A
The Committee has completed the Implementation Review *of North Atlantic common minke whales. Based on the results of the* Implementation Simulation Trials, *the Committee agrees that variants 1, 3, 4 and 5 (see Item 6.1.2) are acceptable in terms of conservation performance. Of those, variant 5 achieves the best performance in terms of catch.*

6.2 North Pacific common minke whales

6.2.1 Review of new information

The Committee was informed that a minor error had been detected in the code implementing the *Implementation Simulation Trials* for the western North Pacific minke whales. The error has been corrected, with no substantial changes to the conclusions from the *Implementation Review* that was completed in 2013 (IWC, 2014b). The Committee was also informed (see Annex I and Item 19) that the results of kinship analyses are inconsistent with the mixing matrices associated with stock structure hypothesis C as currently implemented in the *Implementation Simulation Trials*. The implications of this will need to be accounted for during the next *Implementation Review*.

6.2.2 Prepare for the next Implementation Review

The *Implementation* for the western North Pacific minke whales was the most complex and challenging, owing in particular to lack of data from some areas to help address stock structure uncertainty. The Committee noted that considerable new information (especially genetics data) has been collected since the last *Implementation Review* in 2013. The Committee recognised that the most difficult aspect of the last *Implementation Review* had been selecting, modelling and assigning plausibility to stock structure hypotheses. Despite considerable new data and analyses, it was likely that resolving how to handle stock structure uncertainty in the next *Implementation Review* will again be challenging.

Attention: SC, C-A
Much progress on complex topics such as addressing stock structure uncertainty can be accomplished during focused workshops. The Committee therefore ***recommends*** *that a preparatory Workshop be held prior to SC/67b focused on stock structure for western North Pacific minke whales. For practical and cost reasons, this meeting can be held immediately before or after the Second Intersessional Workshop for the western North Pacific Bryde's whales (see Item 6.3).*

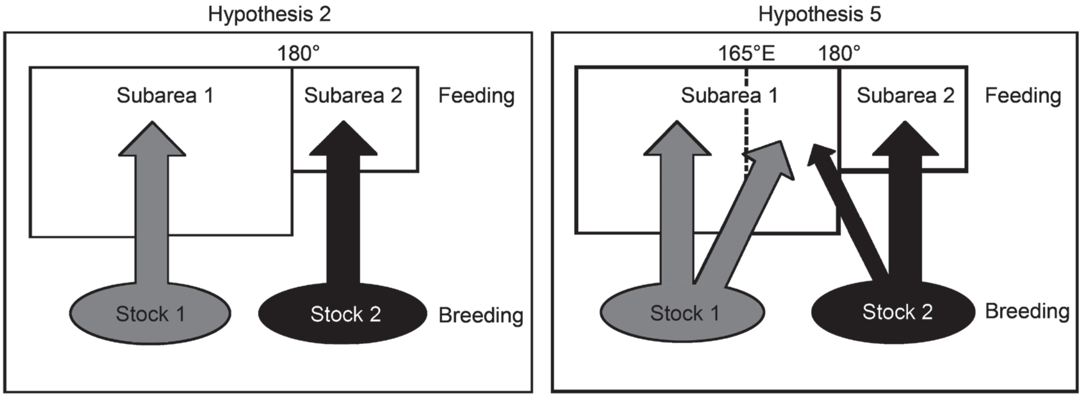

Fig.3. The two hypotheses that will be considered in the *Implementation Simulation Trials.*

6.3 Western North Pacific Bryde's whales

6.3.1 Report of the intersessional Workshop

Regular *Implementation Reviews* are required under the RMP. The first *Implementation Review* for the western North Pacific Bryde's whales was originally scheduled for 2013. However, in 2012, the Committee postponed the *Implementation Review* until 2016 to allow additional sightings and genetics data to be available and analysed (IWC, 2013b). The Committee has agreed that this will be a full *Implementation Review.* The first intersessional Workshop on the *Implementation Review* of western North Pacific Bryde's whales took place in March 2017, chaired by Donovan (SC/67a/Rep07).

The Workshop made considerable progress. It reviewed the new information relevant to stock structure and agreed to take forward two stock structure hypotheses (Fig. 3):

(a) *Hypothesis 2*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2.
(b) *Hypothesis 5*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2 with mixing occurring in sub-area 1E. There are more animals from stock 1 than stock 2 in the mixing area.

The Workshop also reviewed new information on abundance estimates and developed a workplan to try to obtain agreed abundance estimates (including additional variance) for use in conditioning the trials and the *CLA*, developed a new set of simulation trials for the *Implementation Review* that involve exploring the implications of uncertainty in stock structure, stock boundaries, MSYR, removals and additional variance, and identified a way to try to complete the *Implementation Review* at the 2017 Annual Meeting..

The Committee was pleased to note that the intersessional Workshop led to considerable progress towards completing the *Implementation Review* and had been conducted in an excellent spirit of co-operation among the participants.

Attention: SC

The Committee ***endorses*** *the report of the Workshop on the* Implementation Review *of western North Pacific Bryde's whales (SC/67a/Rep05),* ***thanks*** *Donovan for chairing it and the participants for their work during it and subsequently (and see Item 6.3.2 with respect to updated trials).*

6.3.2 Progress since the intersessional Workshop

Work had begun on updating the previous *Implementation Simulation Trials* for the North Pacific Bryde's whales to include the new hypotheses and trials, as well as estimated additional variance. However, no conditioning results are available at present. It will be necessary to update the trials to include density-dependence in *M* as agreed last year (IWC, 2017b). In addition, the future survey plan needs to be clarified. The updated trial specifications are available in Annex D, Appendix 6.

6.3.3 Conclusions and recommendations

Attention: SC

The Implementation Review *for western North Pacific Bryde's whales is progressing well, but the ambitious workplan established at the March 2017 Workshop could not be achieved in the limited time available. The Committee therefore recommends that an intersessional workshop takes place to facilitate completing the* Implementation Review.

6.4 Review RMP *Implementation Review* schedule for the next six years

There is a system of regular (5-6 year) *Implementation Reviews* with established guidelines. The current schedule of *Implementation Reviews* (which may need to be adjusted if the *Implementation Reviews* that are scheduled first take longer than anticipated) is as follows.

(1) Western North Pacific Bryde's whales: Started in 2017 (expected to be completed in 2018).
(2) Western North Pacific common minke whales: Starting in 2018.
(3) North Atlantic common minke whales: Starting in 2022.
(4) North Atlantic fin whales: Starting in 2023.

It is not feasible to simultaneously conduct more than one *Implementation* or *Implementation Review*; discussion of the personnel and resources required to allow the *Implementation Review* process to continue is provided under Item 26. The Committee is starting the *Implementation Review* for the western North Pacific common minke whales with a preparatory meeting before SC/67b. The focus of the Committee at the 2018 Annual Meeting will be completing the *Implementation Review* for the western North Pacific Bryde's whales, reviewing the conclusions of the preparatory meeting, and planning for the First Intersessional Meeting for the western North Pacific common minke whales.

6.5 Work plan

Details of work to be undertaken both before and during the 2018 Annual Meeting are given in Annex D, item 3.6 and summarised in Table 4.

7. ABORIGINAL SUBSISTENCE WHALING MANAGEMENT PROCEDURE

This item continues to be discussed as a result of Resolution 1994-4 of the Commission (IWC, 1995), which has been

Table 4

Work plan for RMP *Implementation*-related matters.

Item	During the intersessional period	During SC/67b
North Atlantic minke whales	-	Review any new abundance estimates, with ASI.
Western North Pacific minke whales	Conduct a preparatory meeting focused on synthesising information on stock structure.	Initiate the *Implementation Review.*
Western North Pacific Bryde's whales	(a) Conduct the Second Intersessional Workshop. (b) Code the resulting trials, condition the trials, and conduct projections under proposed RMP variants.	Conduct the work required for the 'Second Annual Meeting' and complete the *Implementation Review.*
North Atlantic fin whales		Review any new abundance estimates, with ASI.

strengthened by Resolution 2014-1 (IWC, 2016a). The report of the Standing Working Group (SWG) on the development of an aboriginal whaling management procedure (AWMP) is given as Annex E. The Committee's deliberations, as reported below, are largely a summary of that Annex, and the interested reader is referred to it for a more detailed discussion. The primary issues at this year's meeting comprised: (1) developing *SLA*s (*Strike Limit Algorithms*) and providing management advice for Greenlandic hunts, with a focus on fin and common minke whales; (2) providing management advice for aboriginal hunts (see Item 8); and (3) additional work related to the AWS (Aboriginal Subsistence Whaling Management Scheme). Considerable progress on items (1) and (3) was made because of the AWMP Intersessional Workshop on Developing *SLA*s for the Greenland hunts and the AWS, held from 17-22 December 2016 in Copenhagen, Denmark (SC/67a/Rep06) and use of the AWMP Developers' Fund.

7.1 *SLA* development for the Greenland hunts

At its 2018 meeting, the Commission will be setting new block quotas for aboriginal hunts. In Greenland, a multispecies hunt occurs; in West Greenland this involves catches of common minke, fin, humpback and bowhead whales. The Committee has reiterated its strong intention to complete and recommend *SLA*s for all Greenland hunts by the 2018 Scientific Committee meeting. The Commission had endorsed the *Humpback SLA* in 2014 (IWC, 2015d) and the *WG-Bowhead SLA* in 2016 (IWC, 2017b). Progress on fin and common minke whales is provided below. The Working Group on ASI (Annex Q) had reviewed the new Greenland abundance estimates referred to it by the AWMP intersessional Workshop (SC/67a/Rep06) and had endorsed the estimates that had been provided in table 1 of that report for use in the *SLA* development process and implementation.

The Committee has recognised that in a multi-species hunt such as that in Greenland, hunters would like to have some flexibility across species in terms of meeting the overall need expressed as edible products. It has agreed that the inclusion of such flexibility across a series of interlinked *SLAs* is complex (e.g. IWC, 2011a). The Committee has therefore agreed that this aspect only be considered after single species *SLA*s have been developed and adopted (IWC, 2012a, p.16).

7.1.1 Development of an SLA for the Greenlandic fin whale hunt

In 2015 (IWC, 2016d), the Committee agreed that from a conservation perspective, it was acceptable to try to develop an *SLA* for this hunt on the assumption that the animals off West Greenland comprised a single population represented by the abundance estimates from that area. In doing so, the Committee recognised that this will make achieving need satisfaction more difficult.

7.1.1.1 NEW INFORMATION (INCLUDING THE REPORT OF THE INTERSESSIONAL WORKSHOP)

The AWMP intersessional Workshop (SC/67a/Rep06) held in December 2016 noted that the point estimate of a comparable 2015 survey estimate of fin whales off West Greenland was only one tenth the size of the previous one (465 in 2015 compared to 4,470 in 2007). The difference between these estimates is certainly too large to attribute to hunting, and furthermore there was no evidence to suggest a real decline in abundance. Consequently, the Workshop examined the possibility that in some years only part of this population is present off West Greenland. It therefore agreed to model these abundance estimates by means of a two-component process whereby each year either all whales in the population entered the West Greenland region, or only a proportion of those whales (where the proportion was drawn randomly from a probability distribution). The Workshop had agreed that this issue must be reflected in the way future survey estimates for this region are generated when testing *SLA*s and that the trials incorporate conservative and realistic testing scenarios.

The Committee **thanked** the Intersessional Workshop for the good progress made, noting that without such workshops it will not be possible to develop *SLA*s by 2018.

After a review of the conditioning results, the Committee adopted the conditioned trials except for two trials (GF24-2 and GF24-4, see Annex E) that were excluded because the abundance data were not adequately fitted by the model. Table 5 shows the agreed final trial structure.

SC/67a/AWMP06 and SC/67a/AWMP12 describe candidate *SLAs* for the West Greenland fin whale hunt. The performance of the candidate *SLA*s ranged from fully meeting the conservation performance criterion for all *Evaluation Trials* with $MSYR_{1+}$ of 1% and medium and high need envelopes, to alternatives with poorer conservation performance but improved need satisfaction. They cope with sporadic low abundance estimates by ignoring them, at least for a certain period. This new approach must be carefully tested. The Committee noted that there was a balance to be struck between designing new trials to test the conservation risk associated with an *SLA* eliminating low abundance estimates, and allowing *SLA*s to treat the data in any manner (i.e. acceptability is determined by *SLA* performance in realistic trials, regardless of design features).

Although some *Evaluation Trial*s should specifically test the effect of disregarding outlying abundance estimates, the Committee noted that the *Robustness Trials* were well suited for more speculative exploration of performance of such *SLA*s. This issue will be considered further at the first of the proposed Intersessional Workshops (see Item 25).

7.1.1.2 CONCLUSIONS AND RECOMMENDATIONS

There is still considerable additional work required before final selection of an *SLA* for West Greenland fin whales. Tasks include: (a) developing new trials exploring

Table 5a

The *Evaluation Trials* for fin whales. Values given in **bold type** show differences from the base case values.
For all trials, the probability *p* that all animals are off West Greenland when a survey takes place=0.5; if some whales are not off West Greenland, the proportion off West Greenland is generated from a beta distribution with parameters (3,7).

Trial	Description	$MSYR_{1+}$	Need scenarios	Survey frequency	Historical survey bias	No of replicates	Future survey CV
01-4	$MSYR_{1+}$ = 4%	4%	A, B, C	10	1	400	0.40
01-2	$MSYR_{1+}$ = 2.5%	2.5%	A, B, C	10	1	400	0.40
01-1	$MSYR_{1+}$ = 1%	1%	A, B, C	10	1	400	0.40
01-7	$MSYR_{1+}$ = 7%	7%	A, B, C	10	1	400	0.40
02-4	5 year surveys	4%	A, B	5	1	400	0.40
02-2	5 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	5	1	400	0.40
03-4	15 year surveys	4%	A, B	15	1	400	0.40
03-2	15 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	15	1	400	0.40
03-1	15 year surveys; $MSYR_{1+}$ =1%	1%	A, B, C	15	1	400	0.40
04-4	Survey bias = 0.8	4%	A, B	10	0.8	400	0.40
04-2	Survey bias = 0.8; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	0.8	400	0.40
05-4	Survey bias = 1.2	4%	A, B	10	1.2	400	0.40
05-2	Survey bias = 1.2; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	1.2	400	0.40
06-4	3 episodic events	4%	A, B	10	1	400	0.40
06-2	3 episodic events; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	10	1	400	0.40
06-1	3 episodic events; $MSYR_{1+}$ =1%	1%	A, B, C	10	1	400	0.40
07-4	Stochastic events every 5 years	4%	A, B	10	1	100	0.40
07-2	Stochastic events every 5 years	2.5%	A, B	10	1	100	0.40
08-4	Asymmetric environmental stochasticity	4%	A, B	10	1	100	0.40
08-2	Asymmetric environmental stochasticity	2.5%	A, B, C	10	1	100	0.40
08-1	Asymmetric environmental stochasticity	1%	A, B, C	10	1	100	0.40
09-2	$MSYR_{1+}$ = 2.5% with future survey CV 0.35	2.5%	A, B, C	10	1	400	0.35
10-2	$MSYR_{1+}$ = 2.5% with future survey CV 0.45	2.5%	A, B, C	10	1	400	0.45

Table 5b

The *Robustness Trials* for fin whales.

Trial no.	Factor	$MSYR_{1+}$	Need scenario	No of rep	Future survey CV
21-4	Linear decrease in *K* in future	4%	A, B	100	0.40
21-2	Linear decrease in *K* in future	2.5%	A, B	100	0.40
22-4	Linear increase in *M* in future	4%	A, B	100	0.40
22-2	Linear increase in *M* in future	2.5%	A, B	100	0.40
23-4	Strategic surveys	4%	A, B	100	0.40
23-2	Strategic surveys	2.5%	A, B	100	0.40
25-4	*p*=0.5; Proportion generated from beta (2,10)	4%	A, B	100	0.40
25-2	*p*=0.5; Proportion generated from beta (2,10)	2.5%	A, B	100	0.40
26-4	*p*=0.189 (Proportion generated from beta (3,7)	4%	A, B	100	0.40
26-2	*p*=0.189 (Proportion generated from beta (3,7))	2.5%	A, B	100	0.40
27-4	*p*=0.811 (Proportion generated from beta (3,7))	4%	A, B	100	0.40
27-2	*p*=0.811 (Proportion generated from beta (3,7))	2.5%	A, B	100	0.40
28-2	Baseline with future survey CV 0.2	2.5%	A, B	100	0.20
29-2	*p*=0.5; Proportion generated from beta (2,10)	2.5%	A, B	100	0.20

the implications of *SLAs* that disregard low abundance estimates; (b) updating conditioning; and (c) developing a format for tabular and graphical display of the behaviour of such *SLA*s that integrates aspects of the D1 and D10 statistics (that measure conservation performance), with the goal of better understanding when and how often the *SLA*s disregard abundance estimates, and the performance implications thereof.

Attention: SC, C-A, ASW
The Commission requires advice on new ASW quotas at the 2018 Scientific Committee meeting. This advice is best provided using long-term SLA*s. Considerable intersessional work is required to complete the* SLA *for the Greenland hunt of fin whales. The Committee* ***advises*** *the Commission that its intersessional workplan should allow it to recommend a West Greenland fin whale* SLA *at its 2018 Annual Meeting. To achieve that goal the Committee* ***recommends*** *that:*

(1) the tasks outlined in this report should be completed intersessionally under the auspices of the AWMP Steering Group prior to the AWMP Workshop in late October 2017 (see Item 25); and

(2) the Workshop should: (a) review the new trials exploring the implications of SLA*s that disregard low abundance estimates; and (b) review the final trial results and complete the selection of an* SLA *for West Greenland fin whales.*

7.1.2 Development of an SLA *for the common minke whale hunt off Greenland*
The development of an *SLA* for the common minke whale hunts off West and East Greenland is the most complex of those required for Greenland. It has been agreed that the basis of the development approach should be the RMP operating models for the entire North Atlantic. Stock structure issues were examined in 2014 by a joint AWMP/RMP Workshop (IWC, 2015b) that resulted in four stock structure hypotheses and a number of associated mixing matrices – see figs 2 and 3 in IWC (2015b). An initial RMP trial structure was developed in 2014 (IWC, 2015b).

7.1.2.1 NEW INFORMATION (INCLUDING THE REPORT OF THE INTERSESSIONAL WORKSHOP)
The AWMP Intersessional Workshop (SC/67a/Rep06) received the new 2015 abundance estimate for West Greenland minke

whales, and noted that one explanation for the large difference in the abundance estimates was movement of whales from the west (WG) to the east coast (CG) of Greenland. The Workshop recommended that the *Implementation Simulation Trials* for the North Atlantic common minke whales (Annex D, Appendix 6) be evaluated to show if they exhibited behaviour consistent with negative spatial correlation in abundance between West and East Greenland that might be associated with whale movement between regions.

The Committee reviewed the RMP *Implementation Simulation Trials* which were completed at this meeting (see Item 6.1 and Annex D) given the previous agreement to use the operating model framework as the starting point for the AWMP development process. Punt and Allison reported that the RMP *Implementation Simulation Trials* structure successfully introduced negative correlation in the simulated abundances between East and West Greenland.

Tiedemann reviewed stock structure inferences agreed upon during the AWMP/RMP Joint Workshop (IWC, 2015b) with special reference to Greenland (sub-areas WG and CG - see fig. 1 of Annex E). He outlined ongoing analyses of new samples and techniques not considered in the 2014 review and it was further suggested to add additional previously unanalysed specimens from Iceland (2016) and Greenland (2013-16) and to try to acquire further samples from Canada. With some support funding, validation of POPs and analysis of new samples can be accomplished in time for the October 2017 Workshop. Clarifying stock structure hypotheses is an essential component of the work needed to complete and test candidate *SLA*s.

SC/67a/AWMP05rev used an age- and sex-structured population model with density regulated growth to estimate source-sink-like migration of minke whales in West Greenland waters. The hunt of minke whales in West Greenland is relatively large compared with the estimates of absolute abundance for the area, but a constant female biased sex ratio in the catches indicates that the hunt is sustainable. This suggests that the hunt is also likely to be supported by whales from other areas. SC/67a/AWMP05rev shows that it is possible to estimate this influx of whales using an open population model and a likelihood function that includes both the abundance data from West Greenland and the reported catches by sex.

Two alternative approaches for modelling the effect in SC/67a/AWMP05rev were considered: (a) the proportion of the West Greenland sub-stock that feeds off West Greenland is density-dependent, i.e. the mixing matrices are density-dependent, and (b) there is density-dependent dispersal between the W-1 stock (in trials with two W stocks) and the W-2 sub-stock and between the C stock and the W-2 sub-stock.

7.1.2.2 CONCLUSIONS AND RECOMMENDATIONS

Development of an *SLA* for the Greenlandic hunt of common minke whales constitutes the largest remaining task of the Committee. Moreover, it is the most complex case that has been undertaken. Development of earlier *SLA*s have required up to five years. However, the Committee can build upon the operating models developed for the RMP *Implementation Review* and believes it should be able to develop an *SLA* for the common minke whale hunts off Greenland by next year's meeting with sufficient resources and two intersessional workshops. The first Workshop (autumn) will evaluate the trials structure, provisional conditioning, and identify any required modifications as well as consider candidate *SLA*s. Subsequently, necessary modifications to the trial structure will be coded and final conditioning undertaken. The second workshop (spring) will evaluate this work and examine initial performance results from candidate *SLA*s. Final evaluation of *SLA*s based on the full set of agreed trials will occur at the 2018 Scientific Committee meeting.

Attention: SC, C-A, ASW

The Commission requires advice on new ASW quotas at the 2018 Scientific Committee meeting. This advice is best provided using long-term SLA*s. Considerable intersessional work is required to complete the* SLA *for the Greenland hunt of common minke whales. The Committee* ***advises*** *the Commission that its intersessional workplan should allow it to recommend a common minke whale* SLA *at its 2018 Annual Meeting. To achieve that goal the Committee* ***recommends*** *that:*

(1) two intersessional Workshops are held in Copenhagen, one in autumn 2017 and one in spring 2018; and
(2) financial support is given for genetic analyses using additional samples.

7.1.3 West Greenland bowhead whales

The *WG-Bowhead SLA* had been tested on conservative scenarios because the catches from Canada are not subject to IWC management and it is not known whether future surveys in Canada will take place or how regularly. The AWMP Intersessional Workshop (SC/67a/Rep06) agreed that the effects if the number of replicates to be used in the development of an *SLA* should be examined for the *WG-Bowhead SLA Evaluation Trials*. SC/67a/AWMP04 reported on the results of this simulation exercise. Examination of the results shows that for one trial not even 1,000 replicates would be sufficient to provide sufficient precision for the estimated probability interval of the D10 statistic to include the threshold value of 1.

Attention: SC

Following the results of the simulation exercise in SC/67a/AWMP04, the Committee ***agrees****:*

(1) to set the number of replicates for Evaluation Trials *to 400 for the West Greenland bowhead whale case (the number of replicates for other development cases will be determined on a case-specific basis) since there is Monte Carlo error in the estimates of the performance statistics and recognising the diminishing returns in precision obtained as the number of replicates increase; and*
(2) that Allison and Brandão should rerun a selection of the trials with 400 replicates to verify the original trial conclusions and the results should be presented at the intersessional Workshop in autumn.

7.2 Aboriginal Whaling Management Scheme

The Scientific Committee initially recommended (and has subsequently repeated) the scientific aspects of an Aboriginal Whaling Scheme (AWS) in 2003, but this has still not been adopted by the Commission (IWC, 2003) and subsequent years)[6]. Since that time, the Committee has developed several additional *Strike Limit Algorithms*, established its Data Availability Agreement (IWC, 2004a, p.56; 2004b), considered further additional issues such as survey intervals, and developed greater experience with all aspects of the AWMP.

[6]The original ASW proposal was, in summary, for a grace period of one block during which the block strike limit was halved and the hunters could choose how to allocate the catches by year. If an abundance estimate was agreed during the grace period, the *SLA* would be used to calculate a new limit for the block.

AWS provisions are one of the last major remaining components of the comprehensive aboriginal subsistence whaling management framework first requested by the Commission in 1994 and developed with an enormous expenditure of scientific effort and resources over the last two decades. The Commission has agreed that the AWS is a key component of this framework. Accordingly, in consultation with the Commission and its ASW sub-committee, the Scientific Committee informed the Commission in 2015 (IWC, 2016e) that it intends to develop recommendations for all scientific components and aspects of an AWS. Ideally, this work will be completed well in advance of the 2018 Commission meeting when new aboriginal whaling limits are due to be established. Last year (IWC, 2017d), the Committee made considerable progress on this work and developed an outline ('Some ideas on draft principles and scientific provisions of a potential Aboriginal Whaling Scheme (AWS)'). The focus of discussions last year had related to the interim allowance strategy and carryover provisions.

7.2.1 The interim allowance strategy

The 'interim allowance' strategy deals with the situation where an abundance estimate is temporarily and unintentionally delayed more than 10 years from the previous survey (IWC, 2016e, p.22). It was first tested using the *Bowhead SLA* and found to be acceptable in that case (IWC, 2017b, p.22). Punt developed code for testing the interim allowance strategy for West Greenland bowhead, humpback and fin whales. SC/67a/AWMP01 presented the results of testing for the West Greenland humpback whale case.

Attention: SC; C-A; ASW; G

*The Committee **agrees** that:*

(1) *the interim allowance strategy is acceptable for the* WG Humpback SLA*;*
(2) *testing for West Greenland bowhead whales should occur intersessionally;*
(3) *testing for West Greenland fin and common whales should be undertaken once those* SLA*s have been developed; and*
(4) *testing the interim allowance strategy for the* SLA *for eastern north Pacific gray whales should occur during the next* Implementation Review.

7.2.2 Carryover provision

A review of the originally proposed (IWC, 2003) AWS provision for the carryover of unused strikes to provide the necessary flexibility for hunters to meet need when the hunts operate in unpredictable and difficult environmental conditions began two years ago. During the initial development of *Strike Limit Algorithms* and the AWS, the Commission had agreed (IWC, 2001, p.20):

> '…that blocks of five years with an inter-annual variation of fifty percent were satisfactory in terms of allowing for the likely variability in hunting conditions. It therefore agreed that these values are appropriate for use in trials. It was recognised that this does not commit the Commission to these values in any final aboriginal whaling management procedure.

At that time, the Committee also agreed that the same 50% allowance could be carried over between the last year of one block and the first year of the next. The rationale for this limitation has not changed: from a scientific perspective, *SLA*s are robust with respect to this carryover provision, particularly since all allocated strikes are considered as taken in the testing process. Considerable work on carryover provisions was undertaken at the 2016 Annual Meeting and this was reported to the Commission who were informed that the Committee hoped to be able to present a proposed carryover provision in 2018 as part of a revised AWS. It was noted that there is a lack of clarity and consistency in the way this issue is dealt with in the present *Schedule*.

This work continued at the intersessional Workshop held in December 2016 thanks to extensive work by Givens (2016). The Workshop developed two possible options (the 'block-based' and the 'annual expiration' option) and provided examples of how these might work. The Workshop agreed that whatever approach or approaches may be ultimately proposed to the Commission, it is important that they are presented as simply as possible to facilitate Commission discussion and adoption. Discussion at this meeting focussed on how best to provide advice to the Commission, taking into account the difficulties that had been experienced in previous Commission discussions of the use of carryover provisions when adopting catch/strike limit blocks.

Attention SC; C-A; ASW; G

The concept of carryover is an essential component of the Aboriginal Whaling Management Scheme. The Committee's role is to provide scientific advice on any carryover provisions that meet the conservation objectives of the Commission whilst providing adequate flexibility to the hunts. The Committee:

(1) ***reiterates** its previous agreement that that* SLA*s are robust with respect to a 50% inter-annual variability within blocks and to the same 50% allowance between the last year of one block and the first year of the next;*
(2) ***recognises** that are strengths and weakness in the options it is considering and **agrees** that these should continue to be considered and developed intersessionally;*
(3) ***recommends** that:*
    (a) *Donovan should raise the issue of carryover with the Commission's ASW-WG which will meet in the intersessional period, summarising the work the Committee has done so far and noting its willingness to review any options referred to it at the 2018 Scientific Committee meeting; and*
    (b) *members of the Committee who are from countries with subsistence hunts should also draw attention to the willingness of the Committee to review any options referred to it at the 2018 Scientific Committee meeting;*
(4) ***advises** that whatever approach is adopted, it is important to establish an initialisation year for the carryover calculations to begin; and*
(5) ***recognises** that choosing an initialisation year is a matter for the Commission but **agrees** that from a scientific perspective, it is acceptable to go back up to 3-4 blocks (unless there had been a quota reduction during the period)*[7].

7.2.3 The full AWS

The Committee did not have time to further review the other issues on the draft AWS developed last year (IWC, 2017c). This item will be included on the agenda of the intersessional Workshops. An intersessional correspondence group (see Annex W) was established to review the existing draft and provide a discussion document for the First Intersessional Workshop.

[7]To assist the Commission, Annex E, Appendix 4 summarises the situation with respect to carryover for each hunt for up to four blocks.

Table 6

AWMP *Implementation* and *Implementations Reviews.*

Hunt	Year *SLA* developed (*IR*s completed)	Next *Implementation Review*
Alaskan bowhead	2002 (2007, 2012)	Start 2018
Chukotka gray/Makah gray	2004 (2010)/2013	Start 2019
West Greenland humpback	2014	Start 2020
West Greenland bowhead	2015	Start 2021
West Greenland fin	2017/18 est.	2023 estimated
West Greenland/East Greenland common minke	2018	2024 estimated

Table 7

Proposed work plan (ICG=intersessional correspondence group, SG=Steering Group.

Topic	Intersessional	2018 Annual Meeting
(1) Development of Greenland *SLA*s	SG-AWMP, two Workshops (autumn, spring)	Complete and recommend
- Fin whales (review results)	Finalise at first Workshop	Recommend *SLA*
- Common minke whales (develop)	Both Workshops	Recommend *SLA*
- *WG-Bowhead SLA* trials (review results)	Finalise at first	Confirm *SLA*
(2) Aboriginal Whaling Scheme	ICG-AWS, short review of progress at Workshops	Recommend draft
- Interim allowance strategy	ICG-AWS	Complete
- Carryover provisions	Donovan to consult ASW-WG	Complete
- Remaining issues	ICG-AWS	Complete
(3) B-C-B bowhead *Implementation Review*	SG-BCB	Complete
(4) Review new Makah hunt proposal	Workshops if proposal submitted	Complete if possible
(5) Provide catch/strike limit advice	-	Recommend limits

7.3 Review *Implementation Review* schedule for next 6 years
The provisional timetable for *Implementation Reviews* given in Table 6.

The Committee noted that the next *Implementation Review* for B-C-B bowhead whales is scheduled to start in 2018. Guidelines for *Implementation Reviews* are provided in IWC (2013c). The primary objectives of an *Implementation Review* are to:

(1) review the available information (including biological data, abundance estimates and data relevant to stock structure issues) to ascertain whether the present situation is as expected (i.e. within the space tested during the development of the *SLA*) and determine whether new simulation trials are required to ensure that the *SLA* still meets the Commission's objectives; and
(2) to review information required for the *SLA*, i.e. catch data and, when available at the time of the Review, new abundance estimates (note that this can also occur outside an *Implementation Review* at an Annual Meeting).

Attention: SC, C-A, ASW
The Committee ***agrees*** *that at present, there is no information that suggests that the situation for the B-C-B bowhead whale stock is outside the tested parameter space. On this basis, it* ***agrees*** *that:*

(1) it should be possible to complete the Implementation Review *at the 2018 Annual Meeting;*
(2) the Steering Group (Annex W) established to prepare for the Review *should ensure that the appropriate Data Availability Guidelines are publicised and met; and*
(3) that the necessary information to complete the Review *is presented.*

7.4 Work plan
The AWMP work plan is summarised in Table 7. Budgetary items are considered under Item 25.3.

8. STOCKS SUBJECT TO ABORIGINAL SUBSISTENCE WHALING INCLUDING MANAGEMENT ADVICE

The Commission is considering the renewal of catch/strike limits for aboriginal subsistence whaling hunt at its 2018 meeting. The Committee has agreed that the best way to provide advice to the Commission on such hunts is through long-term *SLA*s. The first *SLA*s agreed were for the hunts for the B-C-B Seas stock of bowhead whales and the Chukotkan hunt of eastern gray whales (advice for the proposed Makah hunt was developed in 2013). An *Interim SLA* (IWC, 2009) was developed for the Greenland hunts (up until 2018) to allow the development of long-term *SLA*s for these hunts. The Committee endorsed the *Humpback SLA* in 2014 (IWC, 2015c), and the *WG-Bowhead SLA* in 2016 (IWC, 2017b) and expects to finalise *SLAs* for the remaining Greenland hunts at its next meeting (see Item 7).

The Committee notes that when providing management advice on subsistence whale hunts it provides advice in a specific way, i.e. it comments only on whether the need request or present limits can be safely met from the perspective of the Commission's conservation objectives. If it or they cannot be safely met, then the Committee provides advice on what strike limit is acceptable from a conservation perspective.

8.1 Eastern Canada/West Greenland bowhead whales
8.1.1 New information (including catch data)
The Committee welcomes the provision of detailed information from Canada on their bowhead hunt showing that two females were taken in 2016 with none struck and lost. Samples of liver, skin, blubber, and muscle were collected from both whales. The Canadian quota for the Eastern Canada-West Greenland bowhead whale population is 7 for 2017. No bowheads were taken off Greenland in 2016.

The Committee noted that the reported catch was within the parameter space that was tested for the *WG-Bowhead SLA* and that the *SLA* had been developed on the conservative assumption that the number of animals estimated off West Greenland represented the total abundance of animals in West Greenland-Eastern Canada.

Attention: SC, G, CG-A
Information from Canada is important for the provision of management advice for the Greenland hunt. Last year, the Committee received two draft abundance estimates for eastern Canada: a line transect abundance estimate for 2013 (Doniol-Valcroze et al.*, 2015) and a genetic mark-recapture of abundance for the period of 2008 to 2012 (Frasier* et al.*, 2015). The Committee:*

*(1) **recommends** that the authors of those papers are invited to the next Annual Meeting with a view to the Committee reviewing and endorsing the new abundance estimates; and*
*(2) **recommends** continuation of the Greenlandic large-scale biopsy sampling programme and encourages continued collaboration with Canada on genetic and other work related to stock structure and abundance.*

8.1.2 Management advice

Attention: C-A
*The Committee **reiterates** that the agreed WG-Bowhead SLA (IWC, 2016g) remains the appropriate tool to provide management advice for bowhead whales off West Greenland. Using this, together with the agreed 2012 estimate of abundance for West Greenland (1,274 CV=0.12), the Committee **advises** that an annual strike limit of 2 whales will not harm the stock.*

8.2 North Pacific gray whales

8.2.1 New information (including catch data)

New abundance estimates for the Pacific Coast Feeding Group, the eastern North Pacific, the Sakhalin Island feeding group, and the larger Sakhalin Island and Southern Kamchatka feeding group were available after being reviewed by the *Ad hoc* Working Group on Abundance Estimates, Stock Status and International Cruises (see Annex Q) and accepted by the Committee.

SC/67a/AWMP03 presented data on aboriginal subsistence whaling in Chukotka during 2016. Hunting was conducted at 15 local communities. A total of 120 gray whales, 54 males and 66 females, were landed in 2016 including one stinky (i.e. inedible) whale. No whales were struck and lost. The paper also presented information on length, weight, edible products as well as some discussion of need. Tissue sampling occurred for 60 whales.

SC/67a/AWMP011 summarised the catch from 2012-16, with a total of 640 gray whales landed, 165 of which were investigated by Russian scientists. Twelve 'stinky' whales with a strong medical smell and taste were landed during this time. No whales were observed in poor body condition. A total of 71 gray whale were photo-identified during surveys in the Mechigmensky Bay from 2013-16 and added to the Chukotka regional catalogue which is available online at: *https://yadi.sk/i/9qx1eUiNs6t6s*. A comparison of the Chukotka catalogue to those from Kamchatka and Sakhalin waters showed no positive matches.

Attention: SC, G, CG-A
*The Committee **welcomes** the information on Russian studies of gray whales and **recommends** the continued collection of photo-identification of live and harvested whales, and genetic samples and biological observations of harvested whales.*

At the 2016 Commission meeting, the Russian Federation expressed concern that the present catch limits were insufficient to meet subsistence needs due to the landing of inedible, stinky whales counting against the catch limit for gray whales. In response to the concern, the Commission instructed the Scientific Committee to examine two scenarios that bracket the likely range of stinky whales landed and struck and lost whales in future hunts (Morishita *et al.*, 2016):

(a) that from 2019, the number of killed animals in each year is increased by ten whales (to include both inedible and struck-and-lost whales); and
(b) that from 2019, the number of killed animals in each year is increased by 6% of the landed (this includes both inedible and struck-and-lost).

The examination was undertaken using the existing *Gray Whale SLA*. The Committee noted that *SLA*s deal only with the number of strikes taken regardless of whether the animals are landed, lost and/or stinky and count every strike as a dead animal. For scenario (a) it has been assumed that the catch limit would average 134 whales per year during the block instead of the current average of 124 whales per year. For scenario (b) the ratio of landed whales to the number of struck and lost whales and inedible, stinky whales in recent years has been used to determine a multiplier to increase the catch limit for running the *SLA*.

Allison reported that, depending on scenario, the above changes would lead to a block quota starting in 2019 of between 789 to 815 strikes (or an average of 132-136 strikes per year). She had run the *SLA* and found that these strike limits are allowed by the *SLA*. Details of the runs and data used are given in Annex E (Appendix 5).

8.2.2 Management advice

Attention: C-A, SC, CG-A

(1) As in previous years, the Committee agrees that the Gray Whale SLA *remains the appropriate tool to provide management advice for eastern North Pacific gray whales. The Committee **advises** that the present block quota is in accord with the* SLA *and will not harm the stock. In addition, it confirmed that a six-year block quota beginning in 2019 of up to 815 strikes would not harm the stock.*
*(2) Weller reported that the US Government is currently reviewing a revised whaling management plan for the Makah hunt in Washington State. The Committee **encourages** the USA to provide the Committee with any revised plans as early as possible to allow consideration of the revised hunt management plan to occur intersessionally, such that, should they be deemed necessary, there is time for additional trials to be developed and run before the Annual Meeting in 2018. An* Implementation Review *for gray whales is currently planned in 2019.*

8.3 Bering-Chukchi-Beaufort (B-C-B) Seas bowhead whale

8.3.1 New information (including catch data)

Harvest data from the aboriginal hunt in Alaska were presented in SC/67a/AWMP02rev1. In 2016, 59 bowhead whales were struck resulting in 47 animals landed, including 28 females, 18 males and one whose sex was not determined. Eight of the nine females presumed to be mature (based on total length or pregnancy) were examined and five were pregnant, suggesting a high pregnancy rate in 2016. SC/67a/AWMP03 reported that Chukotkan natives in the Russia Federation harvested two bowhead whales (one male and one female) in 2016.

SC/67a/AWMP10 provided a summary of the health status of Bering-Chukchi-Beaufort Seas (B-C-B) bowhead whales as requested by the Committee in 2016. The report summarised extensive information from a wide variety of studies. The health metrics that are most relevant to the *Implementation Review* (population size and trend, calf production and crude pregnancy rates) show stable or positive trends. No serious health issues were identified but some indicators should be carefully monitored, these include: the number of bowhead carcasses recorded during aerial marine mammal surveys, killer whale predation on calves, entanglement of fishing gear, and general pathological findings. The authors thanked the whale hunters of the Alaskan coast communities for their cooperation.

Attention: SC, G, CG-A
The Committee ***welcomes*** *the report on the health status of B-C-B bowhead whales which it hopes can be generated every other year. It* ***encourages*** *other aboriginal whaling groups and researchers to collect similar data which in many cases does not require specialist equipment. This would allow assessment of differences in parameters such as prevalence of killer whale scarring in different ecosystems or to identify health parameters that differ between healthy, growing populations such as B-C-B bowhead whales, and those with conservation concerns.*

SC/67a/AWMP09 presented new photo-identification data that were collected from a 2011 aerial survey of B-C-B bowhead whales. The data were used to estimate bowhead survival rate and population abundance using Huggins models embedded in a Robust Design capture-recapture analysis. The estimated survival rate was 0.996 with approximate lower confidence bound 0.976, which is consistent with previous estimates and with research showing that bowheads exhibit great longevity (up to 200 years).

SC/67a/AWMP07 reported that the population survey for B-C-B bowheads expected in spring 2017 did not occur for several reasons, including funding, and environmental conditions. The last successful survey was in 2011. The next survey will occur in time to produce a new estimate of abundance by 2021.

Whilst recognising the difficulties, the Committee noted the importance of acquiring a new abundance estimate for B-C-B bowheads within the next few years. It noted that estimates from other approaches than the ice-based census (e.g. using photo-identification data) would be acceptable if the CVs fell within the range considered when developing the *Bowhead SLA*[8]. It was noted that the CV of the next B-C-B bowhead abundance estimate may exceed 0.25 due to difficulties associated with deteriorating ice and lead conditions. In this event, the Committee may decide that an *Implementation Review* is necessary, to consider trials with larger survey CVs.

Attention: SC, G, CG-A
The Committee ***encourages*** *efforts to try to ensure that an ice-based census of bowhead whales off Point Barrow can be completed, noting that the methodology has produced some of the best series of estimates available for cetaceans. It* ***recommends*** *that funding is made available to complete such a survey. The Committee noted that it is unlikely that a survey will be completed in 2018 due to the need to prepare for the* Implementation Review.

8.3.2 Management advice

Attention: C-A
The Committee ***reiterates*** *that the* Bowhead SLA *continues to be the most appropriate way for the Committee to provide management advice for the Bering-Chukchi-Beaufort Seas stock of bowhead whales. The Commission adopted catch limits for a six-year block in 2012, i.e. 2013-18. The total number of whales landed shall not exceed 336 and the number of annual strikes shall not exceed 67; however, there is a carryover provision that allows for any unused portion of a strike quota from past years be carried forward to future years provided that no more than 15 strikes be added for any one year. The Committee* ***advises*** *that based upon the Bowhead SLA, these limits will not harm the stock.*

8.4 Common minke whales off East Greenland

8.4.1 New information (including catch data)

In the 2016 season, 15 common minke whales were landed in East Greenland, and none were struck and lost. Three of the landed whales were males, 12 were females, and genetic samples were obtained from 12 of the landed whales.

Attention: SC, G, CG-A
The Committee ***encourages*** *the continued collection of samples of common minke whales landed off East Greenland and a collaborative approach to analyses.*

8.4.2 Management advice

Attention: C-A
The Committee notes that catches of minke whales off East Greenland are believed to come from the large Central stock of minke whales. The most recent strike limit of 12 represents a small proportion of the Central stock (IWC, 2016f, p.189). The Committee ***advises****, as last year, that the annual strike limit of 12 will not harm the stock.*

8.5 Common minke whales off West Greenland

8.5.1 New information (including catch data)

In the 2016 season, 146 common minke whales were landed in West Greenland and two were struck and lost. Of the landed whales, there were 110 females, 35 males and one of unknown sex. Genetic samples were obtained from 114 of these whales in 2016 and the Committee was pleased to note that samples from the West Greenland hunt are included in ongoing genetic analyses of common minke whales in the North Atlantic. The Committee noted that one common minke whale died because of entanglement in West Greenland in 2016.

Attention: SC, G, CG-A
The Committee ***encourages*** *the continued collection of samples of common minke whales landed off West Greenland and the collaborative approach to analyses. It* ***stresses*** *the importance of comparative analyses with Canadian samples.*

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[8]The *Bowhead SLA Evaluation Trials* used estimated survey CVs up to 0.25, and *Robustness Trials* up to 0.34.

8.5.2 Management advice

Attention: SC, G, CG-A
In 2009, the Committee was able to provide management advice for common minke whales off West Greenland for the first time. This year, noting that an SLA for this stock is expected at the Scientific Committee meeting next year, the Committee ***advises****, as last year, that an annual strike limit of 164 will not harm the stock.*

8.6 Fin whales off West Greenland

8.6.1 New information (including catch data)

A total of eight fin whales (four females and four males) were landed, and one was struck and lost, off West Greenland during 2016. The Committee was pleased to note that genetic samples were obtained from seven of these, and that the genetic samples of fin whales off West Greenland are analysed together with the genetic samples from the hunt in Iceland. The Committee noted that one fin whale died because of entanglement in West Greenland in 2016.

Attention: SC, G, CG-A
The Committee ***encourages*** *the continued collection of samples of fin whales landed off West Greenland and a collaborative North Atlantic approach to analyses.*

8.6.2 Management advice

Attention: C-A
Noting that an SLA *for fin whales off West Greenland is expected at the Scientific Committee meeting next year, the Committee advises, as last year, that an annual strike limit of 19 whales will not harm the stock.*

8.7 Humpback whales off West Greenland

8.7.1 New information (including catch data)

A total of five (one male and four females) humpback whales were landed, and none were struck and lost, in West Greenland during 2016. The Committee was pleased to learn that genetic samples were obtained from all the landed whales and that Greenland was contributing fluke photographs to the North Atlantic catalogue, both from captured whales and other field studies. Three humpback whales were observed entangled in fishing gear in West Greenland in 2016, which is considerably lower than the ten whales that were entangled in 2015. Of these, two were permitted to be killed, and one was disentangled by fishermen The Committee noted last year that bycaught whales had been included in the scenarios for the development of the *Humpback SLA* and that if high levels continued, then this would need to be considered in any future *Implementation Review* (the next is expected in 2020).

Attention: SC, G, CG-A
With respect to West Greenland humpback whales, the Committee:

(1) reiterates the importance of collecting genetic samples and photographs of the flukes from humpback whales landed of West Greenland and a collaborative approach to analyses; and
(2) welcomes the news that the Greenland authorities obtained IWC disentanglement training in 2016 and that they successfully disentangled one humpback whale.

8.7.2 Management advice

Attention: C-A
The Committee reiterates that the agreed Humpback SLA *(IWC, 2015a) remains the appropriate tool to provide management advice for humpback whales off West Greenland. Using this, Committee advises, as last year, that an annual strike limit of 10 will not harm the stock.*

8.8 Humpback whales off St Vincent and The Grenadines

8.8.1 New information (including catch data)

No whales were taken by St Vincent and The Grenadines in 2016. One female (length 50') has been taken so far in 2017.

Last year, the Committee had expressed concern that there is no officially agreed abundance estimate from the MONAH programme that took place in 2004 and 2005. A recent NOAA status review (Bettridge *et al.*, 2015) referred to that programme and provided an estimate of 12,312 humpback whales (95% CI 8,688-15,954) for 2004/05 but referenced this as 'NMFS, unpublished data'.

Attention: SC, G, CG-A
With respect to humpback whales off St. Vincent and The Grenadines, the Committee:

(1) ***recommends*** *that the status and disposition of genetic samples collected from past harvested whales be determined and reported next year;*
(2) reiterates the recommendation that photographs for photo-id and genetic samples are collected from all whales landed in future hunts;
(3) requests that a scientific representative from the St Vincent and The Grenadines attends next year's Scientific Committee meeting, especially since next year the Commission will review aboriginal whaling quotas; and
(4) ***recommends*** *that the USA (NOAA, NMFS) provides a paper to the next meeting that will allow the Committee to properly review this abundance estimate and, if appropriate, adopt it as an estimate suitable for providing management advice.*

8.8.2 Management advice

Attention: C-A
The Committee has ***agreed*** *that the animals found off St Vincent and The Grenadines are part of the large West Indies humpback whale breeding population (the last agreed abundance estimate was for 1992/93 - 11,570 (95% CI 10,290-13,390 – but see Item 8.8.1 above). The Commission adopted a total block catch limit of 24 for the period 2013-18 for Bequians of St Vincent and The Grenadines. The Committee advises, as last year, that this block catch limit will not harm the stock.*

9. WHALE STOCKS NOT SUBJECT TO DIRECTED TAKES

9.1 In-depth Assessments (IA)

9.1.1 Comprehensive Assessment of North Pacific humpback whales

9.1.1.1 PROGRESS ON INTERSESSIONAL WORK

SC/67a/Rep08 provided an Executive Summary[9] of the IWC's first Workshop on the Comprehensive Assessment

[9]The Workshop discussed an enormous amount of material and did not complete its work until the evening of the last day. It was not possible in the short time before the Committee meeting to finalise the Report and the participants authorised the Chair to develop an Executive Summary.

of North Pacific Humpback Whales. The objective was to identify and review available information on stock structure, removals (catches, bycatches and ship strikes), abundance and trends (by stock and area), biological parameters and environmental issues. The Workshop was held from 19-21 April 2017 at the kind invitation of the Marine Mammal Laboratory in Seattle. It was convened by Phil Clapham, and Greg Donovan was elected Chair.

9.1.1.2 PREPARATION FOR ASSESSMENT

9.1.1.2.1 STOCK STRUCTURE HYPOTHESES

The Workshop reviewed information on stock structure from a suite of datasets including photo-identification, genetics, telemetry, acoustics, catches and sightings. This included reviewing the SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) project and updated information from the Russian Pacific, the Bering and Chukchi Seas, Japan and Mexico. Geographic 'building blocks' were developed that were to be used when describing the various stock structure hypotheses for the summering and wintering groups (see Annex F, item 4 for more details).

The Committee received updates on several additional biopsy and photo-identification projects. One update was on work conducted on Saipan in the Marianas during February 2017. This new catalogue, containing fluke images for 24 humpback whales, is being compared to catalogues from the Philippines, Okinawa, Russia, and Japan. The genotype of one individual had been matched between Saipan and Ogasawara; given the small sample size, this suggested a strong connection between the two areas.

The other update was on the genetic and photo-identification studies in Okinawa waters that have been active since 1991. Currently these samples are being compared with other data sets. Similar data are potentially also available from Ogasawara.

9.1.1.2.2 ABUNDANCE DATA AND TRENDS

The Workshop examined a comprehensive ongoing mark-recapture analysis using data for the whole North Pacific derived from the SPLASH dataset. The completed analysis will consider the revised (since SPLASH) stock structure hypotheses considered at the Workshop. The Workshop also compiled a list of completed abundance estimates and data that could be used to generate estimates for areas needed in this assessment.

9.1.1.2.3 CATCH HISTORY AND OTHER REMOVALS

The Workshop examined the existing catch data and agreed the series for incorporating into the assessment. After reviewing available information on bycatch and ship strikes, the Workshop agreed that it will develop several scenarios reflecting both past and likely future removals that will capture the uncertainties.

The Committee was advised that additional data on mortalities were available from various sources and **agrees** that such data should be sent to the Convenor of the North Pacific humpback assessment steering group (see Annex W).

9.1.1.2.4 LIFE HISTORY PARAMETERS

The Workshop compiled and reviewed available information on biological parameters for humpback whales in all oceans.

9.1.1.2.5 ENVIRONMENTAL ISSUES

The Workshop considered the potentially changing carrying capacity in the North Pacific. It was agreed that whilst separating the effects of environmental changes from the traditional view of populations approaching carrying capacity is something to strive for, such data are not available. However, the Workshop noted several interesting studies linking humpback whale occurrence and density with environmental factors. Further investigations into the effects of environmental changes in the habitat of humpback whales are encouraged.

9.1.1.3 ASSESSMENT MODEL

In the light of discussions of the available data, the Workshop agreed that future modelling efforts should employ a simple modelling framework based upon an age-aggregated model using a Bayesian estimation approach.

9.1.1.4 CONCLUSIONS

The Workshop made considerable progress towards completing a Comprehensive Assessment. It developed several research recommendations that do not have cost implications for the IWC that are detailed in Annex F.

Attention: SC

The Committee thanks Donovan and the Workshop participants, commending them for the progress that has been made. It established an intersessional steering group under Clapham (Annex W), tasked with ensuring progress with the recommendations made at the Workshop with respect to:

(a) refining and prioritising the stock structure hypotheses developed at the Workshop and develop draft mixing matrices;

(b) facilitate the additional work on abundance estimates and any other model inputs; and

(c) finalising plans for a second workshop in 2018.

Details of work to be undertaken both before and during the 2018 Annual Meeting are given in Annex F, item 4.4. The two-year work plan is summarised in Table 8.

9.1.2 In-depth Assessment of North Pacific sei whales

9.1.2.1 PROGRESS ON INTERSESSIONAL WORK

SC/67a/IA02 documented progress with model development. The model can be run when the input data have been prepared. The catch series and Japanese *Discovery* marking data have been coded and entered with the assistance of Allison and Yoshida. No new analyses of sightings data were presented. The specific data items for use in the assessment are discussed below.

9.1.2.2 PREPARATION OF DATA FOR THE ASSESSMENT

9.1.2.2.1 STOCK STRUCTURE HYPOTHESES

Issues of stock structure were discussed extensively at the 2015 and 2016 meetings (IWC, 2016e; 2017b). Last year, the Committee agreed to proceed on the basis of two alternative hypotheses: (i) a single stock for the entire North Pacific (Kanda *et al.*, 2015; Pastene and Yoshida, 2015); and (ii) a 5-stock hypothesis presented in Mizroch *et al.* (2016). After much discussion, the Committee considered that the evidence for the 5-stock hypothesis is weak. The genetic information was consistent with a single stock in the area covered by the samples. However, it noted that all the samples had been taken from the area of just one of the stocks proposed in Mizroch *et al.* (2016), namely the North Pacific pelagic stock.

There is no implication that the lines shown in Appendix 2 in Annex F correspond to stock boundaries and the decision to proceed does not imply endorsement of either hypothesis at this stage.

9.1.2.2.2 ABUNDANCE DATA AND TRENDS

Last year, the Committee identified abundance data that ranged from surveys from which usable abundance estimates are already available to surveys resulting in zero or minimal

Table 8

Work plan for North Pacific humpback whales (from IA).

Species/area	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Comprehensive assessment of North Pacific humpback whales	Reconvene intersessional steering group and convene 2nd Workshop to further data preparation and development of the assessment model	Review progress of intersessional Workshop and continue comprehensive assessment

sei whale sightings, which can be used to bound the area of abundance. This year, the Committee developed a final list of abundance information for use in the assessment (see Appendix 3 of Annex F). It comprises of estimates that are published or contained in documents to the Committee and data from published sources that can be used with minimal analysis. In addition, areas were identified where sei whales do not occur to any significant extent. Most of the remaining work on abundance involves extracting existing estimates from papers and assigning or prorating them to sub-regions.

9.1.2.2.3 MARKING DATA

The coding of the Japanese *Discovery* marking data is now complete. A small US dataset is being coded that could be used if submitted to the Secretariat in time for the assessment, but these are not essential input to the assessment.

The Committee had little information on marking efficiency, mark retention, or recovery efficiency. Several options on how to handle these issues were suggested in Annex F. The North Pacific sei whale assessment steering group (Annex W) is encouraged to investigate the sensitivity of these options.

9.1.2.2.4 CATCH HISTORY

Allison reported that nearly all catches have either actual positions or have been assigned approximate positions that are precise enough to assign them to one of the sub-regions for the assessment. The only exception is some USSR catches where a decision needs to be made where to assign them to. Decisions have been made on assigning catches of uncertain species and sex.

9.1.2.2.5 LIFE HISTORY PARAMETERS

The life history and exploitation-related parameters required by the assessment model are age-at-recruitment (or selectivity ogive), age-at-maturity (or maturity ogive), and the natural mortality rate. For initial runs of the assessment model, the same parameter values would be used as at the last assessment of North Pacific sei whales.

9.1.2.3 ASSESSMENT MODEL

The model described in SC/67a/IA02 is similar to that used in multi-stock *Implementation Simulation Trials*. The time step is half-yearly, with summer defined as May to October and winter as November to April. The model can accommodate any definitions of feeding and breeding areas with any degree of mixing between them. The model uses catches, marks and recoveries, and abundance information, which are used to calculate a likelihood function of the parameters. This model will be used for the assessment. The North Pacific sei whale assessment steering group (Annex W) will compile the list of input data (and see above). The Committee also recognised that the assessment model may need to consider density dependence, if there are sufficient data.

The Committee did not develop detailed mixing matrices, but realised the model should allow movement between the wintering grounds and the summer feeding areas, as indicated by the mark recaptures. Several general options for initial exploration were discussed in Annex F. The North Pacific sei whale assessment steering group (Annex W) will review initial model runs and can consider alternative mixing assumptions if initial runs of the assessment model are not consistent with the data.

Attention: SC, S

The Committee ***agrees*** *to proceed with assessment modelling for North Pacific sei whales based on two alternative hypotheses – a single stock and 5 stocks using the model described in SC/67a/IA02. To facilitate the completion of this assessment under the intersessional steering group (Annex W), it:*

(1) ***authorises*** *the ISG to modify proposed boundaries, if necessary, to facilitate the divisions of data into sub-regions;*

(2) ***agrees*** *that the ISG will not attempt to assign relative plausibilities to the alternative hypotheses at this stage of the assessment;*

(3) ***agrees*** *that the ISG should produce a table of inputs to the assessment model including those for abundance. uncertain species and sex were made;*

(4) ***recognises*** *that new estimates or existing estimates that have not been formally categorised for use in assessments will need to be examined by the working group on abundance estimates (see Item 12); and*

(5) ***requests*** *Allison to identify any remaining needed adjustments to the catch series for North Pacific sei whales that may be necessary, and to refer them to the ISG for endorsement.*

9.1.2.4 WORK PLAN

Details of work to be undertaken both before and during the 2018 Annual Meeting are given in Annex F, item 3.4. The two-year work plan is summarised in Table 9.

9.1.3 In-depth Assessment of Indo-Pacific Antarctic minke whales

In 2014, after 13 years, the in-depth assessment of Antarctic minke whales in the Indo-Pacific Antarctic region was completed. At that time, it was suggested that all of the components and results of the assessment that had been concluded over the years be brought together in one document. SC/67a/SH14 was presented to this meeting as a draft of the document for consideration by the Committee. The document covered a wide variety of topics discussed over 13 years including systematics, commercial and research catches, abundance estimates, spatial distribution patterns, stock structure, biological information, population dynamics, feeding ecology and energetics, pollutants and marine debris, and species interactions. The Committee welcomed the document and acknowledged the great effort that had gone into summarising the information and results collected over a period of so many years. After a general discussion, several suggestions to improve the document were made and these are detailed in Annex F. An intersessional correspondence group under Murase (Annex W) has been established to finalise the manuscript, considering comments received during this year's meeting, and to submit the manuscript to a peer-reviewed journal.

Table 9

Work plan for North Pacific sei whales (from IA).

Species/area	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
In-depth assessment of North Pacific sei whales	Re-establish the ISG (Annex W) to further data preparation and development of the assessment model.	Review progress of intersessional work and continue in-depth assessment.

Table 10

Work plan for North Pacific blue whales.

Species/area	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
North Pacific blue whale assessment	Review information to examine the feasibility of undertaking an assessment and as appropriate develop a timetable.	Review progress on the research items identified and the work of the intersessional group, and develop a work plan.

9.2 Evaluation for potential new In-Depth Assessments

9.2.1 North Pacific blue whales

9.2.1.1 REVIEW OF NEW INFORMATION

SC/67a/NH01 reports on the preliminary analysis of a year (2012) of low frequency acoustic data collected by seismometers off Hokkaido, Japan. The authors identified a new call type ('Japan-type song') that is probably produced by blue whales and is different from those previously reported in the Northwestern Pacific. SC/67a/NH02 summarises previously published information regarding the occurrence of blue whale songs across the North Pacific. The Northeast Pacific song type is commonly recorded along the west coast of North America. The Northwest Pacific song type is commonly recorded in the central and western North Pacific. The two songs overlap in the Gulf of Alaska as well as lower latitude areas of the central North Pacific. Rone *et al.* (2017) provided information on blue whales observed from sighting surveys in the Gulf of Alaska in 2009, 2013 and 2015.

9.2.1.2 EVALUATING THE POSSIBILITY OF INITIATING AN ASSESSMENT AND WORK PLAN

An intersessional correspondence group (ICG) chaired by Branch reported on data available for an assessment of North Pacific blue whales. It had identified five priority action items: (1) obtain abundance estimates from the IWC-POWER surveys; (2) obtain abundance estimates from the JARPN and JARPNII surveys; (3) analyse and compare genetic samples from the Eastern North Pacific, IWC-POWER and JARPN and JARPNII to examine stock structure throughout the North Pacific; (4) compare existing photo-id catalogues (e.g. IWC-POWER, Cascadia Research Collective, JARPN/JARPNII catalogues); and (5) review new acoustic locations and song information. Although good progress is being made more work is still needed before an assessment can be initiated, especially with respect to new abundance estimates and stock structure information. The Committee **agrees** that the ICG (see Annex W) should continue its work.

9.2.1.3 WORK PLAN

The work plan for North Pacific blue whales is shown in Table 10.

9.2.2 Southern Hemisphere Pygmy blue whales

9.2.2.1 SOUTHERN HEMISPHERE POPULATION STRUCTURE

The Committee is currently preparing for a Comprehensive Assessment of pygmy blue whales. For this reason, it continues to gather information on population structure using acoustic and genetic data (see item 5.1 in IWC, 2017e). Progress has been made on building a pygmy blue whale song library with effort directed towards finding the best quantitative ways to discern differences between song types and song type variants. This work will be concluded in 2018. To further assist with genetic assessments, an intersessional group was formed to ensure standardisation of DNA profiles among researchers working on both blue and fin whales across the Southern Hemisphere and protect against depletion of tissue samples which are shared amongst multiple research groups, through coordinated data sharing and development of genomic archives where possible.

SC/67a/PH04 provided a progress report on matching within the Southern Hemisphere Blue Whale Catalogue, which has been supported by funding from the Committee (see item 10.2.2 in IWC, 2017e). This helps understanding of blue whale movements between regions, and allows estimation of regional abundance. Since 2016, this catalogue has increased by 13% with photo-identifications from the western Indian Ocean. New research groups from Chile and the western Indian Ocean have joined the catalogue, and plan to upload their photographs shortly. The Catalogue is expected to be held on the IWC server by December 2017.

Attention: SC
The Committee ***encourages*** *the continuance of the Southern Hemisphere Blue Whale Catalogue, and* ***recommends*** *a priority focus on matching photographs within regions to estimate regional abundance of pygmy blue whales.*

9.2.2.2 INDONESIA/AUSTRALIA BLUE WHALES

The Southern Hemisphere Blue Whale Catalogue holds 525 right sides and 508 left side photo-identifications from Australian catalogues. It may be large enough to enable abundance estimation but this cannot be confirmed until all date and location data are available from regional contributors.

Attention: SC, G
In order that assessment of the suitability of Australian photographs for estimating regional abundance can be conducted, the Committee ***recommends****:*

(1) Australian research groups submit this date and location information to the Southern Hemisphere Blue Whale Catalogue; and
(2) Quality Control analysis of the Australian component of the Catalogue.

9.2.2.3 MADAGASCAR BLUE WHALES

The Committee was informed about ongoing acoustic monitoring off the northwest coast of Madagascar. Between December 2016 and April 2017, Madagascar-type blue whale song was detected on all recorders throughout December and into at least early January. Sri Lanka-type blue whale song was detected on 11 December and was consistently detected for at least two days. These preliminary results suggest the seasonal presence of an aggregation of blue whales off the northwest coast of Madagascar, representing two different 'acoustic populations'. The detection of Sri Lanka-type songs was unexpected, and may suggest a previously unknown migratory route for these whales. Acoustic deployments are ongoing and will be reported to the Committee in 2018.

Attention: SC, G
The distribution, population isolation and abundance of Madagascar-type blue whales is unknown. The Committee ***encourages*** *additional offshore surveys and data collection (e.g. acoustics, genetics and photo-identifications) by regional scientists to further assess the composition of this northwest Madagascar aggregation.*

9.2.2.4 NEW ZEALAND BLUE WHALES

SC/67a/SH02 summarised a recent study of New Zealand blue whales (2014-17) with a focus on the Taranaki Bight. This multi-disciplinary study included acoustics, genetics and photo-identification of New Zealand blue whales, with 31 whales genetically identified. These blue whales have significantly lower genetic diversity than the other blue whale populations. They were significantly differentiated from Antarctic blue whales and Southeast Pacific blue whales, but not from Australian blue whales. However, the work presents multiple lines of evidence supporting the recognition of a resident or seasonally resident blue whale population around New Zealand.

Attention: SC, G
The New Zealand population of blue whales is poorly understood. The Committee:

(1) ***commends*** *the exceptional work detailed in SC/67a/SH02;*
(2) ***encourages*** *further data gathering and analysis to obtain a mark recapture abundance estimate;*
(3) ***recommends*** *that the photo-identifications are combined with others within the Southern Hemisphere Blue Whale Catalogue to measure regional abundance and connectivity;*
(4) ***encourages*** *further acoustic monitoring at sites close to New Zealand; and*
(5) ***encourages*** *acoustic data collection from other sites in the southwest Pacific, given the low differentiation between New Zealand and Australia, and the need to understand the level of seasonal overlap of New Zealand and Australia blue whale song types.*

9.2.2.5 SOUTHEAST PACIFIC BLUE WHALES

LeDuc *et al.* (2017) investigated global blue whale stock structuring. Blue whales in the northeast and southeast Pacific are genetically differentiated, while samples in the Eastern Tropical Pacific (ETP) showed some degree of spatial differentiation, supporting the hypotheses that the region is used by whales from both hemispheres but in different seasons (see Annex I, item 2.1). The Committee discussed whether low levels of differentiation across the ETP might imply inter-breeding between the two populations. The Committee also discussed the value of comparing the newly found biological data from Japanese catches of blue whales off Chile in the 1960s to catches in other waters (e.g. the Antarctic and Indian Oceans) to establish whether the Chilean blue whale is morphologically distinct from the Antarctic blue whale and other pygmy blue whales.

Redfern *et al.* (2017) constructed habitat use models for blue whales using sightings and effort data from the California Current and ETP to infer areas of likely habitat use in the Northern Indian Ocean, where blue whale distribution is poorly known. These models could also be used to predict blue whale distributions off Chile. This would provide useful potential distributional information in relation to the pre-assessment of southeast Pacific blue whales, allowing assessment of whether the regional abundance estimates are representative of the whole population.

An IWC Workshop was held in Chile in December 2016 (SC/67a/Rep03), to explain the IWC population assessment process and facilitate blue, humpback, and fin whale photo-identification standardisation and integration. A blue whale discussion group reviewed progress on catalogue sharing, data availability and dataset sizes. Most photo-identification data are from the Chiloe Island region, with some opportunistic sightings from Isla Chañaral to the north. All groups agreed to contribute to the Southern Hemisphere Blue Whale Catalogue to proceed towards a southeast Pacific blue whale assessment. The work has been slowed by the need for each group (with limited resources) to fully reconcile their blue whale photographs before contributing them to the Catalogue.

Attention: SC, G
To proceed to an assessment, there is a need to better establish the genetic identity, habitat use and abundance of southeast Pacific blue whales. The Committee:

(1) ***encourages*** *further effort to collect genetic samples from Peru and Ecuador;*
(2) ***recommends*** *predicting southeast Pacific blue whale habitat following Redfern* et al. *(2017), and assessing the results using southeast Pacific sightings and effort data;*
(3) ***welcomes*** *progress towards combining blue whale catalogues in the region; and*
(4) ***strongly encourages*** *Chilean researchers to reconcile their catalogues internally and upload them to the Southern Hemisphere Blue Whale Catalogue to allow estimation of regional abundance.*

9.2.3 Antarctic blue whales (Areas III and IV)

9.2.3.1 GENETIC STUDIES

SC/67a/SH11 presented genetic species identification from bones (25 blue whales) found at South Georgia and the Antarctic Peninsula, likely to have been deposited ~100 years ago. Blue whale genetic diversity was high. A total of 14 of 21 maternally inherited haplotypes were unshared with contemporary blue whale samples, suggesting a loss of genetic diversity from South Georgia.

The Committee were also informed about progress on the analysis of a set of ~1,000 fin and blue whale baleen plates collected from Antarctic Areas IV and V during 1946-49 by Japanese whalers and stored at the Smithsonian Institution. A subset of baleen samples is now undergoing DNA extraction and sequencing to test the feasibility of applying next-generation sequencing on these samples. A report will be provided in 2018.

Attention: SC, G, S
Given the importance of bone and baleen collections for documenting the loss of genetic diversity and shifts in population structure, the Committee:

(1) encourages collection and analyses efforts to continue; and
(2) requests the Secretariat to write a letter of support to CITES to assist with collection of whalebones from the Antarctic.

Table 11

Work plan for Southern Hemisphere Antarctic and pygmy blue whales.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Antarctic blue whales	Antarctic Blue Whale Catalogue – continue matching.	Report
	Continue analysis of Antarctic blue whale baleen plates.	-
	Complete analysis of post-CPIII to measure blue whale abundance.	Report
Pygmy-type blue whales	Southern Hemisphere Blue Whale Catalogue – matching (Annex W).	Report
	Analysis of blue whale catches in all regions (pelagic fleets and land stations) to delimit population, boundaries, regions.	Report
	Development of permanent blue whale song reference library to assist with standardisation and analysis of call distribution and structure.	Website
Southeast Pacific blue whales	Analyse Chilean blue whale catch length data and compare with blue whale catches from other regions.	Report
	Reconcile Chilean photo-identification data within the SHBWC.	-
	Apply habitat models developed for California Current and Eastern Tropical Pacific to construct habitat use analyses for Chilean blue whales and validate with sightings data (Annex W); standardisation of DNA profiles (Annex W).	Report
Southwest Indian Ocean blue whales	Conclude acoustic study off NW Madagascar.	Report
Australia/Indonesia blue whales	Complete addition of date/location metadata to Australia/Indonesia blue whale photos within the SHBWC and conduct quality control across all images.	Report
New Zealand blue whales	Continue reconciliation of NZ photo-identification catalogues within the Southern Hemisphere Blue Whale Catalogue.	Report

9.2.3.2 CRUISE REPORTS

SC/67a/ASI07 and SC/67a/SP05 reported Antarctic blue whale photo-identifications (9 individuals) and biopsies (2 individuals) from the NEWREP-A survey (a dedicated sightings survey in Area V-West) and the Antarctic minke whale sampling survey (conducted in Area III-East and Area IV). During these surveys, a total of 15 schools with 19 individuals of blue whales were sighted.

9.2.3.3 ACOUSTIC STUDIES

Samaran reported on the goals and outcomes of a pre-meeting of the IWC-SORP Acoustic Trends project. The project goal is to investigate trends in acoustic detections of Antarctic fin and blue whales. The pre-meeting conducted a high-level review of their work completed to date, identified gaps in data collection efforts, and developed a plan to expand data collection from the Southern Ocean Hydrophone Network. They also developed a new framework for standardised analysis of long-term Antarctic acoustic recordings, identifying a need for additional coupled behavioural and acoustic studies to enable a more robust interpretation of acoustic data with a view towards development of call density and animal abundance estimates. This plan will be implemented over the next two years with a report presented to the Committee in 2018.

The Committee was pleased to receive a large number of papers providing information on acoustic studies in the Southern Hemisphere on blue whales. These included studies analysing the effect of environmental conditions on acoustic behaviour and sightings (Shabangu *et al.*, 2017), studies on spatio-temporal distribution and seasonal movements throughout the Antarctic and towards the tropics (Thomisch *et al.*, 2016). These are discussed in detail in Annex H, item 3.2.3.

Attention: SC, G

The Committee ***welcomes*** *the significant new results on Antarctic blue whale distribution and seasonal movements, and* ***encourages****:*

(1) the IWC-SORP Acoustic Trends project to develop methods for abundance estimation of fin and blue whales using acoustics, noting the importance of this to IWC assessment work;

(2) the collection of Antarctic blue whale biopsy samples and photo-identifications from lower latitudes to better understand blue whale population structuring (and see Items 9.2.2.5 and 9.2.3.1); and

(3) the continuation of acoustic monitoring to document blue whale seasonal movements.

9.2.3.4 PROGRESS TOWARDS POPULATION ASSESSMENT AND WORK PLAN

The Committee was informed that an estimate of model-based abundance from post-CPIII SOWER surveys is being developed and would be provided to the 2018 meeting.

SC/67a/PH01 reported the results of the comparison of Antarctic blue whale identification photographs from two new sources to the existing Antarctic Blue Whale Catalogue. The summary of this paper can be found in Annex S, item 3. The value of continuing opportunistic data collection, particularly photographs, on Antarctic blue whales was highlighted, since this species remains poorly known. The number of resightings from the Antarctic Blue Whale Catalogue to date means that it is premature to try to estimate abundance at this stage.

Attention: SC, G

The Committee ***welcomes*** *the progress being made towards being able to undertake regional population assessments of blue whales. In particular, it* ***recommends*** *continuing opportunistic photo-identification data collection in the Antarctic to assist with developing estimates of population abundance for Antarctic blue whales.*

9.2.4 Southern Hemisphere fin whales

9.2.4.1 POPULATION STRUCTURE

Last year, the Committee initiated discussion on the possible assessment of Southern Hemisphere fin whales (IWC, 2017b, p.42). This year, it reviewed the limited information currently available to summarise population structuring of Southern Hemisphere fin whales, noting that they may comprise two subspecies, *B. physalus quoyi* and *B. physalus patachonica* (a pygmy form hypothesised to be located in the low to mid latitudes). Global population structuring of fin whales was investigated by Archer *et al.* (2013) but the uneven geographical spread and small number of samples from areas other than the southeast Atlantic prohibits a statistically robust assessment of Southern Hemisphere fin whale population structure. Acoustic data show distinct call features for fin whales in East Antarctica (~70°E) compared to those near the west Antarctic Peninsula and Scotia Sea (Gedamke, 2009). Unpublished analyses of fin whale vocalisations off Juan Fernandez Island (Chile) indicate that these are also comparable to those detected off the west Antarctic Peninsula.

Attention: SC, G, S
Knowledge of population structure is essential to future efforts to assess Southern Hemisphere fin whales. To determine the longitudinal differentiation and potential sub-species structure among fin whales the Committee ***encourages*** *using:*

(1) strategic collection of skin biopsy and bone samples for genetic and isotope analysis;
(2) satellite telemetry to discern seasonal movements; and
(3) photo-identification to understand site fidelity and residency patterns and linkages between high- and low-latitude grounds.

The Committee also ***recommends*** *that the Secretariat provide a letter of support for a study examining the evidence for B. patachonica, which requires access to the holotype for this species from the Buenos Aires Museum.*

9.2.4.2 DISTRIBUTION AND ABUNDANCE

SC/67a/SH09 reviewed available metadata on Southern Hemisphere fin whales, compiling data from dedicated and opportunistic surveys, moored acoustic recorders, sonobuoy surveys, photo-identifications, satellite tagging and biopsy sampling. Most datasets were from the western Antarctic Peninsula and Scotia Arc. Apart from circumpolar IDCR/SOWER data, limited sighting effort has been conducted in Areas II, III, IV and V. Most acoustic recordings in areas other than the western Antarctic Peninsula and Scotia Sea are from Area IV/V. No telemetry data from Antarctic regions other than the western Antarctic Peninsula were identified. However, telemetry data, biopsy samples, photo-identification data and effort-related sightings data are available from the coast of Chile. The authors concluded that major gaps exist with regard to understanding population structure and identity, migration patterns and movements of fin whales within the area, as well as abundance, habitat utilisation and foraging ecology. A summary of these data is provided in Appendix 2 of Annex H.

SC/67a/WW02 reports the movements of six fin whales satellite tagged off Isla Chañaral, Chile (~29°S) during austral spring 2015. Whales were tracked between 4 and 162 days. Five of the six whales remained at middle latitudes for prolonged periods of time, moving in a north-south pattern near the coast, and spending most of their time in area-restricted search behaviour. One individual exhibited clear southbound migratory behaviour, remaining in transit for most of the period it was tracked. These results suggest that some of the fin whales that are observed in Chile follow a migration to high latitudes, whereas others remain in lower latitudes, likely feeding, along the Chilean coast. The method of de la Mare (2014) was used to give some example results from estimating indices of relative abundance for Antarctic fin whales (see Annex H, Appendix 2). Catch per unit effort (CPUE) data can be used to assess regions of past high densities of fin whales in the Southern Ocean.

Matsuoka and Hakamada (2014) provided estimates of abundance for fin whales from Antarctic Areas IIIE-IV, as well as for Areas V-VIW, using data from JARPA and JARPA II line-transect sighting surveys from 1989/90-2008/09 collected south of 60°S to the ice edge during the austral summer. These abundance estimates will be reviewed by the ASI Working Group (Annex Q) at next year's meeting.

Attention: SC, G
With respect to obtaining information on the distribution, movements and abundance of Southern Hemisphere fin whales for use in an assessment, the Committee ***recommends*** *that:*

(1) telemetry studies, photo-identification and biopsy sampling be continued; and
(2) de la Mare incorporate newly available Soviet fin whaling data into his catch density model to derive the fullest possible picture of past fin whale aggregation patterns.

9.2.4.3 CRUISE REPORTS

SC/67a/ASI07 and SC/67a/SP05 provided information on fin whales from the 2016/17 NEWREP-A sighting survey in the western sector of Area III-East (55-65°E), Area IV (70-130°E) and Area V (130-165°E. A total of 118 schools with 350 individual fin whales were sighted during these surveys.

9.2.4.4 ACOUSTIC STUDIES

SC/67a/SH03 presented preliminary analyses of directional sonobouys and real-time passive acoustic detection for fin whales during the Antarctic Circumnavigation Expedition, January-March 2017. The Committee looks forward to receiving the final analyses.

Recent visual observations suggest that the region around Elephant Island (61°08'S 55°07'W) may be important feeding area for fin whales, perhaps during migration. SC/67a/SH06 reported preliminary analysis of acoustic data from north of Elephant Island from January-November 2013. Fin whales were present for most of the period, peaking in the austral autumn with low or no presence in August and September. Acoustic presence peaked during austral autumn.

Attention: SC, G
The Committee ***encourages*** *further acoustic analysis of fin whale calls to discern population structure and distribution patterns. The Committee also* ***encourages*** *data sharing between acoustic studies to provide a more comprehensive view of fin whale seasonal occurrence and distribution.*

9.2.4.5 PROGRESS ON POPULATION ASSESSMENTS

SC/67a/IA01 analysed Japanese catches of fin whales in the Southern Hemisphere, comparing true Soviet length data from the *Yuri Dolgorukiy* factory fleet during 1960-75 to data for the same period reported to IWC by Japan. Length distributions between the two nations were broadly similar, although a peak in Japanese catches at 17.4m (the minimum length for this species) prior to implementation of the International Observer Scheme in 1972 suggested a degree of 'stretching' to hide some catches of under-sized animals. The authors conclude that the Japanese Southern Hemisphere fin whale data in the IWC Catch Database are probably largely reliable.

The Committee was informed that design-based strata-level estimates of abundance from IDCR-SOWER CPIII surveys are being developed and would be provided to the 2018 meeting.

SC/67a/SH07 outlined a plan to coordinate future research on Southern Hemisphere fin whales, focused on the western Antarctic Peninsula.

Table 12

Work plan for Southern Hemisphere fin whales.

Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Complete work on design-based strata-level abundance estimates.	Report
Continue to compile available data and assess gaps for an assessment.	Report
Complete review of population structuring.	Report
Include newly available Soviet catches in modelling of Southern Ocean fin whale catches to estimate relative densities across the Southern Hemisphere.	Report

Attention: SC, G

To allow for a possible future assessment of fin whales, the Committee ***agrees*** *that considerably more co-ordinated research is needed. It* ***recommends*** *the following goals (from SC/67a/SH07) for the western Antarctic Peninsula region, recognising that this will be a long-term plan:*

(1) characterise the whales in the aggregations acoustically and genetically to determine the population identity of whales using this area (a single breeding stock vs. multiple stocks mixing);
(2) explore the spatio-temporal extent of the aggregations and estimate density and abundance of aggregating fin whales;
(3) investigate the feeding ecology and prey dependencies, identifying vulnerabilities;
(4) track movements and habitat use of fin whales in the area; and
(5) identify migration routes and destinations.

9.2.6.5 WORK PLAN

The work plan is shown in Table 12.

9.2.5 North Atlantic sei whales

9.2.5.1 REVIEW OF NEW INFORMATION

Little is known about the distribution and abundance of sei whales in the western North Atlantic. Cholewiak provided an update on recent passive acoustic data collected by the NOAA Northeast Fisheries Science Centre that provide new insights into sei whale acoustics and distribution. Two studies were described: (1) year-round data were analysed from two sites along the shelf break of Georges Bank, USA; and (2) an array of recorders was used to localise and track sei whales in Massachusetts Bay (in the northeastern USA). In the first study, peak detections occurred at these sites in late October and late December, providing the new information on winter occurrence of this species. The second study characterised three types of vocalisations that have not been previously described, providing new vocalisations that may be used for passive acoustic monitoring efforts. The Committee **welcomes** this new information, **encourages** this work and looks forward to future results.

9.2.6 North Atlantic right whales

Last year, the Committee had recommended that a comprehensive update on North Atlantic right whales be submitted in 2017 (IWC, 2017b). It was requested that this update include recent findings from ongoing research on distribution, mortality and calving for all range states including Iceland, as well as information on mitigation measures that are occurring in both US and Canadian waters, including measures proposed to mitigate the potential effects of future geological and geophysical seismic surveys.

In lieu of the comprehensive update requested in 2016, the Committee was informed that the US Northeast Fisheries Science Center (NEFSC) had developed a Bayesian state-space implementation of a Jolly-Seber mark-recapture model that will estimate abundance and survival over the period 1990-2015. The paper detailing this analysis is not yet available. Information was also received concerning an unusually low number of calves (n=5) in 2017. Kraus *et al.* (2016) reported that of the diagnosed mortalities of right whales between 2010 and 2015, 85% were attributed to bycatch/entanglements and 15% to ship strikes. This is in contrast to the records from 1970 to 2009 that reported 35% of the diagnosed mortalities were due to bycatch/entanglements and 44% due to ship strikes. Thus, while the combination of shipping lane changes and ship speed reductions appear to have significantly reduced the number of ship strikes on right whales (Laist *et al.*, 2014), modifications of fishing gear have not resulted in an observed decrease in series injuries and mortalities (Pace *et al.*, 2014). Annex G, Appendix 2 provides an updated summary on North Atlantic right whales provided by the NEFSC. See additional discussions on entanglements under Item 13.1.4.

Attention: CG-A, SC, G,

The Committee ***reiterates*** *its previous recommendation for the submission of a comprehensive update on the status of North Atlantic right whales (IWC, 2017b, p.40), which are endangered. It* ***stresses*** *the importance of this being submitted to the 2018 meeting of the Committee to enable an initial review of status. This will allow time, if necessary, for explanations or additional analyses to be undertaken before the proposed 2018 Workshop on the Comparative Biology, Health, Status and Future of North Atlantic Right Whales: Insights from Comparisons with other Balaenid Populations. The Committee* ***agrees*** *that the Steering Committee (Annex W) should continue its work to plan the workshop.*

9.2.7 North Pacific right whales

SC/67a/NH07 summarised North Pacific right whale sightings by Japanese cruises in the western North Pacific since 1982 including recent Japanese and Russian joint cruise data. SC/67a/NH04 summarises recent sightings of western North Pacific right whales mainly in Russian coastal waters. In recent years, an increasing number of sightings have been reported but it is not clear whether these reflect a true increase in abundance or an increase in search effort. The Committee thanked the authors of these papers that responded to a previous Committee recommendation (IWC, 2017b, p.40). The Committee was also pleased to hear of a collaboration between Japanese and American scientists for a basin-wide genetic study.

Attention: SC, G, CG-A

The Committee made several research recommendations that will improve its ability to assess the status of right whales in the North Pacific (for details see Annex I):

(1) development of an abundance estimate from the Japanese cruises;

(2) a comparison of photo-identification catalogues from Japan, Russian, the USA and Canada; and
(3) a genetic comparison of samples from Japan, Russian, the USA and Canada.

It ***encourages*** *that this work is completed as soon as possible and the results reported to the Committee.*

9.3 New information and workplan for other northern stocks

9.3.1 North Pacific fin whales

9.3.1.1 REVIEW NEW INFORMATION

The Committee welcomed new information on fin whales observed from sighting surveys in the Gulf of Alaska in 2009, 2013 and 2015 (Rone *et al.*, 2017). Overall, the results suggest that fin whales are increasingly common within the former whaling grounds of the Gulf of Alaska, but it is not clear whether the apparent shift to an inshore distribution is real or a function of sighting effort.

The Committee was also pleased to hear of an ongoing analysis of fin whale song patterns in Southern California and the Gulf of California, Mexico, from data collected since 2001, and in recordings collected at low latitudes across central and western Pacific since 2009. The Committee looks forward to receiving a paper detailing the results next year.

Archer at Southwest Fisheries Science Center (NOAA Fisheries) is conducting a global review of fin whale taxonomy with a focus comparing North Pacific fin whales with those in the North Atlantic. It was noted that there are no samples are currently available from fin whales in the East China Sea. This is an important data gap since early immunogenetic (Fujino, 1960) and morphological studies (Ichihara, 1957) indicated that these fin whales comprise a separate stock. The Committee looks forward to an update on this genetic study next year.

The Committee **welcomes** this new information, **encourages** this work and looks forward to future results.

9.3.2 Omura's whale

9.3.2.1 REVIEW NEW INFORMATION

Omura's whales were first described as a species by Wada *et al.* (2003) and understanding of the biology of the species has increased considerably since then. To establish the known range and start to assess range-wide threats to Omura's whales, SC/67a/NH12 summarised its distribution based upon reports (n=116) verified by the authors. All records were between 35°N and 35°S, with 79% between 23.5°N and 23.5°S. Cerchio reported on new findings on northwest Madagascar Omura's whales. Cerchio *et al.* (2015) reported on the detailed physical description and ecology of a population of Omura's whale off Madagascar; additional information on this population is presented in Annex G, item 7. de Vos (2017) reported on the first documentation of Omura's whale off Sri Lanka.

Attention: G

The Committee ***welcomes*** *the substantial new information presented on the poorly known Omura's whale. It encourages further work throughout range, particularly in areas where research similar to that being conducted off Madagascar can be conducted. The Madagascar studies have made a substantial contribution to knowledge of this species and the Committee* ***recommends*** *that this work to be continued and expanded.*

9.3.3 North Atlantic Bryde's whales

Rosel *et al.* (2016) presented information on Bryde's whales in the Gulf of Mexico where they are the only resident baleen whale species. They are restricted to a small area, mainly in the northeastern Gulf along the continental shelf. In 2009 (the year before the *Deepwater Horizon* oil spill) the population was estimated to be 33 (CV=1.07), similar to the eastern North Pacific right whale population. Their distribution may have covered the northern and southern Gulf as whaling records report sightings and some takes of 'finback' whales there which were probably Bryde's whales (Reeves *et al.*, 2011). The small population size, restricted range and low genetic diversity places these whales at significant risk of extinction. The northern Gulf is highly-industrialised. Oil and gas operations, commercial fishing, and large ports with significant shipping pose significant threats (Rosel *et al.*, 2016). Several human-induced mortalities are known in recent years. The impact of the 2010 *Deepwater Horizon* oil spill may have resulted in a maximum 22% decline.

The available evidence clearly demonstrates that this recently identified taxon, which ranks as at least a new subspecies and possibly a species. Its precarious conservation status mimics that of the eastern North Pacific right whale population estimated to be about 30 whales. Therefore, these Gulf of Mexico Bryde's whales should also be considered critically endangered.

Attention: CG-A, S

The Committee ***agrees*** *that the small population of Bryde's whales in the Gulf of Mexico (which ranks as at least a separate subspecies and possibly a species) is the world's most critically endangered baleen whale and there is grave concern for its continued survival. It* ***recommends*** *that US authorities use all available legal and regulatory tools to provide the maximum protection for this population. The necessary actions are detailed in Annex G, item 9 and include: (a) the continued exclusion of seismic surveys from the eastern Gulf of Mexico; (b) the design and conduct of targeted research programmes and restoration projects; (c) measures to reduce the risk of ship strikes and entanglement; and (d) collaborative studies by Mexican and US scientists in the southwestern Gulf where American whalers encountered what were likely Bryde's whales in the late 18th and 19th centuries.*

The Committee ***requests*** *that the Secretariat: (a) transmits the concerns in Annex G, item 9 to the range states; and (b) to IMO with respect to ship strike mitigation.*

9.3.4 North Atlantic blue whales

The Committee received new information on studies on blue whale song occurrence in the North Atlantic. There appears to only one blue whale song type in the North Atlantic, excluding Antarctic blue whale songs reported from low latitudes (SC/67a/SH10).

9.3.5 North Atlantic humpback whales

The Committee received information on an Unusual Mortality Event (UME) along the United States Atlantic coast from Maine to North Carolina between 1 January 2016 and 5 May 2017. A total of 43 humpback whale mortalities have been documented. For further discussion see Item 15.7.1 and Annex K.

9.3.6 North Atlantic bowhead whales not subject to aboriginal subsistence whaling

No new information was available to the Committee.

9.3.7 North Pacific bowhead whales not subject to aboriginal subsistence whaling

SC/67a/NH10 presented a mark-recapture abundance estimate for bowhead whales in the western Okhotsk Sea.

Table 13

Work plan for other Northern Hemisphere stocks (excluding those subject to ASW).

Topic	Intersessional period	2018 Annual Meeting (SC/67b)
North Atlantic sei whales	-	Review new information, if any.
North Atlantic right whales	Plan for future Workshop (Annex W)	Review workshop report.
North Pacific right whales	SG-4 on right whale Workshop	Review proposal.
North Pacific fin whales	-	Review new information, if any.
North Pacific blue whales	ICG-18 on North Pacific blue whale assessment	Review ICG recommendations.
Omura's whale	-	Review new information, if any.
North Atlantic Bryde's whales	Intersessional work of the Secretariat with range states and IMO with respect to ship strike mitigation.	Review report for the Secretariat.
North Atlantic blue whales	-	Review new information, if any.
North Atlantic humpback whales	ICG-5 abundance reviews from Icelandic surveys.	Review recommendations from ICG-5 on Icelandic surveys, with ASI.
North Atlantic bowhead	-	Review new information, if any.
North Pacific bowhead	-	-
North Pacific sperm whales	ICG-19 on sperm whale assessment.	Review recommendations.
Indian Ocean sperm whales	ICG-19 on sperm whale assessment.	Review recommendations.

The Committee endorsed the 2016 estimate of 218 whales (CV=0.22) as adequate to provide a general indication of abundance (see Annex Q, item 12.1).

Attention: SC, G
The Committee expressed ***concern*** *at the small population size of the Okhotsk Sea bowhead whales. It noted that there was some evidence that this population may be in decline. Additional data are required to understand the status of this population. The Committee* ***recommends*** *that fieldwork resume in 2018 and be repeated at least every 2nd year thereafter.*

9.3.8 North Pacific sperm whales
Rone *et al.* (2017) provided information on the occurrence and distribution of sperm whales in the northwestern Gulf of Alaska (south and east of Kodiak, including offshore waters), from three joint visual/acoustic surveys conducted in 2013 and 2015. SC/67a/NH06 presented sightings of sperm whales in several coastal areas of Russia.

The Committee agrees that the Intersessional Group on investigating possible ways to assess sperm whales is reappointed under Brownell (Annex W).

9.3.9 Northern Indian Ocean sperm whales
SC/67a/SH13 reported on the known historical and recent unpublished records of sperm whale captures, strandings and sightings from Oman and the United Arab Emirates (UAE). There is a year-round presence of sperm whales off these coasts. The authors suggest that Arabian Sea sperm whales form a discrete population that is likely to be subject to threats associated with increased shipping activity. A threefold increase in container shipping traffic between 2004 and 2014 was noted. A project, initiated by Government of Fujairah and Port of Fujairah in 2017 is the first dedicated field based study on sperm whales in the region and offers the potential to disseminate information on the negative associations of whales and ships to the 14,000 vessels that visit the port every year.

Attention: SC, G
The Committee ***encourages*** *analysis of genetic samples from Northern Indian Ocean sperm whales to better assess the level of differentiation and diversity of this poorly understood population.*

9.3.10 Work plan
The work plan is given in Table 13.

9.4 New information and work plan for other Southern stocks
9.4.1 Southern Hemisphere sei whales
No new information was provided this year.

9.4.2 Southern Hemisphere humpback whales
9.4.2.1 BREEDING STOCK D
The assessment of the breeding stocks D (West Australia), E1 (East Australia) and Oceania was completed in 2014 (IWC, 2015d), but there were substantial associated problems in obtaining a reliable estimate of absolute abundance for breeding stock D. The available survey data for this breeding stock have presented two challenges: (1) there are few data to inform a correction for surface availability; and (2) there is a potential inconsistency between observer protocols and the Distance-based approach employed to estimate abundance. See Annex H (IWC, 2016h; 2017e) for a detailed discussion of these issues. The provision of a reliable abundance estimate for Breeding Stock D is also important for stock assessments off East Australia and Oceania, since all three populations have been co-analysed in a three-stock model framework, to accommodate overlaps in high latitude catch allocation (IWC, 2015d). This year the Committee agreed that there was no strong case to further examine past survey data for BSD, because recent efforts by two experienced modellers could not improve on previous analyses of abundance. Rather efforts should focus on designing and implementing a new 'survey' (perhaps using new approaches, as provided by drones, for example). Prior to implementation, an assessment of the feasibility of such a 'survey', focusing in particular on the study conducted by du Fresne *et al.* (2014), is required.

Attention: SC, G, CG-R
Obtaining a reliable estimate of absolute abundance for humpback whale Breeding Stock D (west Australia) is a priority for any future in-depth assessment. The Committee ***recommends*** *an evaluation of abundance survey feasibility be carried out for this population, focusing in particular on the study conducted by du Fresne* et al. *(2014), with a view to implementing a new survey of this population in the future.*

9.4.2.2 BREEDING STOCK G
As discussed for blue whales above, an IWC photo-identification Workshop was held in Chile in 2016 (SC/67a/Rep03, see Item 9.2.2.5 for details). The Workshop participants agreed a strategy for combining photo-identification catalogues from the Central and Eastern South

Table 14
Work plan for Southern Hemisphere humpback whales.

Item	Intersessional period	2018 Annual Meeting (SC/67b)
Ongoing work	Re-analysis of sightings data reported by duFresne to assess best location/approach for new sightings surveys off West Australia (BSD).	Report
	Analysis of high and low latitude stock mixing proportions in the southeastern Indian Ocean and southeast Pacific using genetic data.	Report

Pacific and the Antarctic Peninsula. A compilation of existing photo-identification data was made as part of an existing initiative (Humpback Whale Catalogue Sharing Initiative, HWCSI) to investigate connectivity among various areas in both breeding and feeding grounds of BSG (SC/67a/Rep03, table 4). All participants who were part of the HWCSI agreed to collaborate on developing new population estimates of abundance for BSG humpback whales, via the following process: (1) development of a data sharing agreement; (2) reconciliation of regional catalogues; (3) matching of photo-identification data (e.g. use of existing software); (4) description of quality control procedures; (5) development of a framework to compute new abundance estimates.

SC/67a/PH03 summarised work conducted in the past year by the Antarctic Humpback Whale Catalogue (detailed in Annex S). Olson noted the development of an automated matching system by the Happywhale project (SC/67a/PH02), which is collaborating with the Antarctic catalogue, potentially represents a major advance for catalogue matching, which can offer the possibility of rapid comparisons to facilitate broad investigations involving multiple catalogues across a wide area.

9.4.2.3 FEEDING GROUNDS
SC/67a/ASI07 and SC/67a/SP05 report sightings of 253 groups of humpback whales (516 animals) during the NEWREP-A survey (a dedicated sightings survey in Area V-West) and 534 groups (1,017 animals) during the Antarctic minke whale sampling survey (conducted in Area III-East and Area IV). A total of 30 individual humpbacks were photo-identified, and 11 were biopsied (SC/67a/ASI07: seven individuals and SC/67a/SP05: four individuals).

The Committee received an update about the population structure of breeding stock A, B, C and Arabian Sea humpback whales, which is now published (Kershaw *et al.*, 2017). The paper contains some increased sample sizes and new analyses that overall reinforce previous conclusions discussed in Annex H (IWC, 2008b) and subsequent Scientific Committee reports.

9.4.2.4 WORK PLAN
The work plan is given in Table 14.

9.4.3 Southern Hemisphere right whales not the subject of CMPstem
This year, the Committee was provided with updates on whale trends and distribution for three southern right whale calving grounds: off South Africa; south and southwest Australia; and in the New Zealand sub-Antarctic. In 2016, the Committee agreed to re-examine the estimates of historical population size of southern right whales (IWC, 2017b, p.38). This year, the Committee initiated a review of available catch data for southern right whales (with a focus on pre-modern whaling catches) to decide if any substantive new information is available to assist with assessments of stock status for this species. This review will continue (see work plan below).

9.4.3.1 SOUTH AFRICA
SC/67a/SH05 provided the results of the 2016 survey of southern right whales along the coast of South Africa, part of the extensive long-term monitoring programme. Only 55 cow-calf pairs and 9 unaccompanied whales were sighted during the entire survey. This is the lowest sighting density of the last 25 years and about 10-15% of the expected total based on surveys up to 2014. This marked decline has been recorded in the last few years, with unaccompanied adults declining since 2010 and cow-calf pairs since 2015. A subsequent analysis of seasonal presence patterns does not suggest that there has been a shift in coastal longshore distribution, since sightings have been reduced at all locations along the South African coast. It suggests that animals have remained offshore and not returned to the coast to calve in 2015 and 2016.

Attention: SC, G, C-A, CG-A
The Committee is ***concerned*** *that the future of this exemplary long-term monitoring programme of right whales in South African waters remains uncertain. The Committee:*

(1) ***strongly recommends*** *continuation of the survey and the use of IWC funds to allow the survey to take place as a one-off extraordinary measure (see item 6.1.3 of Annex H);*
(2) ***requests*** *the Commission to* ***urge*** *South Africa to do all it can to ensure the long-term future of this vital monitoring programme; and*
(3) ***encourages*** *South African scientists to investigate the offshore movements and locations of southern right whales with future surveys.*

9.4.3.2 AUSTRALIA
The Committee was informed about the latest of a series of aerial surveys conducted in South and West Australia in late August 2016. Counts were obtained of 628 individuals including 228 calves of the year. These counts were higher than the very low count of 97 individuals in 2015, but still below the recent trend line. Regression analysis from 1993-2016 gives increase rates for all animals of 5.55% (95% CI 3.78-7.86), and for cow/calf pairs 6.01% (3.49-8.59) per annum. Work at the Head of the Bight (South Australia) now comprises 26 years of cliff-based counts and photo-identifications; southern right whales are particularly concentrated in this location. The estimated increase rate of whales sighted there from 1991-2016 is 5.5% (95% CI=0.03) per annum. There is no evidence for a population increase in calving females at Logan's beach, southeastern Australia, where they are most concentrated.

Attention: SC, G, CC, CG-A
With respect to right whales in southeast Australia, the Committee:

(1) expresses ***concern*** *that abundance remains low despite this area having been a significant historic calving ground; and*

Table 15

Workplan for southern right whales not subject to CMPs.

Item	Intersessional period	2018 meeting
All	Update available data regarding pre-modern catches in the Southern Hemisphere.	Report
South Africa	Conduct 2017 right whale aerial survey off South Africa to collect photo-identification and count whales.	Report

*(2) **recommends** that an assessment of the likely effects of fish farms and other developments in hindering population recovery in this region.*

9.4.3.3 NEW ZEALAND

Torres *et al.* (2016) surveyed southern right whales around the sub-Antarctic Campbell Island in the austral winter of 2014, using a variety of techniques. Primary findings suggest that this area is part of the broader New Zealand southern right whale population, and primarily used by sub-adults who forage in the sub-Antarctic. SC/67a/SH08 presented calving rate estimates for this population from the Auckland Islands over 2006 to 2013. Calving interval was estimated at 3.31 years (95% CI 3.06-3.57) and juveniles and adult survival at 0.98 (SE 0.07). A stochastic model using these values and accounting for parameter uncertainty and year-to-year variability, estimates population growth at 4.8% (95% CI 2.4%-6.4%).

9.4.3.4 WORK PLAN

The work plan is given in Table 15.

9.4.4 Antarctic minke whales

SC/67a/ASI07 and SC/67a/SP05 report sightings of Antarctic minke whales during the NEWREP-A survey (a dedicated sightings survey in Area V-West) and the Antarctic minke whale sampling survey (conducted in Area III-East and Area IV). A total of 481 groups of Antarctic minke whales (873 individuals) were sighted. Three satellite tags were successfully deployed on Antarctic minke whales. A feasibility study on biopsy sampling Antarctic minke whales was conducted and 15 biopsy samples were collected (see Appendix 1, SC/67a/ASI07).

9.4.5 Dwarf minke whales

No new information was provided this year.

9.4.6 Southern Hemisphere Bryde's whales

Pastene *et al.* (2015) summarised a genetic analysis to investigate the species identity and population genetic structure of South American Bryde's whales using samples collected off Chile and Brazil. Phylogenetic results identified the Bryde's whales of South America as *Balaenoptera brydei*. No significant genetic differentiation was found between Chilean and Peruvian Bryde's whales, but significant differences were found between western South Atlantic (Brazil) and eastern South Pacific (Peru and Chile) Bryde's whales, consistent with the notion that *B. brydei* is not distributed south of ~40°S on both sides of South America.

SC/67a/SH15 presented results from 2000-17 surveys and photo-identifications of Bryde's whales along the Ecuador, Peruvian and Panama coasts, spanning 573 marine mammal surveys. During these, 81 groups of Bryde's whales (102 individuals) were recorded and 64 individuals were photo-identified. Three were resighted; one of these was between Ecuador and Peru.

Attention: SC, G

*Bryde's whales in the South American waters are poorly understood. The Committee **welcomes** these new contributions (Pastene* et al.*, 2015 and SC/67a/SH15). It **encourages** genetic studies to confirm the identity of Bryde's whales in Ecuadorean and Peruvian waters, given the possible presence of two Bryde's whale forms in the region (*B. b. edeni *and* B. b. brydei*).*

9.4.7 Southern Hemisphere sperm whales

SC/67a/SH12 reported detections of sperm whales from visual observations and a towed array of hydrophones over 2014-17 in sub-Antarctic and Antarctic waters of the northwest Antarctic Peninsula. The study increases the knowledge of the status of sperm whales in the Southern Ocean and emphasises the importance of acoustics to detect populations. Details can be found in Annex H, item 8.

10. STOCKS THAT ARE OR HAVE BEEN SUGGESTED TO BE THE SUBJECT OF CONSERVATION MANAGEMENT PLANS (CMP)

This item covers stocks (with a focus on progress with scientific work and information) that are either: (1) the subject of existing CMPs; or (2) are high priority candidates for a CMP. It also considers stocks that have previously been considered as potential CMPs, recognising that the Commission has stressed the need for Range States to support any IWC CMPs.

10.1 Stocks with existing CMPs

10.1.1 SE Pacific southern right whales

10.1.1.1 NEW INFORMATION

The Committee received information on the entanglement and mortality of a right whale from this critically endangered population in southern Chile in February 2017 (SC/67a/HIM14). This is discussed further in Annex J, item 2.1. See also Items 10.1.1.2 and 13.1.3.

SC/67a/CMP13 reported on recent progress on the development of acoustic monitoring of this population, a project which was supported by the Scientific Committee in 2016. The use of moored hydrophones to investigate seasonal distribution of animals along the coasts of Chile and Peru is proposed and this may potentially provide information on the location of breeding grounds using reproductive vocalisations. The information the project may provide is central to the implementation of the long-term monitoring programme envisioned by the CMP. The Committee noted that the primary goal is to identify breeding areas for this population and the secondary goal is to use acoustic recordings to inform vessel-survey effort.

10.1.1.2 PROGRESS WITH THE CMP

SC/67a/CMP09 reported on the first international coordination meeting to implement the eastern south Pacific southern right whale CMP which was held 7-8 March 2017 in Santiago, Chile. During the meeting, a Memorandum of Understanding between Peru and Chile to formalise co-operation on the CMP was agreed, a Bi-National Steering Committee for 2017-18 was established, priority actions were reviewed and an implementation strategy was proposed. Short-term priority rangewide actions included the identification of a breeding area; increased photo-identification and genetic data; increased capacity regarding entanglement response and increased species identification capacity. A second meeting is scheduled for March-April 2018 in Peru.

Attention: CC
*The Committee **welcomes** the progress being made in implementing the SE Pacific southern right whale CMP for this critically endangered population. The Committee:*

*(1) **commends** the scientific work being undertaken and the international co-operation this entails and it **looks forward** to receiving the results of the acoustic studies;*
*(2) expresses **concern** regarding the entanglement mortality reported in SC/67a/HIM14 and **reiterates** that anthropogenic mortality should be kept to a minimum; and*
*(3) **welcomes** the information that increased entanglement response capacity is a priority action within the CMP.*

10.1.2 Southwest Atlantic southern right whales

10.1.2.1 NEW INFORMATION

SC/67a/CMP01 reported on aerial surveys conducted to estimate the relative abundance of southern right whales from the mouth of the Chubut River (42°30') to Puerto Lobos (42°), with long-term efforts to document temporal changes in distribution by age and sex classes. The authors concluded that data support the increasing trend in abundance for southern right whales in the Península Valdés nursing area, while the rate of increase is decreasing. Additionally, it was noted that the rate of increase for calves is smaller than previously reported and that the numbers of solitary individuals and breeding groups are no longer increasing, suggesting that whales are relocating within and out of the Península Valdés area. The authors commented that once whales reach a density of 2.5-3.0 per km^2 they begin to relocate along the coast in areas presumed to be of poorer habitat.

SC/67a/CMP06 reported on the series of aerial surveys of this population undertaken since 2007 in San Matías Gulf, Argentina. Whales were mainly found near the northwest coast of the San Matías Gulf but some changes in distribution have been noted. In discussion, it was noted that although the kelp gull population in the San Matías Gulf has been increasing, gull harassment has not been recorded in areas outside Península Valdés.

SC/67a/CMP08 provided information on opportunistic sightings of southern right whales on the Patagonian shelf and shelf break off Argentina during austral summer was presented, along with satellite-telemetry data from whales tagged off Península Valdés following the Committee's recommendation last year (IWC, 2017b). Encounter rates in the Patagonian shelf between 42°S to 46°S were substantially higher than south of 46°S and in the shelf break, which is consistent with satellite-telemetry data and indicated a probable feeding ground. In discussion, it was noted that traditionally, catalogues of this species involve aerial photographs using aerial surveys. The authors noted that photographs had been taken from the vessel and they welcomed future discussions on how to reconcile these with aerial photographs.

10.1.2.2 PROGRESS WITH THE CMP

The Committee was updated on actions developed during June 2016-April 2017 in Argentina for the southern right whale CMP for the SW Atlantic (see Annex O, Appendix 2). Activities were proposed and carried out to: (1) ensure long-term monitoring of abundance, trends and biological parameters; (2) enhance existing stranding networks including the capacity for undertaking post-mortem examinations; (3) research movements, migration routes and the location of feeding grounds; (4) develop and implement a strategy to minimise kelp gull harassment; and (5) develop a strategy to increase public awareness.

The report highlighted telemetry studies undertaken to address activity (3) regarding movements, migration routes and the location of feeding grounds, for whales wintering near Península Valdés. Between 2014-16 ten location-only and six archival transdermal satellite tags were deployed on individuals of both sexes and different maturity/reproductive stages. Data showed substantial individual and yearly variation and provided new insights regarding habitat use and the potential for connections with additional habitat along the coast of Argentina during the breeding and calving season. Future studies are planned.

Attention: CC, CG-R
*The Committee **welcomes** the progress being made in implementing the SW Atlantic southern right whale CMP for this endangered population. It **acknowledges** the importance of the CMP and **encourages** the continued cooperation and collaboration between all research groups and stakeholders to build the knowledge needed to inform mitigation action for this population. In particular, the Committee **recommends**:*

(1) continued exploration of methods to encounter and observe live calves prior to death and to gather individual health information on both cows and live and recently deceased calves;
(2) increased efforts to elucidate the differences between nutritional stress imposed on calves caused by disruption of nursing behaviour and other types of physiological stress resulting from open wounds, energetic expenditure related to avoidance behaviours and other stressors experienced by whales;
(3) continuation of the work to understand habitat-use, dispersal and migratory patterns at different scales, in connection to overall population demography;
(4) continuation of long-term monitoring studies including photo-identification and aerial surveys;
(5) increased effort to obtain biopsy samples given the few that are now available; and
(6) increased use of suitable platforms of opportunity for data collection.

*The Committee **reiterates** previous recommendations to continue development, implementation and support for the Action Plan to mitigate kelp gull-Southern right whale interactions, recognising the efforts made by the local government of Chubut (IWC, 2016j).*

10.1.3 North Pacific gray whales

10.1.3.1 THE RANGEWIDE ASSESSMENT

The fourth Rangewide Workshop on the Population Structure and Status of North Pacific Gray Whales was held from 27-29 April 2017 in La Jolla, California (SC/67a/Rep04). This series of workshops originated in the need to consider new telemetry and photo-identification data that suggested that the 'traditional' ideas surrounding two separate populations in the North Pacific ('eastern' and 'western') needed re-evaluation. The present Workshop's primary focus was to review new information in the light of the stock structure hypotheses developed at previous workshops. Updated information on the analyses of whole genome sequences and SNPs and news that additional studies were ongoing to compare samples from Sakhalin Island and Mexico were presented. New photo-identification data for PCFG (Pacific Coastal Feeding Group) whales was presented, and the Workshop reviewed new information on abundance and on mixing rates for PCFG whales for use in the modelling framework. The formal review of the abundance estimates presented at the Workshop was referred to SC/67a. An important component of the Workshop discussions was related to how to develop and include time series of bycatch (and ship strike) data in the assessment. Based upon the new information, the Workshop agreed to take four stock structure hypotheses forward.

Punt summarised the progress made on the modelling aspects of the work plan since the Workshop. He noted that that the model specifications and associated code had been updated to treat entanglements and ship strikes separately and to calculate survival rates for PCFG animals separately for animals that joined the population before and after 1999.

There was some discussion of the work needed to finalise the assessment at the next meeting. As requested, the Committee reviewed the new abundance estimates presented at the Workshop. These were endorsed and accepted for use in modelling (Item 12.1).

In discussion of the approach used to estimate bycatches and ship strikes, it was noted that the mixing rates used in the model were informed by data from northwest Washington, and that these data do not represent a random sample of the west coast. It was suggested that photo-identification and telemetry data could assist in providing some inferences on residence time. Recognising the difficulties of modelling bycatch and the associated uncertainty, the Committee agreed that the three scenarios agreed upon during the Workshop represented a reasonable way forward.

In recent years as part of the rangewide review, the Committee has recommended and encouraged the sharing of gray whale samples to better understand the stock structure of North Pacific gray whales. Japan kindly indicated its willingness to share samples collected by its scientists if a formal request was submitted. A formal request from USA to Japan through the IWC Data Availability Group is now being reviewed by Japan. The Committee noted that such cooperation and collaboration is also facilitated through the Memorandum of Cooperation (MoC) 'concerning conservation measures for the Western Gray Whale population' among the participating range states. The Committee looks forward to receiving papers detailing analyses that incorporate these data. Recommendations related to the CMP can be found under Item 10.1.3.3.

Attention: SC, CC

The Committee ***recognises*** *the importance of the rangewide review of the status of North Pacific gray whales to the updating of the CMP and to the provision of advice on aboriginal subsistence whaling. The Committee:*

(1) ***thanks*** *the Convenors and participants of the rangewide Workshop on North Pacific gray whales, welcomes the progress made and* ***endorses*** *the report of the Workshop and its recommendations; and*
(2) ***recommends*** *that a 5th workshop be undertaken with a goal of completing the rangewide review at the 2018 Annual Meeting.*

10.1.3.2 REGIONAL STUDIES

See Item 13.1.2 for information on known sources of data on non-hunting, human-caused injuries and mortalities of gray whales in the North Pacific from stranding networks (SC/67a/HIM06), and gray whale entanglements in the western North Pacific (SC/67a/HIM17).

10.1.3.2.1 RUSSIA

The Committee has had a long-standing co-operation with the IUCN Western Gray Whale Advisory Panel (WGWAP) and the CMP is a joint IUCN/IWC CMP for western gray whales. A progress report on this work can be found in Annex O, Appendix 5. Since 2016, the Panel's Noise Task Force met twice and focussed primarily on follow-up work related to monitoring and mitigation during Sakhalin Energy's 2015 seismic survey off Sakhalin Island and development of a monitoring and mitigation plan for another large-scale seismic survey in 2018.

The Committee reviewed findings from 2016 field studies conducted by the Russia Gray Whale Project (formerly the Russia-US Programme) on gray whales feeding near Piltun Lagoon in the western North Pacific off Sakhalin Island (SC/67a/NH03). This research programme has been ongoing since 1997 and represents the 20+ year time series that has served as the foundation for the assessment of the population.

There was a general discussion of the information from the Sakhalin and Kamchatka areas including the results of SC/67a/NH11 (for a full discussion of that paper see Item 12). Additional studies off Kamchatka will assist in better understanding the relationship between whales from Sakhalin and Kamchatka.

Attention: SC, S

The Committee ***commends*** *the ongoing work on gray whales in the Russian Federation. The Committee:*

(1) ***recommends*** *that studies in the Kamchatka area resume as they can provide valuable information for analyses regarding stock structure and status;*
(2) ***recognises*** *the importance of the work of the Russian Gray Whale Project to the assessment of the animals feeding of Sakhalin and* ***recommends*** *that it continues;*
(3) *in light of previous recommendations that the two groups working off Sakhalin (the Russia Gray Whale Project and the Joint Programme of Sakhalin Energy and ENL) work together to develop a single, publicly available photo-identification catalogue,* ***encourages*** *Donovan to work with the various data holders to facilitate the development of a single, reconciled catalogue and database; and*
(4) ***encourages*** *the Russian Federation to continue to collect photo-identification data (including from Chukotka) and recommends that any technical obstacles (e.g. lack of small boats) be overcome to collect biopsy samples from areas where there are few samples for rangewide genetic analyses.*

10.1.3.2.2 JAPAN

The recent status of conservation and research on gray whales in Japan was reported in SC/67a/CMP02. During May 2016-April 2017, no anthropogenic mortality has been reported from the adjacent waters off Japan, while two opportunistic sightings of gray whales were made in Tokyo Bay on 22 February and 18-23 April.

Sightings from Izu archipelago and Shizuoka prefecture from 2015 to 2016 were identified as the same individual. In discussion, an additional report (sourced on Facebook) of a gray whale seen and reported photographed off Aogashima Island, Japan, was noted. Whilst the photograph was clearly of a gray whale, the Committee noted that confirmation of the location can be more problematic in such cases unless the original source is known.

Attention: CG-A
The Committee ***welcomes*** *the provision of information from Japan on gray whales, especially that of the sightings off Japan's coast, and* ***encourages*** *researchers to continue to collect sighting information on this species off the coast of Japan which may also provide information as to what age classes are found there.*

10.1.3.2.3 EAST CHINA SEA

Gagnon (2016) reported on recent acoustic detections made by the US Navy of what have been tentatively classified as gray whales in the East China Sea. These detections have been made on numerous occasions over the last six years (2011-16) using towed hydrophone arrays in mobile, high-precision acoustic monitoring systems. These calls have been detected annually in relatively shallow waters between September and March. The whales remain in the same general areas for weeks at a time, but have generally been observed to be moving south in the autumn and north in the spring. These acoustic data have not yet been accompanied by visual observations to confirm species identification . The author expressed his willingness to collaborate with biologists familiar with gray whale calls, with the goal of verifying species identification. If it is determined with high probability that these are gray whale calls, it will be important to develop a dedicated field-research effort to verify species identification with visual observations, photographs and biopsies.

Attention: CC, CG-R, G
The acoustic information provided in Gagnon (2016) is potentially of great importance to our understanding of population structure and breeding grounds of gray whales in the western North Pacific. The Committee:

(1) ***welcomes*** *the information regarding acoustic detections of possible gray whales in the East China Sea and expresses its* ***appreciation*** *to the author and the US Navy for bringing it forward;*
(2) ***endorses*** *the recommendation from the Workshop that every effort be made to determine with high probability whether or not the calls are from gray whales and* ***encourages*** *the US Authorities to assist in this process; and*
(3) if they are gray whale calls, ***recommends*** *that a dedicated field effort is planned and executed to observe, photograph and biopsy the animals.*

10.1.3.2.4 MEXICO

The results of gray whale research conducted in the breeding lagoon of San Ignacio and Bahía Magdalena complex were presented in SC/67a/CMP11. Overall, the number of gray whales and their seasonal occupation in the lagoon were slightly lower than seen in previous years, and the authors thought that this was probably due to cooler sea-surface temperatures. Conversely, the number of single animals observed in the Bahía Magdalena complex was notably higher in 2017.

An update and overview of results from shore-based surveys of northbound eastern North Pacific gray whale calf production was presented. Calf production has been particularly high during the past 5 years with an estimated total production of more than 6,500 calves during this period. The 2016 estimate of calf production (1,351) is about 5% of the reported total abundance (26,960) for the eastern North Pacific population in 2016. The midpoint of the migration is now occurring about a week later than it did in the mid-1990s.

Attention: G, CG-R
The Committee ***welcomes*** *the results of the long-term studies of gray whales in the wintering areas in the lagoons of Mexico and the northbound shore-based migration counts. It* ***reiterates*** *the importance of these long-term studies and* ***recommends*** *that they continue, particularly for analyses of abundance and calf production in conjunction with environmental factors. Such analyses can provide general as well as specific insights on the population dynamics of whales in response to environmental factors.*

10.1.3.3 PROGRESS WITH THE CMP

The Committee **recognises** the importance of the IUCN/IWC CMP to the conservation of gray whales. It **reiterates** its willingness to assist in scientific aspects of the development and updating of the CMP. As referred to above, the forthcoming rangewide Workshop will provide a major component of the scientific input to the CMP.

Attention: CC, C-R
The Committee is willing to assist in the development and updating of the IUCN/IWC CMP for western gray whales. Accordingly, the Committee:

(1) ***reiterates*** *its support for the stakeholder workshop planned to occur before the 2018 Commission meeting and* ***recognises*** *that the results of the Workshop are important for the updating of the CMP;*
(2) to facilitate the stakeholder workshop, ***recommends*** *that a small drafting group meeting be held to update the scientific aspects of the CMP;*
(3) ***encourages*** *the range states of other CMPs to follow the positive example of the Memorandum of Co-operation signed by Japan, Russian Federation, USA, Korea and Mexico.*

10.1.4 Franciscana

10.1.4.1 NEW INFORMATION

SC/67a/SM04 provided a preliminary report on an assessment of the fisheries characteristics in two Franciscana Management Areas (Ia and Ib) thought to have the smallest abundance, which are geographically disjoint from all other areas and likely subject to high levels of bycatch. Of the 76 fishers interviewed, 54 claimed to know of franciscana, but only nine could accurately identify them based on illustrations.

In discussion, it was noted that, typically, most fishers can identify franciscana in the field and that the improper identification of the species from photographs may have been an artefact of the photographs that were used or that fishers chose to provide false answers in the interest of securing access to fishing within these areas.

10.1.4.2 PROGRESS WITH THE CMP

SC/67a/SM12 reported on the beginning of the implementation of the franciscana CMP. A Steering Committee has been initiated including representatives from Argentina, Brazil, and Uruguay, IWC Conservation Committee Chair, IWC Scientific Committee Chair, IWC CMP Standing working group Chair and IWC Head of Science. Iñíguez is the co-ordinator. The two main objectives of the CMP are to protect franciscana habitat and to minimise anthropogenic threats (e.g. bycatch) to the population. A number of priority actions have been developed to meet those objectives.

The Committee **welcomed** news that Brazil will be providing one million dollars for research and conservation work according to its National Action Plan for Franciscana in management areas II and III.

Attention: CC, SC
The franciscana CMP is the first for a small cetacean species and the Committee welcomes the development of more small cetacean CMPs as appropriate. The Committee:

(1) *commends the breadth of work that has been undertaken towards franciscana research and conservation;*
(2) *commends efforts being made to coordinate research across international boundaries;*
(3) ***recommends** that this collaboration continue and expands, whilst recognising the difficulties involved;*
(4) ***recommends** that a review of franciscana be conducted as soon as possible that incorporates new estimates of franciscana mortality (as previously recommended by the Committee); and*
(5) ***recommends** that the use of pingers be further investigated in the range of the coastal environment of this species.*

10.2 Progress with identified priorities

10.2.1 Humpback whales in the northern Indian Ocean including the Arabian Sea

10.2.1.1 NEW INFORMATION

The Committee was pleased to receive several papers reviewing information from around the region, including humpback whales in the Persian Gulf (SC/67a/CMP14), baleen whale records from Pakistan including the results from a promising programme implemented by WWF-Pakistan to train captains and crew members of tuna gillnet vessels to document sightings, entanglements and bycatch (SC/67a/CMP05); and baleen whale records from the Indian coast of the Arabian Sea. Details can be found in Annex O, item 3.1.1.

SC/67a/CMP12 reported on Oman-based satellite telemetry studies initiated in 2014. Telemetry data from nine whales showed whales spending 35% of their time in the Gulf of Masirah and 27% in Hallaniyat Bay. The authors updated the Committee on the increasing threats to areas of critical habitat and high cetacean biodiversity, including increased numbers of gillnet fishing vessels in Hallaniyat Bay. Shipping traffic in the Gulf of Masirah is expected to increase in baleen whale the next five years due to new investment and the further development of the port of Duqm and associated industrial area. The port of Duqm has supported and is currently supporting a management and mitigation plan, but continued effort is required to ensure that research informs such plans. The authors noted that recent stranding records confirm the importance of addressing bycatch in this area.

SC/67a/CMP15 reported on the use of an Ensemble Ecological Niche Modelling approach to predict humpback whale habitat throughout the Arabian Sea using vessel-sightings data and satellite-telemetry data from Oman. Model predictions fit well with historical locations of Soviet whale captures from the 1960s and co-occur with areas of high vessel-traffic density in the Northern Indian Ocean. Telemetry data provided the most robust source of data, but models could be improved upon by incorporating data from other range states.

The progress of the Arabian Sea Whale Network (ASWN), an informal collaboration between researchers and conservation bodies working toward better understanding and the conservation of whales in the Arabian Sea, was presented in SC/67a/CMP07rev1. The paper summarised the 12 reports prepared for this Committee meeting by ASWN members and colleagues working in the region, including contributions from Oman, India, Pakistan, Sri Lanka and the Persian Gulf, demonstrating concrete progress toward increased awareness, data collection and capacity building in the region. Most recommendations (see IWC, 2016h, p.280) related to improved communication, awareness raising and capacity building have progressed adequately, but the raising of funds for shared regional-level projects has been challenging and limited to funds granted by the IWC and WWF. Co-funding from WWF and the Environment Society of Oman enabled EWS-WWF to sign a contract with Flukebook[10] allowing photo-identification data from Oman to be included in the online platform starting in June 2017. A fully functioning data platform with expanded capacity to archive and analyse sightings, strandings and genetic data, as well as photo-identification data should be ready to share by next year.

Attention: SC, G, C-R, CC
*The Committee **welcomes** the new information from the region on this critically endangered population and commends the researchers for their initiative, who are sometimes working in difficult conditions with a low level of funding. In light of the information presented, the Committee:*

(1) ***recommends** that additional systematic research be conducted within the Persian Gulf area to characterise the residency of whales reported in this area;*
(2) ***commends** the initiation of the 2012 observer programme in Pakistani waters, work which produced considerable data where previously there was none - and **recommends** that it continue and be replicated, where possible, throughout the region, especially where it is not feasible to conduct systematic cetacean surveys;*
(3) ***welcomes** the new records of humpbacks from the Indian coast of the Arabian Sea, recognising the importance of the research efforts - and **recommends** that further emphasis be placed on using acoustics to document cetaceans in these and other areas of the region;*
(4) ***recommends** that all entanglements be reported to the IWC and ship strikes entered into the IWC database;*
(5) ***recommends** that an enhanced effort be made to archive any tissue samples that are or become available in a central repository;*
(6) ***expresses** its appreciation to the Government of India, Maharashtra Forest Department and the local office of the United Nations Development Programme for their support of the work reported in SC/67a/CMP03;*
(7) ***recommends** that the satellite-telemetry work in Oman (SC/67a/CMP12) as much remains to be learned about whales in this area and where sources of potential anthropogenic mortality appear to be increasing;*
(8) ***recommends** that the collaborative efforts with industry to minimise risks to cetaceans in the port of Duqm be adopted in other ports and harbours in the region; and*
(9) ***welcomes** the extensive ensemble niche modelling work (SC/67a/CMP15) to predict humpback whale habitat throughout the Arabian Sea and **recommends** that the modelling be expanded to: (a) include data reported from Pakistan and India and be used to inform future research efforts; and (b) be used to examine potential threats from shipping using AIS/Vessel traffic data and fishing using any available data on fishing effort in the region.*

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[10]*http://www.flukebook.org/.*

10.2.1.2 PROGRESS WITH INTERNATIONAL CO-OPERATION AND REGIONAL MEASURES SUCH AS CMPS

SC/67a/CMP07rev1 summarised the progress of the Arabian Sea Whale Network (ASWN), an informal collaboration between researchers and conservation bodies. Progress was also made towards the implementation of a regional online data platform, funded under IWC SH3B, where a contract between the IWC and the Emirates Wildlife Society (EWS)-WWF, who will host the project, was signed in February 2017. See also Item 10.2.1.1.

The Committee was provided an update from the intersessional correspondence group assigned to consider proposing the Arabian Sea as candidate for a CMP. The group had been unable to secure endorsement from range state members and thus it initiated the ASWN to build momentum towards the development of regional conservation initiatives in the including a CMP. The IWC Scientific and Conservation Committees recently reiterated the value of an Arabian Sea CMP for this species (IWC, 2017b).

The Committee was informed that CMS has introduced a new mechanism with which to designate the status of species or populations as 'Concerted Action'. Efforts are underway to draft and complete a proposal to obtain this recognition for Arabian Sea humpback whales during the next CoP of CMS parties in October 2017. It would be valuable if the IWC collaborates on this effort, following the model of the joint IWC/IUCN CMP for western gray whales. Efforts are also underway to obtain support from the relevant range states for this initiative, which, as a joint IWC-CMS initiative, would include all Arabian Sea humpback whale range states.

Attention: C-A, S, SWG-CMP, CC

*The Committee **reiterates** its serious concern about the status of the critically endangered Arabian Sea humpback whale population and the anthropogenic threats it faces. It **stresses** the value of regional initiatives and **encourages** range states to explore the possibility of future collaboration. The Committee therefore:*

*(1) **commends** the work performed by researchers in the Arabian Sea, noting the expansion of research topics and recognising the difficulty of establishing and maintaining such a network, which it recognises as important for the conservation and management of this highly endangered humpback population;*
*(2) **encourages** range states to explore the possibility of future collaboration either through a CMP and/or CMS 'Concerted Action' and encourages IWC co-operation in these initiatives.*
*(3) **recommends** further development of the online regional data archiving platform to facilitate regional analyses and the comparison of data between study sites and the identification of locations conducive to passive acoustic monitoring to inform directed effort for documenting basin-wide distributions;*
*(4) **recommends** that the IWC Secretariat communicate the Committee's endorsement of the online data archiving platform to the relevant range states;*
*(5) **reiterates** last year's recommendation to collect tissue sample where possible to facilitate studies on the genetic identity of Arabian Sea humpbacks; and*
*(6) **recommends** continuation and expansion of all work that improves the knowledge of Arabian Sea humpback whales to inform conservation and mitigation measures.*

10.3 Stocks previously suggested as potential CMPs

No new information was provided for the following populations: (1) blue whales from the northern Indian Ocean; (2) sperm whales in the Mediterranean; and (3) boto in Amazonia. Donovan reported that efforts are underway to develop a CMP for fin whales in the Mediterranean by ACCOBAMS following the IWC model (and see Item 4.5.4).

10.4 Work plan

The work plan is shown in Table 16.

11. STOCK DEFINITION AND DNA TESTING

This agenda item merges two previously separate sub-groups (the Working Group on Stock Definition and the Working Group on DNA). The new Working Group on Stock Definition and DNA Testing (see Annex I) assessed genetic methods used for species, stock and individual identification, including matters associated with the maintenance of DNA registers (see Item 11.1); continued to develop and update guidelines for preparation and analysis of genetic data within the IWC context (see Item 11.2); and provided the Committee with feedback and recommendations concerning stock structure related methods and analyses, including those relevant to other sub-committees (see Item 11.3).

11.1 DNA testing

The DNA item has been considered since 2000 in response to IWC Resolution 1999-8 (IWC, 2000).

11.1.1 Genetic methods for species, stock and individual identification

This year, several papers were presented that used Single Nucleotide Polymorphisms (SNPs) to look at population or species-level questions of relevance to the Committee. Two of these papers used available whole genome data to design panels to genotype a moderate number of SNPs, most or all of which were chosen from genes known to be under selection, for use with population-level questions (e.g. stock structure, relatedness) in gray whales and bowhead whales, respectively (SC/67a/SDDNA02 and SC/67a/SDDNA03). A third paper used whole genome data to design a panel consisting of a small number of highly diagnostic SNPs to detect hybrid and back-crossed individuals across minke whale species (Malde *et al.*, 2017). These three papers highlighted the value of having whole genome sequence data available, which facilitates the design of SNP panels to address specific questions and allows multiple such panels, designed for different purposes, to be developed as needed.

The fourth paper used a different approach, double digest restriction-site associated DNA sequencing (ddRAD-seq), that does not require that genome sequence data is available *a priori* but instead allows for the simultaneous discovery and genotyping of thousands of SNPs (Lah *et al.*, 2016). These SNPs were used in combination with 13 microsatellite loci and mitochondrial haplotype data to examine spatial structure in harbour porpoises in the Baltic Sea; analysis using this combined dataset provided improved delineation of harbor porpoise population assignments for the Baltic Sea porpoises. When the data types were compared, SNPs outperformed microsatellite markers, particularly in the assignment of specimens to clusters of genetically similar individuals that may constitute separate stocks.

Attention: SC, G

*The Committee **welcomes** the opportunity to review papers that used Single Nucleotide Polymorphisms (SNPs) to look at population or species-level questions. The comparison of SNP data produced in different laboratories and over time*

Table 16

Summary of the work plan for the sub-committee on Conservation Management Plans (CMP).

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Southeast Pacific right whales	-	Review progress on scientific aspects of the CMP.
South Atlantic right whales	-	Review progress on scientific aspects of the CMP.
Gray whales	Workshop; CMP drafting group	Complete rangewide review.
Franciscana	-	Prepare for in-depth review.
Humpback whales in the northern Indian Ocean	-	-

is more straightforward than in microsatellites (traditionally the most commonly used nuclear markers) and thus facilitates the collaboration and data sharing that is often important in addressing questions of relevance to the Committee.

11.1.2 'Amendments' of sequences deposited in GenBank

While *GenBank* is an important resource to the scientific community, it is essentially an uncurated database of DNA sequences and thus contains sequences that are misidentified or have other annotation problems (Federhen, 2014). While retaining the 'raw data' represented in *GenBank* is valuable, less-experienced users may be unaware that additional sequence validation may be needed when incorporating *GenBank* sequences into a study.

Attention: SC, G

*The Committee **encourages** continued efforts to work with GenBank staff to identify a mechanism to allow annotation of GenBank sequences by interested parties to note taxonomic mis-assignment, questions about the source of the organism involved, or locus misidentification. The Committee **agrees** that a section discussing the precautions that should be used when including GenBank sequences in a study should be added to the IWC DNA quality guidelines (Item 11.2.1 below).*

11.1.3 Collection and archiving of tissue samples from catches and bycatches

The Committee previously endorsed a new standard format for the updates of national DNA registers to assist with the review of such updates (IWC, 2012a, p.53), and the new format has worked well in recent years. This year the update of the DNA registers by Japan, Norway and Iceland were based again on this new format. Details are given in Appendices 3-5 of Annex I for each country, respectively, covering the period up to and including 2016.

The Committee thanked the countries involved for providing this information.

11.1.4 Reference databases and standards for diagnostic DNA registries

The status of the DNA registries of Japan, Norway, and Iceland, respectively, are summarised in Annex I, Appendices 3-5. Almost all samples in the three registries have been analysed for microsatellites, and work on unanalysed samples is continuing. Almost all samples in the registries of Japan and Iceland have also been analysed for mtDNA. The Committee appreciates the efforts of Japan, Norway and Iceland in compiling and providing this detailed information of their registries.

Last year, the Committee welcomed information from Norway that they planned to upgrade the Norwegian minke whale DNA register (NMDR) by genotyping a suite of carefully selected Single Nucleotide Polymorphisms (SNPs) intended to keep the register's primary function of traceability of whale products in Norway and in the international market. The Committee also noted that SNP genotyping should be seen as a complement to, not a replacement of, the current microsatellite genotyping (IWC, 2017b, p.71).

Attention: SC, CG-A

*During this year's discussion of the Norwegian minke whale DNA register, the Committee was informed that mtDNA analysis on Norwegian samples had been discontinued and that microsatellite typing would eventually be replaced by SNP analysis. The Committee **expresses** concern regarding the comparability of the DNA registers in the future and **reiterates** the recommendation from last year that additional technical details of Norway's plan be provided at future meetings (IWC, 2017b, p.71). The Committee **encourages** coordination of all DNA registers so that they are based on comparable genetic markers, while also acknowledging that DNA registries are maintained on a voluntary basis.*

11.2 Guidelines for DNA data quality and genetic analyses

Two sets of guidelines have been developed for reference in the Committee's discussions of stock structure. Both sets are subject to ongoing update as appropriate.

11.2.1 Update DNA quality guidelines to include discussion of NGS data

The first set of guidelines addresses DNA validation and systematic quality control in genetic studies. These guidelines have been made available as a 'living document' on the IWC website since 2011[11]. In recent years, it has become common for the Committee to review papers using data derived from Next Generation Sequencing approaches, including SNPs, to address stock structure questions (see Item 11.3). Last year, the Committee agreed that the DNA data quality guidelines needed to be updated to incorporate discussion of data quality measures used for Next Generation Sequencing data (IWC, 2017b). The Committee reviewed a draft of the updated guidelines and suggested additional revisions to be addressed intersessionally.

Attention: SC

*The Committee **emphasises** the importance of keeping its guidelines related to genetic data quality and analyses up to date. It therefore **reiterates** the need to update these guidelines to incorporate discussion of data quality measures used for Next Generation Sequencing data. The intersessional working group established last year and convened under Tiedemann (Annex W) will continue its work to address this issue (see Item 12.5).*

11.2.2 Genetic analysis guidelines (completion)

The second set of guidelines covers types of statistical analyses of genetic data that are commonly used in IWC contexts, and contains examples of management problems

[11]*http://iwc.int/scientific-committee-handbook#ten.*

that are regularly faced by the Committee. These genetic analysis guidelines were completed intersessionally and have been accepted for publication by the *Journal of Cetacean Research and Management*.

11.3 New statistical and genetic issues concerning stock definition

The Stock Definition and DNA Working Group discussed several papers relevant to stock structure discussions in other Committee sub-groups early in the meeting and passed its advice on to them (see Annexes D, G, H, M, O and Q). Technical comments on these papers are given in Annex I.

During the intersessional period, new information on the stock structure of western North Pacific common minke whales and western North Pacific Bryde's whales became available. These discussions are summarised below.

11.3.1 Simulation tools for spatial structuring (e.g. TOSSM)

Genetic analyses on the stock structure of North Pacific common minke whales have been conducted by Japanese scientists following specific recommendations made at the Expert Workshop to Review the ongoing JARPNII Programme (IWC, 2010b). Results of these analyses were reviewed at the Expert Panel of the Final Review of the Western North Pacific Japanese Special Permit Programme (JARPNII) (IWC, 2017a) and at the subsequent IWC Scientific Committee meeting in 2016 (IWC, 2017b). At SC/67a, the Committee reviewed new results addressing these recommendations (SC/67a/SDDNA01) as well as a summary of previously conducted work (SC/67a/SDDNA05rev1).

In order to make progress on understanding stock structure in North Pacific minke whales, the 2009 Expert Panel Review recommended that the spatial distribution of close kin be examined (IWC, 2010b, p.419). Last year, the Committee heard a summary of preliminary results of an ongoing analysis to identify parent-offspring pairs among sampled North Pacific minke whales that were also presented at the 2016 Expert Panel review (IWC, 2017a). Although a technical evaluation of the analysis was not possible at that time, given that no primary paper was provided for review, the Committee provided advice on several topics (IWC, 2017b, p.46).

This year, the Committee reviewed a paper summarising these results and addressing some of the topics listed last year. SC/67a/SDDNA01 presents the results of using a dataset of complete genotypes at 16 microsatellite loci, accompanied with mtDNA and biological information, in 4,554 North Pacific common minke whales to infer Parent-Offspring (PO) relationships, using a Maximum-Likelihood approach. In accordance with the advice received last year (IWC, 2017b, p.46), the occurrences of PO pairs was addressed using mother-foetus pairs as positive controls, the relationship between estimated and observed values of the False Discovery Rate (FDR) and Power (P) was evaluated by simulation, and additional microsatellites (n=10 loci) were used in conjunction with biological information to validate identified PO pairs.

Among the validated P-O pairs, O stock pairs were significantly overrepresented, while pairs between J and O stock individuals were absent. Specimens neither assigned to J nor O stock ('unassigned') exhibited a stronger affinity to the O stock. The J stock seems to appear on both sides of Japan closer to the coast, while the O stock occurs mostly east of Japan, both close to the coast and far offshore. This analysis provides no evidence for further stock structure in the area covered by this data set.

In reviewing technical aspects of SC/67a/SDDNA01, concern was expressed about the lack of independence that is incurred when the same dataset (the 16-locus genotype data) is used to assign individuals to stocks (Pastene *et al.*, 2016a), estimate the likelihood of possible POP relationships within those stocks, and then make inferences about the plausibility of stock structure hypotheses based on these findings. Alternative stratification schemes, such as using geography or a second set of independent microsatellite loci to stratify the samples into genetic clusters, would circumvent this concern. It was noted that the lack of independence does not invalidate the inferred PO pairs, but could bias the estimates of FDR. This bias is expected to result in additional False Positives (FPs), as individuals belonging to the same stock would be genetically more similar to each other than expected in a random sample set. This pattern can be seen in the separate analysis of the J stock minke whales, in which no FPs were identified. The two known J-Stock POPs (i.e. mother-foetus pairs) were not detected, neither in the complete dataset nor when the J stock minke whales were analysed separately.

Among inferred O-stock PO pairs, many included one individual sampled near the coast and one sampled in offshore waters, and the biological data associated with these individuals suggested a pattern of offspring being found close to shore and the parent (both mothers and fathers) being found offshore. It was further noted that in the assigned O-stock whales, the number of sampled males is markedly larger than the number of sampled females (Annex I, Appendix 2).

Attention: SC

In reviewing the result of kinship-based analyses of North Pacific common minke whales, the Committee:

(1) ***agrees*** *that this work provides a good example of the value of increasing the number of loci in analysis of kinship in reducing False Discovery Rate and increasing statistical power;*

(2) ***recognises*** *the value of having biological data associated with the individuals used in kinship-based analyses, which allowed the plausibility of genetically inferred Parent-Offspring pairs to be verified;*

(3) ***encourages*** *the inclusion of such biological data when available.*

The Committee also received a summary of updates on stock structure analyses of western North Pacific common minke whales that have been conducted in response to recommendations of the Committee and Expert Panels (SC/67a/SDDNA05). This summary covered genetic analyses (kinship, assignment tests, ordination-based methods, and assessment of statistical power), morphometrics, and catch-at-age analysis. The proponents considered that the results: (1) provided strong support to stock structure Hypothesis A (proposing only J and O stocks), with a single O stock exhibiting a pattern of sexual and age segregation during migration; and (2) contradicted Hypothesis C, which proposes two J stocks and two O stocks.

In considering the technical aspects of work presented in SC/67a/SDDNA05, the Committee noted that the subset of samples selected for additional genotyping was not chosen at random from the entire area but were instead chosen at random from a subset of samples collected in sub-areas 6 and 7 with the intent of generating a dataset that would include a relatively equal proportion of J and O stock whales. Given that these samples represent only a portion of the area being considered, however, this selection could result in a bias in the assignment probabilities generated in the STRUCTURE analysis.

Attention: SC
With respect to genetic studies of western North Pacific common minke whales presented in SC/67a/SDDNA05, the Committee:

*(1) **welcomes** the typing of additional loci in the subset of samples and recognised the logistical constraints inherent in genotyping additional samples; and*
*(2) **advises** that an assignment test analysis in which the additional loci were genotyped in samples collected from a broader region would be a more appropriate than using only a subset of samples from certain areas.*

In terms of the implications of new information in evaluating the plausibility of the stock structure hypotheses included in the *IST*s for Western North Pacific minke whales, the Committee noted that several gaps in understanding persist for western North Pacific common minke whales: (1) the breeding areas remain unknown, and current hypotheses only partially consider the potential for mixing of whales on migratory routes or wintering grounds; (2) the results presented in SC/67a/SDDNA05 do not contribute to an understanding of the heterogeneity that has been identified in some previous studies within the O-type whales (Wade and Baker, 2012); and (3) while the table illustrating the location and number of inferred PO pairs within and between regions suggests connectivity between areas, it does not provide information on how those numbers compare to the numbers of sampled animals in each region for which no PO pair relationships were inferred, which would provide insight into the relative magnitude of connectivity between areas.

Attention: SC
*Although questions about the stock structure of minke whales in the western North Pacific may not be fully resolved, particularly in the absence of knowledge about the location of breeding grounds, the Committee noted the importance of evaluating the evidence at hand with respect to the stock structure hypotheses under consideration. As such, the Committee **agrees** that the results of the kinship analysis are inconsistent with the mixing matrices associated with Hypothesis C as currently implemented in the RMP trials (isolation between sub-areas 7CS-7CN, 8 and 9). The Committee **thanks** the authors of SC/67a/SDDNA01 and SC/67a/SDDNA05 for their work to address the recommendations of the Expert Panel and the Committee.*

11.3.2 North Pacific Bryde's whales
With respect to North Pacific Bryde's whale, one of the short-term recommendations made by the JARPN II expert review panel was that the presence of multiple stocks within sample partitions should be assessed using ordination-based methods such as STRUCTURE and DAPC (IWC, 2017a, p.543). In response to this recommendation, last year the proponents presented the results of a STRUCTURE analysis to the Committee; this analysis did not detect heterogeneity within sub-area 1 or between the two sub-areas (1 and 2), which had been identified as significantly differentiated using contingency table analysis. Given these results, the Committee noted that the STRUCTURE analysis had little power to detect clusters when F_{ST} is low and only weak levels of differentiation are present and recommended that further analyses using alternative ordination-based methods be conducted to evaluate their use in addressing the presence of multiple stocks within sample partitions (IWC, 2017b, p.47).

In response to last year's recommendation by the Committee, the proponents presented SC/M17/RMP01, the results of a Discriminant Analysis of Principal Component (DAPC) at the Workshop on the *Implementation Review* of Western North Pacific Bryde's whales Japan (SC/67a/Rep07). Consistent with the STRUCTURE results, the DAPC analysis did not detect additional structure within the North Pacific, although structure was identified at a broader scale (e.g. between Bryde's whales from the North Pacific, eastern and western South Pacific and eastern Indian Ocean). In combination with the previous results showing significant differentiation between sub-areas 1 and 2 in both mitochondrial and microsatellite DNA but no detected heterogeneity within sub-area 1 (Pastene *et al.*, 2016b), these results are consistent with the occurrence of two weakly-differentiated stocks within the region encompassing the sub-areas.

While at the review, additional analyses were suggested and subsequently conducted to further explore the possibility of spatial genetic structure (SC/67a/Rep07). These analyses examined patterns of fine-scale spatial heterogeneity relative to the longitude of sample origin. Mean values of microsatellite heterozygosity (H_E and H_O), mitochondrial haplotype diversity, and the first two principal components of the DAPC were calculated for sectors consisting of 5° longitude and plotted as moving averages over 10°. Although no patterns of heterogeneity were revealed in the microsatellite data, spatial heterogeneity was detected in the mitochondrial haplotype diversity and the first two PCs of the DAPC.

While the Committee noted that the initial DAPC analyses were not informative about stock structure, the additional spatially explicit analyses provided information relevant to stock-structure which was used in conjunction with biological information for stock structure inference (summarised in table 4 of SC/67a/Rep07). The Committee further noted that spatially explicit analysis of information captured in single principal components (PCs) in a DAPC or other Principal Component Analyses (PCAs) may unravel stock-structure patterns not as easily detected in representations combining several PCs and/or geographic regions in a single visualisation.

Attention: SC
*The Committee **acknowledges** the presented analyses of stock structure in North Pacific Bryde's whales and did not provide any additional recommendations for further analysis. The Committee **re-iterates** the utility of ordination methods in stock structure inference (IWC, 2017b, p.48).*

11.3.3 Terminology
Defining and standardising the terminology used to discuss 'stock issues' remains a long-standing objective of the Working Group, in order to help the Committee report on these issues according to a common reference of terms (IWC, 2014d, pp.287-288). Although some progress was made to clarify how stock structure related terms are used within the sub-committees that focus on baleen whales, difficulties have arisen in trying to align this usage with that of the sub-committee on small cetaceans. This topic will be considered at next year's meeting (see Item 11.4).

11.3.4 Simulation tools for spatial structuring (e.g. TOSSM)

TOSSM was developed with the intent of testing the performance of genetic analytical methods in a management context using simulated genetic datasets (Martien *et al.*, 2009), and more recently the TOSSM dataset generation model has been used to create simulated datasets to allow the plausibility of different stock structure hypotheses to be tested (e.g. Archer *et al.*, 2010; Lang and Martien, 2012).

In recent years, a wide-range of software packages have become available for producing simulated datasets that can be used for statistical inference and/or validating statistical methods (Hoban *et al.*, 2012; and see IWC, 2017b, p.48), and in 2016 the Committee agreed to expand this item (formerly specific to TOSSM) to include a broader range of tools (IWC, 2016e, p.43). The Committee will conduct an intersessional review of the available packages and evaluating their utility to the work of the Committee for consideration next year (see Item 11.4).

11.3.5 Close-kin mark-recapture and epigenetic aging

The Committee heard a presentation on the close-kin mark-recapture (CKMR) approach (Bravington *et al.*, 2016), which uses multi-locus genotyping to find close relatives among tissue samples from dead and/or live animals. The number of kin-pairs found, and their pattern in time and space, can then be embedded in a statistical mark-recapture framework to infer absolute abundance, parameters like survival rate, and even stock structure. Although CKMR should be useful without additional information in many cetacean stock delimitation applications, it will yield precise results much faster if age can be estimated, even roughly.

While age can already be obtained in some situations (e.g. bycatch of odontocetes where teeth can be obtained and sectioned), the utility of CKMR for cetaceans will be now increased given the new capability to use the same tissue-samples for epigenetic ageing (DNA methylation), which has in the last few years been successfully used to estimate age in humpback whales and other mammal species (Jarman *et al*., 2015; Polanowski *et al*., 2014). Methylation rates may be specific to species or even populations, and thus epigenetic age estimates need to be verified. This may be easier with odontocetes, where epigenetic age estimates could be calibrated by comparison to ages estimated by counting growth layer groups in teeth (Perrin and Myrick, 1980). It was noted that while estimates of the actual age of animals is needed for some applications, inference of relative age is sufficient in other cases. Such inferences can be used in calibration of epigenetic methods when long-term close kin sampling is pursued.

Attention: SC

Epigenetic ageing is particularly valuable in the context of estimating abundance with the close-kin mark-recapture approach, as it can increase precision in such estimates by allowing the parent to be distinguished from the offspring. It may further be informative in the context of RMP Implementations *or* Implementation Reviews*. The Committee* ***agrees*** *that learning more about the applicability of epigenetic aging to the work of the Committee is a priority and* ***encourages*** *the submission of papers relevant to this topic next year (see Item 11.4).*

11.3.5.1 INFERENCE OF DEMOGRAPHIC HISTORY USING WHOLE GENOME SEQUENCES

The Committee also received information on the application of a new analysis technique that allows inferences about demographic history to be drawn based on a whole genome sequences (Li and Durbin, 2011). Whole genome sequences possess extensive records of the ancestry of individuals, and individuals belonging to the same population are expected to exhibit the signatures of shared historical events not present in genomes from individuals of different populations. The ability to reconstruct these histories has increased recently due to the reduced cost of genome sequencing and advances in bioinformatics and analytical methods largely originating from human population genomics. SC/67a/SDDNA04 applies this technique to provide insight into the demographic history of gray whales using whole genome sequences from two whales sampled off the coast of Sakhalin Island, Russia, and one whale sampled off the coast of Barrow, Alaska. Given the small number of genomes analysed, this work was largely intended as a 'proof of concept' exercise to demonstrate the feasibility of using this approach with the gray whale genome data, and sequencing of the genomes of additional samples is planned. These preliminary results, however, suggest a greater extent of recent historical inbreeding in the Sakhalin gray whale genomes than in the genome sequenced from the gray whale sampled off Barrow. The inferred trajectories of effective size over time derived from the eastern and two western genomes seemed to be generally similar until the late Pleistocene. However, it was not possible to determine if the Sakhalin whales were part of the eastern or western breeding stocks as some of the analyses employed in this study fail to differentiate them.

The Committee noted that some limitations are inherent in this approach. In particular, the analysis is not informative with respect to recent population history, and both the inferred dates and the estimates of effective population size over time depend on parameter values used for generation time and mutation rate, which are subject to uncertainty. However, the Committee welcomes the opportunity to receive further information on the application of this new technique and looks forward to hearing more details about this work in the future.

11.4 Work plan

The work plan is summarised in Table 17.

12. CETACEAN ABUNDANCE ESTIMATES, STOCK STATUS

In recent years (see IWC, 2014a), the Committee has recognised the need for consistency in the way it reviews and categorises abundance estimates, which in the past were reviewed only within the sub-group to which they were submitted. This year, a new approach was adopted such that all abundance estimates were reviewed by a dedicated Working Group on Abundance Estimates, Stock Status and International Cruises (WG-ASI, whose report is in Annex Q) and the advice passed on to the relevant sub-group early in the meeting if it was needed for their deliberations. WG-ASI was also tasked with the development of a table of an agreed set of abundance estimates for use by the Committee and a biennial document compiling abundance estimates for the Commission and the public that provided a broad overview by species and ocean basin, and by specific areas if appropriate.

In addition, the Committee has been asked by the Commission to provide a biennial document that provides an overview of the status of whale stocks, largely based upon completed assessments and or RMP/AWMP *Implementations* or *Implementation Reviews.*

Table 17
Summary of the SDDNA work plan.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Item 11.1 DNA testing	Develop papers relating to the ToR and comparison of methods for SNP development and assessment.	Review intersessional progress.
Item 11.2.1 DNA quality guidelines	Intersessional email group to discuss updating guidelines to include data produced using next generation sequencing approaches.	Review intersessional progress; present an updated version of the guidelines.
Item 11.3.3 Terminology	-	Revisit terminology with specific reference to the implications of inferred stock structure in other sub-committees.
Item 11.3.4 Simulation-based tools	Intersessional email group to review software packages and evaluate utility to the SDDNA WG.	Review intersessional progress.
11.3.5 Epigenetic ageing	Develop papers relating on epigenetic ageing and it use in discussions of stock definition and/or abundance estimation.	Review intersessional progress.

12.1 Summary of abundance estimates and update of IWC consolidated table

The Committee reviewed new information on abundance estimates of large whales and small cetaceans received (Annex Q, item 3). The Committee noted that estimates of abundance not reviewed during this meeting due to time constraints would be reviewed intersessionally by an intersessional correspondence group who would report on its work to SC/67b.

Attention: SC, S, C-A
New abundance estimates endorsed by the Committee for inclusion in the IWC consolidated table are presented in Table 18. The Committee ***recommends*** *these estimates are incorporated into the table of already agreed abundance estimates and uploaded to the IWC website. The Committee also* ***recommends*** *that the table continue to be updated intersessionally through the intersessional correspondence group (Annex W).*

Based upon the experience gained at this meeting, the Committee noted that a process needed to be developed to facilitate the review of: (a) new abundance estimates in a timely fashion prior or during the Annual Meeting; and (b) existing estimates that had not yet been endorsed by the Committee. This process should include identifying minimum requirements for the presentation and review of abundance estimates for inclusion in the IWC consolidated table. The Committee also noted that this process should consider how to validate non-standard software, non-standard methods, and how to address issues related to estimates computed from population models.

Attention: SC
The Committee ***recommends*** *that draft guidance be developed intersessionally (ICG-4, Annex W) for review at SC/67b on:*

(1) a process to facilitate the review of abundance estimates in a timely fashion prior or during the annual meetings;
(2) minimum requirements for presentation and review of abundance estimates for inclusion in the IWC consolidated table;
(3) a process to validate non-standard software, non-standard methods and how to consider estimates computed from population models;
(4) a process to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the Committee; and
(5) estimates of abundance relevant to the work of the Committee that were available but not reviewed during this annual meeting.

12.2 Methodological issues

12.2.1 Model-based abundance estimates (and amendments to RMP guidelines)

In recent years, the Committee has recognised the need to develop its expertise in evaluating spatial-model-based abundance estimates from sighting surveys because these models have potential advantages in reducing bias resulting from patchy coverage, and in providing more reliable estimates of variance when compared to standard line transect methods. A pre-meeting, held on 7-8 May 2017, reviewed the current state of spatial modelling for cetacean abundance estimation, and introduced a software package 'ltdesigntester' for exploring the reliability of design-based abundance estimates of specific surveys. The report is given as Annex Q, Appendix 6.

The Committee has for some time (IWC, 2015c, p.9) been considering the need to amend the Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme (IWC, 2012a, p.509) to incorporate abundance estimates produced using methods (e.g. spatial models, mark-recapture models) not yet considered by the Guidelines. One of the tasks of the pre-meeting was to consider such amendments for spatial model based estimates, but time constraints meant that these amendments could not be discussed in detail.

Attention: SC
The Committee ***recommends*** *that draft amendments to the Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme be developed intersessionally (ICG-4, Annex W) to incorporate methods to compute abundance estimates not yet considered by the Guidelines, for review at SC/67b.*

12.2.2 Review new survey techniques/equipment

The Committee received new information on novel survey techniques. SC/67a/NH09 presented a new, innovative method to potentially study large whales using Very High Resolution (VHR) satellite imagery using the WorldView-3 satellite. Visual and spectral analysis resulted in the successful detection of four candidate species: fin, humpback, southern right and gray whales. This study showed the potential of using satellite imagery to study baleen whales. The application of high-resolution satellite imagery for ship strike assessments was also raised and its potential for surveying was mentioned (Annex Q, item 6.1.2).

Bravington *et al.* (2016) described a new method for computing abundance estimates and other population parameters by integrating mark-recapture methods with the relatedness of individuals inferred from genetics.

Table 18

Table of agreed abundance estimates during the 2017 Scientific Committee meeting (see below for the key).

Area	Cat.	Eval. extent	RMP/AWMP status	Date stamp	Range of years	Method	Corr.	Estimate	CV	Approx. 95% CI	Original reference	Comments	Aerial coverage	Programme	On web?
North Atlantic common minke whales															
West Greenland	1	1	S	2015	2015	SC	A+P	5,241	0.49	2,114-12,992	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
West Greenland	1	1	S	2007	2007	SC	A+P	9,853	0.43	4,433-21,900	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
East Greenland	1	1	S	2015	2015	LT	A+P	2,681	0.45	1,153-6,235	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
Iceland	Not Ac	-	-	2016	2016	-	-		-	-	SC/67a/NH05	Coverage too poor. Could re-stratify to use as minimum estimate.	-	-	-
ES	P	-	-	-	2014-16	-	-	12,846	-	-	SC/67a/RMP03	Final estimate to be calculated on completion on full survey cycle.	-	-	-
EW	P	-	-	-	2014-16	-	-	16,537	-	-	SC/67a/RMP03	As above	-	-	-
CM	P	-	-	-	2014-16	-	-	57,472	-	-	SC/67a/RMP03	As above	-	-	-
North Atlantic fin whales															
West Greenland	1	1	S	2015	2015	LT	P	465	0.35	233-929	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
North Atlantic humpback whales															
West Greenland	1	1	S	2015	2015	LT	A+P	1,008	0.38	493-2,062	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
East Greenland	1	1	S	2015	2015	LT	A+P	4,288	0.38	2,097-8.770	Hansen *et al.* (2016); IWC/67a/Rep06	-	-	-	R
(Iceland)	-	-	-	-	-	-	-	-	-	-	-	Several estimates to be reviewed intersessionally.	-	-	-
North Atlantic bowhead whales															
Svalbard	3	1	-	2015	2015	LT	A	343	0.488	136-862	Vacquié-Garcia *et al.* (2017)	Partial coverage and high CV.	-	-	R
North Pacific bowhead whales															
Okhotsk Sea	3	1	-	2016	1995-2016	MR	A+P	218	0.22	142-348	SC/67a/NH10	(Require copy of time series	-	-	-
North Pacific gray whales															
Sakhalin Is.	3	4	-	1995	1995-2015	MR:PA	A+P	74	0.06	65-82	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin Is.	3	4	-	2015	1995-2015	MR:PA	A+P	191	0.04	175-208	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin and Kamchatka	3	4	-	1995	1995-2015	MR:PA	A+P	129	0.08	107-149	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin and Kamchatka	3	4	-	2015	1995-2015	MR:PA	A+P	282	0.05	255-312	SC/67a/NH11	(Require copy of time series).	-	-	-
N California-N Vancouver Is.	1	1	-	2015	-	P Id	-	243	0.08	-	Calambokidis *et al.* (2017)	SD=18.9; N_{min}=228.	-	-	-
California	2	1	-	-	2014/15	-	-	28,790	-	23,620-39,210	Durban *et al.* (2017)	Suitable for use in *SLA* and conditioning range-wide model. Some methodological issues.	-	-	-
California	2	1	-	-	2015/16	-	-	26,960	-	24,420-29,830	Durban *et al.* (2017)	As above	-	-	-
North Pacific Bryde's whales															
1W	1	1	I	2011	2008-15	LT	-	15,422	0.289	-	SC/67a/RMP04	$g(0)$=1. Could be updated if $g(0)$ estimated in future. See SC/67a/RMP04 *re* additional variance.	78.4	POWER /JARPNII	-

Cont.

Area	Cat.	Eval. extent	RMP/AWMP status	Date stamp	Range of years	Method	Corr.	Estimate	CV	Approx. 95% CI	Original reference	Comments	Aerial coverage	Programme	On web?
1E	1	1	I	2011	2008-15	LT	-	6,716	0.216	-	SC/67a/RMP04	As above	92.4	POWER /JARPNII	-
2	1	1	I	2014	2008-15	LT	-	4,161	0.264	-	SC/67a/RMP04	As above	78.9	POWER /JARPNII	-
W N Pacific	-	-	-	-	2008-15	LT	-	26,299	0.185	18,000-38,000	-	Combined estimate ~ 26,000	-	-	R
Māui dolphin															
North Island, NZ	1	1	-	-	2015-6	MR	-	63	0.11	-	Baker *et al.* (2012)	Based on assumption of closure.	-	-	-
Hector's dolphin															
Cloudy Bay, NZ	1	1	-	-	2011-12	MR	-	269	0.12	-	Hamner *et al.* (in press)	Based on assumption of closure	-	-	-

Key to table headings:

Heading	Contents
Area	If *Area*s are identified in an RMP context these should be used. If estimates pertaining to only a portion known range are agreed to be included (e.g. for AWMP) a comment should be included to show that this constitutes only part of the population. Otherwise use broad categories (e.g. Schedule *Management Areas*) and indicate whether total or partial coverage unless.
Category	As described below. In each case if not clear add an asterisk to indicate that the estimate needs to be considered further. Use either: (1) acceptable for use in in-depth assessments or for providing management advice; (2) underestimate - suitable for AWMP usage or other 'conservative' management but not reflective of total abundance; (3) while not acceptable for use in (1) or (2), adequate to provide a general indication of abundance; (P) Provisional or Preliminary estimates (will be omitted from published tables); (X1) Category (1) estimates that have been superseded by newer estimates (will be omitted from published tables); or (ND) Not discussed. Used to show other estimates which have not been discussed by the Scientific Committee, but which may be discussed in future. They are shown 'Greyed out' and will be omitted from published tables.
Evaluation extent	Degree to which the estimate was considered originally by the sub-committee concerned. Use: (1) estimate was examined in detail by the sub-committee; (2) estimate was partially examined by the sub-committee but method standard; (3) degree to which the estimate was considered by the sub-committee is unclear but method standard; (4) estimate was partially considered by the sub-committee partially and a new method was used; or (5) degree to which the estimate was considered by the sub-committee is unclear and a new method was used.
RMP/AWMP status	Status in RMP trials. Use: 'I' agreed to be suitable for use in an actual *CLA* calculation to produce a catch limit; 'C' used in the *RMP* trial conditioning as an absolute estimate of abundance; 'C_{min}' used in the *RMP* trial conditioning a minimum estimate of abundance; 'CP' provisional estimate suitable for use in conditioning but further analysis needs to be considered before use in an actual *CLA* or *SLA* calculation; 'T' used in RMP/*SLA* trials but further analysis needs to be considered before use in an actual *CLA* or *SLA* calculation; 'S' agreed to be suitable for use with a *SLA* to produce strike limits; 'E' suitable for conditioning *Evaluation* and Robustness Trials, and for *Implementation Reviews*. 'R' Suitable for conditioning *Robustness Trials* or suitable for conditioning some *Evaluation* or *Robustness Trials*, or *Implementation Reviews*, utilising a minimum estimate of abundance.
Date stamp	The year to which estimate applies. This will normally be the year of the survey unless the estimate is based on multiple years or a population assessment model (Note: Consideration needs to be given as to whether estimates from such models are acceptable for this table, in contrast to, for example, mark-recapture based estimates which do require model-processing.)
Range of years	The years concerned when estimate applies to surveys over a number of years.
Method	LT: line transect (or distance-sampling): MR: mark-recapture; SM: spatial modelling; LT+SM: distance-sampling with spatial modelling; CC: Cue counting; PA: population assessment; PId: Photo-identification of individuals; SC: Strip census; GMR: Genetic mark recapture.
Correction (Corr)	Where applicable, indicate if the estimate is corrected for A: availability (corrects for the time the whales are available at the surface); P: perception bias (corrects for missed sightings); A+P: availability and perception bias; or adjustment for $g(0)<1$ applied. Note. Care should be taken regarding the interpretation of $g(0)$ because the distinction between availability and detection bias for ship-board surveys is somewhat arbitrary and dependent on the exact analysis method employed.
Estimate	Estimate of 1+ abundance unless otherwise indicated.
CV	CV of estimate from survey sampling error only.
CV (AV)	CV with Additional Variance component arising from annual distributional changes added.
95% CI	Approximate 95% confidence intervals (or equivalent) rounded to three significant figures of upper limit.
Aerial coverage	Aerial coverage as a percentage.
IWC reference	The reference to where the estimate was discussed in the Scientific Committee.
Original reference	The reference of the analysis presented originally.
Comments	Brief comments on survey and any difficulties encountered.
Program	Survey program/organiser.
On web?	Is estimate listed on the IWC website? Y: yes R: recommended for inclusion.

Table 19

Work plan for consideration of abundance estimates and status.

Topics	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Process for evaluating abundance estimates	ICG-4 (Annex W): (1) Develop a process to facilitate the review of abundance estimates in a timely fashion prior or during the annual meetings. (2) Identify minimum requirements for presentation and review of abundance estimates for inclusion in the IWC consolidated table. (3) Develop process to validate non-standard software, non-standard methods and how to consider estimates computed from population models. (4) Consider how to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the SC. (5) Amend the RMP Guidelines, particularly in regard to methods so far not included in the guidelines (e.g. spatial modelling and mark-recapture).	Review report from intersessional correspondence group and agree the process for review of abundance estimates in the future. Amend the RMP Guidelines.
Review of abundance estimates	Review estimates of abundance of North Atlantic humpback whales and Asian coastal and river dolphins (ICG-5, Annex W).	Review report from intersessional correspondence group and new estimates presented at SC/67b.
Tables of abundance estimates	Incorporate the estimates agreed at this meeting to the IWC consolidated table and upload them to the IWC website, and continue to update the IWC Abundance Table intersessionally (Allison).	Review intersessional progress and develop the biennial document for the Commission.
Status	Provide information on status from recent *Implementations* or *Implementation Reviews* (Allison, Donovan, Punt, Zerbini).	Review intersessional progress and develop the biennial document for the Commission.

This method is currently referred to as Close-Kin Mark-Recapture (CKMR). For a discussion of this approach see Annex I (item 6.2.1) and Item 11.3.5.

The Committee **looks forward** to receiving new information on novel techniques applicable to the estimation of cetacean abundance.

12.3 Consideration of the status of stocks

The Scientific Committee has been asked to provide the Commission with a summary of advice on the status of stocks on a broad level (e.g. ocean basin or region). RMP and AWMP *Implementation Simulation Trials* are designed to provide robust management advice but not 'status' in the traditional sense expected by the Commission (i.e. what is the present 'stock' level compared to the unexploited level and what are the likely future trends). Rather they provide considerable output for a wide range of plausible scenarios that would need to be integrated and summarised to provide measures of status. The Committee noted that the results of a set of *Implementation Simulation Trials* should be summarised by the following three statistics to provide information on status:

(1) current depletion (number of animals aged 1+ and older relative to 1+ carrying capacity);
(2) current 1+ abundance; and
(3) 1+ abundance in 2050 if all future RMP and AWMP catches (but not projected bycatches) are assumed to be zero.

Results should be provided for two values for the MSY rate (1% in terms of harvesting of the total (1+) component of the population and 4% in terms of harvesting of the mature component) unless the base-case trials are based on a higher value for the lowest plausible value for the MSY rate, or if the MSY rate has been estimated and there is an agreed value. In addition, results should be summarised across simulations and trials (medians over simulations and averages across base-case trials).

Each base-case trial may have a different number of breeding stocks. Results should be reported by area, specifically for the Ocean Basin (i.e. 'Region') and by '*Medium Area*' rather than by the sub-areas on which the population model underlying the trials are based, to avoid having a very large number of summary statistics. However, there needs to be flexibility in reporting. For example, the Committee may also wish to present results for individual biological stocks about which it considers the Commission needs to be informed in situations where the default of reporting results by area provides a misleading impression. The choice of the stocks for which results are reported needs to be decided during *Implementations* and *Implementation Reviews*.

Attention: SC, S

The Committee ***recommends*** *that the 'Guidelines for Conducting* Implementations *and* Implementation Reviews*' (IWC, 2012c) be updated and that the control programs used for* Implementation Simulation Trials *be modified by the Secretariat to report three measures of status: current depletion, current 1+ abundance and 1+abundance in 2050 on an Ocean basin or* Medium Area *basis. In addition, the results for all stocks should be calculated and made available to the Commission where considered appropriate, but not included in the primary summary.*

12.4 Work plan

The work plan is given as Table 19.

13. BYCATCH

At IWC/66 in October 2016, recognising the scope and urgency of the bycatch issue, and that it is recognised as the single greatest threat to cetaceans from human activities globally, the Commission endorsed a number of actions proposed by the Conservation Committee as part of a new Bycatch Mitigation Initiative. These included the formation of a Standing Working Group under the Conservation Committee which will supervise the establishment of an Expert Panel and a coordinator position. The interim coordinator (Simmonds) suggested that one of the first tasks that the Committee could assist with is to provide nominations for the Expert Panel.

13.1 Review new estimates of entanglement rates, risks and mortality (large whales)

13.1.1 Bering-Chukchi-Beaufort Sea (B-C-B) bowhead whales

Scars associated with entanglement injuries and ship strikes have been documented on B-C-B bowhead whales harvested by Alaskan Eskimos for several decades (SC/67a/HIM04).

Aerial photographs taken over multiple years indicated that ~12% of bowhead whales harvested by Alaska native hunters show evidence of rope scarring likely associated with Bering Sea pot fisheries and that about 2% of these animals carry injuries/scars from ship strikes (SC/67a/HIM04). Images from a multi-year photo mark-recapture study (SC/67a/AWMP08) were examined to identify whales that had acquired entanglement injuries during the study period. The probability of a bowhead acquiring an entanglement injury was estimated, suggesting a 2.4% (1.2%, 3.6%) annual probability of acquiring a scar. George *et al.* (2017) found that about 50% of large (~17m) and presumably old, harvested whales carried entanglement scars. These results suggest that entanglement may be of future concern for B-C-B bowhead whales and that the issue warrants further consideration. Suggestions of how to obtain improved information are provided in Annex J, item 2.1. It was noted that an *Implementation Review* for this stock will take place at next year's meeting (see Item 7.3).

Recognising the value of this work, and the increasing concern about the prevalence of large whale interactions with fishing gear, examination of rates of interaction (e.g. scar acquisition) for other populations was suggested. It was noted that the advances in drone technology might help to obtain images for these types of analyses.

13.1.2 Gray whales

Gray whales are likely more vulnerable than most whale populations to interactions with fishing gear due to their nearshore migratory and feeding behaviour. SC/67a/HIM06 compiled all known sources of data on non-hunting, human-caused injuries and mortalities of gray whales in the North Pacific (mainly from 1980 to 2015) when stranding networks were established along the US Pacific coast. The authors estimated the number of serious injuries and mortalities of around 300 gray whales. This represents a minimum estimate because of the difficulties in determining cause of death, limited spatial coverage of stranding networks and that whales injured or killed at sea may not be reported. Primary causes of mortality were net fisheries (39.7%), unknown entanglements (21.5%), ship strikes (19.1%), and pot fisheries (17.1%).

It was noted that it might be possible to extrapolate, using the data presented in SC/67a/HIM06, to regions of gray whale habitat not covered by the established stranding networks. The rangewide assessment of North Pacific gray whales (Item 10.1.3) has developed an approach to modelling bycatches and developing scenarios to consider the various sources of uncertainty (SC/67a/Rep04, item 3.2.1.2).

SC/67a/HIM17 reviews gray whale entanglements in the western North Pacific, including gear types used in the Russian Far East that are known or suspected to impact gray whales. The coastal salmon trap fishery off northeastern Sakhalin Island, which overlaps spatially and temporally with feeding gray whales during the summer and fall, was identified as an area where entanglement risk is very high. This risk is of concern because adult females and their calves show strong site fidelity to this area at a time when females are recovering from pregnancy and lactation and calves are being weaned. This document has been sent to the relevant government agencies in Sakhalin and the Russian Federation.

13.1.3 Southern right whales

Entanglement was identified as the main factor in the death of an eastern South Pacific (ESP) southern right whale stranded on Isla de Chiloe, southern Chile. This is the third entanglement from this Critically Endangered population reported from Chile, raising concerns that this threatens population recovery.

Attention: CC, CG-A
The Committee ***recommends*** *that the planned expansion of entanglement response capability in the eastern South Pacific, as part of the implementation of the CMP for this critically endangered right whale population (see Item 10.1.1), be considered as a matter of urgency.*

13.1.4 North Atlantic right whales

North Atlantic right whales are generally discussed under Item 9.2.6.

Documented entanglements, long-term population studies and mark-recapture techniques were used to evaluate the effect of entanglement events on survival of North Atlantic right whales (Robbins *et al.*, 2015). Estimates were based on 50 individuals observed carrying entangling gear between 1995 and 2008, and compared to 459 others that were never observed with gear during the same period. Entangled adults had low initial apparent survival (0.749, 95% CI: 0.601-0.855), but those that survived the first year achieved a survival rate (0.952, 95% CI: 0.907-0.977) that was more comparable to unaffected adults. Juveniles had a post-entanglement survival rate that was comparable to the initial survival of entangled adults (0.733, 95% CI: 0.532-0.869) and lower than un-impacted juveniles (0.978, 95% CI: 0.969-0.985). Of three entanglement characteristics examined, health status was the best predictor for subsequent survival, but the entanglement configuration and the resulting injuries also appeared to affect the outcome. When the entanglement configuration was assessed as high risk, human intervention (disentanglement) improved survival.

Entangled females showed a lower survival rate than males and it was noted that this may be due to higher energetic burdens related to pregnancy and lactation. The possibility of inferring survival (and mortality) from scarring rates was discussed and has been estimated for humpback whales (Robbins *et al.*, 2009);. However, such inferences require estimates of the frequency of entanglement and survival when entanglement does occur.

The success of a disentanglement intervention varies between species, as well as the complexity and severity of the entanglement itself, but its (positive) effect on subsequent survival of right whales is most pronounced for severely entangled whales. This is likely to be similar for other species, but a comparable analysis for humpback whales was complicated by several factors. Death caused by entanglement can be by drowning, a gradual decline in body condition from impaired feeding, or a chronic infection. Recent work by van der Hoop *et al.* (2016) showed that the drag of even a relatively short length of rope can create significant energetic costs.

13.2 Reporting of entanglements and bycatch in National progress reports

As in previous years, the Committee reviewed summary tables of bycatch and ship strikes from National Progress reports. Discussions related to changes to the National Progress reports are given under Item 22.

13.3 Mitigation measures for preventing large whale entanglement

The IWC's entanglement initiative[12] stresses that entanglement response must include good documentation that should contribute to a better understanding of the issue with the goal of preventing entanglements. The issue of data collection was included in training given to almost 600 trainees from

[12] *https://iwc.int/entanglement.*

15 different countries between 2014 and 2017. These newly formed networks are expected to submit data to the IWC's entanglement database when this is completed. It was noted that a recently convened IWC Workshop on co-operation for transboundary entanglements had already increased communication on gear removed from live entangled whales in Mexico, resulting in the identification of the type and origin of much of it. It was noted that upcoming trainings were being planned for Russia, Colombia, Chile/Peru and Norway, and that several Pacific Island Countries had also expressed interest.

Attention: C-A
*The Committee **agrees** that the IWC's initiative to develop a global entanglement response network is valuable to its work, and **encourages** its continued expansion.*

Between 1990 and 2010 the reported entanglement rate of humpback whales in gear from the pot-based Western Australian rock lobster fishery was relatively stable at around one or two per year. However, from 2010, reported entanglements increased dramatically, peaking at 17 in 2013, linked primarily to the fishery moving from seasonal to year-round (SC/67a/HIM10). To reduce entanglements, a series of fishing gear modifications were implemented eliminating surface rope in waters deeper than 20m and minimising float numbers. The utility of these measures was assessed using entanglements reported between 2000 and 2016, using a model that incorporated expected changes in whale population size, entanglement sighting probability, commercial fishing effort, inter-annual variation in the timing of the whale migration and the implementation of gear modifications. Results suggest gear modifications reduced entanglements by ~65%.

The Committee **commended** Australia and the fishery for what appears to be a major reduction in the numbers of whales entangled in this fishery. Similar gear modifications (e.g. reduced rope from pot gear) along the New England coast of the USA have not produced similar measurable reductions and several possible explanations for this were discussed. The Committee **agrees** that the numbers of witnessed (and reported) entanglement events in both areas are likely a subset of the total entanglements. This is a concern in Western Australia, since both entangled whales that have been tracked with a telemetry device (for later intervention) had moved far offshore, raising the concern that if this is true for other entangled whales then detection of the animals and intervention to remove gear is unlikely.

Samples of rope recovered from North Atlantic right whales were used to determine rope polymer type, breaking strength, and diameter of the recovered gear in order to examine the effects of fishing rope strength on the severity of large whale entanglements (Knowlton *et al.*, 2016). Right and humpback whales were found in ropes with significantly stronger breaking strengths at time of manufacture than common minke whales. The results suggested that broad adoption of ropes with breaking strengths of ≤7.56kN could potentially reduce the number of life-threatening entanglements for large whales by at least 72% but could still provide sufficient strength to withstand the routine forces involved in many fishing operations.

Attention: CC, G
*The Committee **recommended** that ropes with reduced breaking strength should be developed and tested to evaluate efficacy and to determine feasibility of use in a variety of fisheries.*

Mitigation methods that have been undertaken with the objective of reducing cetacean bycatch and their efficacy and future potential were reviewed through case studies (SC/67a/HIM01). These included methods for reducing risk of contact between cetaceans and fishing gear, such as effort reduction, fishing bans and gear modifications, together with methods for reducing harm should entanglement occur. The review found rather few examples of implemented mitigation measures substantially reducing cetacean bycatch. Generally, mitigating cetacean bycatch has not been viewed as intrinsic to successful fisheries management, but rather as a separate management issue. However, where reductions in bycatch have occurred, a feature of these situations has often been that a systemic change in the fishery itself has resulted in reduced cetacean bycatch, rather than the success of any mitigation measures specifically imposed for cetaceans. SC/67a/HIM01 is intended to become a Technical Briefing published by the Convention on Migratory Species.

Attention: C-A, CC, WKM&WI
*The Committee **draws the attention** of the Commission, Conservation Committee and Working Group on Whale Killing Methods and Welfare Issues to the summary of options for mitigation of large whale entanglement provided in Annex W.*

*The Committee **agrees** that a similar table covering measures to mitigate bycatch of small cetaceans would be valuable and included this on the work plan for SC/67b.*

13.4 Estimation of rates of bycatch, risks of, and mortality for small cetaceans

Anderson (2014) highlights the scope and scale of cetacean bycatch in the Western, Central and Northern Indian Ocean tuna fisheries. Gillnets are the main source of bycatch of cetaceans throughout this region, and gillnet fleets are believed to be expanding. There is also evidence of large-scale drift gillnetting on the high seas in the region despite prohibitions by the UN and Indian Ocean Tuna Commission (IOTC). Purse seines have also been set in association with baleen whales.

Attention: SC, S
*In light of information on the scope and scale of cetacean bycatch in in the Western, Central and Northern Indian Ocean and the considerable data gaps associated with intensive and extensive gillnet fisheries, the Committee **recommends** that:*

(1) bycatch in the region be included in the work plan for the 2018 meeting; and
(2) the Secretariat writes to the Indian Ocean Tuna Commission to offer help and advice from the Committee in efforts to implement cetacean bycatch data collection and reporting protocols.

Ridoux described two recent unusual multiple stranding events of common dolphins that occurred in February-March 2017 along the French Atlantic coast. Around 800 dead common dolphins stranded (dead) from 1 January to 31 March 2017, mostly during two distinct events. Bycatch in fisheries was reported to be the primary cause of death given for 119 individuals of the 134 carcasses necropsied before mid-March.

The Committee noted that these events highlighted the need for accurate estimates of bycatch following on from discussions of a study by Peltier *et al.* (2016) last year (IWC, 2017b). In short, that study incorporated modelling of the

Table 20

Summary table of large whale mitigation measures that have been implemented to mitigate large whale bycatch and entanglement.

Measure	Situation to which it might be applied	Implementation process	Selected examples (not comprehensive)	Evaluation
Reducing amount of high risk gear in areas with whales				
Reduce fishing effort with high risk gears across a fishery.	Limits on effort are used in many fisheries management situations to address over capacity and reduce fishing mortality for target species.	A strategic component of fisheries management. Requires better coordination with fisheries management organisations such that effort reductions are prioritised in fisheries which pose a high risk to whales.	Rates of humpback whale entanglement of Newfoundland and Labrador (Canada) showed a clear relationship with fishing effort.	Will reduce risks if part of an overall fisheries management strategy with appropriate monitoring and enforcement.
Long-term or seasonal restrictions to reduce effort with high risk fishing gears in specific areas (e.g. time-area closures).	Any substantial overlap between whale distribution and high risk gears (throughout the year or seasonal).	Implemented by fisheries management organisations at global, regional, national and local levels.	High Seas and European Union (EU) driftnet bans, seasonal closures in New England (USA) trap/pot fisheries.	Only effective for the area and duration to which they apply. Limited efficacy if areas only address a proportion of the overlap between gear and whale distribution.
Reducing amount of line and surface systems in the water in pot/trap fisheries.	Pot/trap fisheries marked with surface floats and with pots/traps linked together by groundline.	Measures taken at local level.	New England vertical line restrictions, sinking ground line and minimising surface floats. Australian western rock lobster fishery. Timed or acoustic release of surface floats to remove vertical line.	Insufficient data from New England (USA) to demonstrate reduced entanglement rates but monitoring on-going. Humpback whale entanglements in western Australia appear to have reduced.
Reduce gear loss.	Particularly pot/trap fisheries in areas covered by ice or with severe weather or in areas with gear conflicts (mobile gear).	Measures taken at national and local levels. Needs to be incentivised through fisheries management.	Bering Sea-Aleutian Island Crab Rationalization Program (USA).	Mainly relevant for fisheries with high rates of lost gear.
Reduce 'wet storage' of gear.	Fishers sometime leave gear in water even when not actively fishing.	Requirements to lift or attend to gear within a set time. Better coordination between fishers who may be using gear just to preserve their patch.	In the Australian west coast rock lobster fishery, pots must be hauled every seven days.	Limited potential for risk reduction but may be achieved through engagement with fishers.
Gear modification to reduce the risk of whales making contact with gear				
Net sleeves or other devices to protect bait/catch to reduce depredation and associations between whales and long-lines	Long-line interactions with odontocetes, including sperm whales.	Co-operative development of practical systems with fishers who benefit from less interference with target catches.	Chilean Patagonian toothfish demersal longline fishery.	Effective at reducing entanglement risk if feeding opportunities are removed such that whales are no longer attracted to the long-lines.
Pingers and acoustic alarms.	Attempting to keep whales away from gear e.g. large set nets.	Pinger requirements have been implemented for set net fisheries to reduce small cetacean bycatch.	No data demonstrating effective use. Studies of commercially used devices on migration routes of humpback whales showed no measurable avoidance response.	Although effective in certain circumstances for small cetaceans, no current systems appear effective for large whales.
Coloured or more visible line.	Allowing whales to detect and avoid gear.	Measures taken at national and local levels.	Not yet implemented.	Proof of concept research undertaken thus far that appears promising, but needs further research for low light and other species.
Reducing the risk of severe or fatal injury if contact does occur				
Weak links and reduced line strength allowing whales to break free from entanglement.	Any line that can pose risk of entanglement; links that break at points such as floats or weights which likely to get jammed around a whale.	Measures taken at national and local levels.	Weak links and limits on line strength required on North Atlantic right whale calving grounds off US.	Studies of gear recovered from entangled whales suggests risks could be reduced by limiting line strength.
Disentanglement.	Areas where whales are likely to be observed and suitably trained and motivated people are equipped to respond.	The IWC has held a number of workshops and training sessions for large whale disentanglement.	In South Africa interventions were successful in removing gear from 81% of whales entangled in shark nets off KwaZulu-Natal.	Not a prevention measure. Only a small fraction of the entanglements that occur are likely to be successfully disentangled in most areas.

drift of carcasses to estimate bycatch numbers from stranded animals. The Committee agreed that this approach be reviewed by an expert group (led by Currey) that will need to include people with expertise not currently residing within the Committee. Ridoux noted that the French authorities are also reviewing the situation. This might provide further information relevant to the work of the Expert Group.

Attention: SC, CG-A
Given that the large number of stranded common dolphins reported at the beginning of 2017 along the French Atlantic coast raise serious concerns, the Committee ***recommends*** *that an expert group (ICG-7, Annex W) be established to evaluate the methods used in Peltier* et al. *(2016) to estimate total bycatches from strandings data in the Bay of Biscay.*

13.5 Scientific aspects of mitigation measures for small cetaceans

13.5.1 Hector's and Māui dolphins in New Zealand

SC/67a/HIM07 estimated that the reported bycatch of Hector's and Māui dolphins was 4-5% of actual bycatch, due to low levels of observer coverage and voluntary reporting by fishermen. Current bycatch was estimated to substantially exceed sustainable levels calculated using the PBR approach (Wade, 1998). The authors stated that observer coverage would need to greatly increase to achieve bycatch estimates with a CV of 30%. Government plans for video monitoring of all inshore fishing vessels could substantially increase the amount and quality of information on dolphin bycatch. They also noted the difficulties of accurately estimating bycatch and population size of small cetaceans or establish a causal link between protection measures and either increasing population size or decreasing bycatch.

In discussion, it was noted the Ministry for Primary Industries in New Zealand (MPI) is currently conducting a spatially explicit risk assessment, which will address their concerns over possible bias in the approach of SC/67a/HIM07. The New Zealand Government are also investigating how best to implement video monitoring and would welcome advice from the Committee. The Committee looks forward to receiving and discussing the results of the risk assessment.

With respect to video monitoring, it was noted that ASCOBANS held a workshop[13] on remote electronic monitoring in 2015 which noted the relatively rare occurrence of cetacean bycatch and recommended that all of the collected video footage be viewed rather than just shorter samples, which are used for other fisheries monitoring purposes. It was suggested that quantitative targets for precision and bias of bycatch estimates would be useful in designing the video monitoring programmes such as that in New Zealand. The need to ground truth video data may result in a need for observers.

SC/67a/HIM12 suggested that less than 30% of Māui habitat is protected from set nets and only 8% is protected from both set net and trawl threats. Gear switching from set net and trawl to longlining has been identified as one potential alternative to reduce the impact of fisheries on this dolphin population. The study noted that the fishing industry is taking proactive steps towards transition to alternative gears.

In discussion, it was suggested that when considering gear switches to reduce bycatch, an important risk statistic is the relative risk for the same catch of the target fish species.

[13]*http://www.ascobans.org/en/meeting/WS-REM-2015.*

Attention: CG-A
The Committee ***agrees*** *that the evidence presented suggests that longlines are a potential alternative to reduce risk from the set nets and trawling currently associated with bycatch of Māui dolphin and that this should be investigated. It* ***recognises*** *that Government support is required to develop and implement such alternatives and assess any associated impacts on target catch or other marine species (and see Item 17.7.1).*

13.5.2 FAO Coordinating Working Party on Fisheries Statistics (CWP)

IWC is a member of the CWP. The Secretariat has been asked by FAO if IWC wished to remain a member of this group. It was noted that recent reports of CWP meetings did not show any activities related to cetacean bycatch. The CWP handbook[14] provides useful information on definitions to describe fisheries including for fishing effort and fishing gears. The Committee already uses FAO codes for gear types in the national progress reports (and it uses these definitions wherever possible.

Attention: S
The Committee ***acknowledges*** *the work of the FAO Coordinating Working Party on Fisheries Statistics (CWP) but notes that given the present CWP focus it is not necessary for the IWC to remain a member. However, the Committee* ***encourages*** *continued IWC engagement with FAO, including its Committee of Fisheries.*

13.5.3 Effect of new USA rules on imports from external fisheries

Williams *et al.* (2016) evaluated a new rule requiring countries exporting seafood to the USA to demonstrate that their fisheries comply with the US Marine Mammal Protection Act (MMPA). Countries will be given a (maximum) 5-year grace period to achieve and document compliance before potential import restrictions come into force. The authors noted that the new regulations present opportunities, but also risks, for work to address cetacean bycatch effectively in some countries.

It was noted that one of the risks relevant to the Committee is the potential for unintended consequences including reduced reporting. In some situations, introduction of penalties for fisheries with cetacean bycatch appear to have caused reporting rates to drop. Another potential risk is that fisheries with a high cetacean bycatch may simply switch markets.

Attention: CG-R
The Committee ***recommends*** *that the USA and/or other countries that are affected by the implementation of the new US law requiring countries exporting seafood to the USA to demonstrate that their fisheries comply with the US Marine Mammal Protection Act, provide updates to the Committee on its implementation.*

13.6 Work plan

The work plan related to bycatch and entanglement is given in Table 21.

[14]*http://www.fao.org/fishery/cwp/en.*

Table 21

Work plan on bycatch and entanglement.

Item	Intersessional period	SC/67b Annual Meeting
Global disentanglement database	Development work continuing	Review proposal
Small cetacean mitigation measures	Develop a summary table of available measures	Review progress
	Assist with bycatch mitigation initiative	Review progress
Indian Ocean bycatch	Secretary write to IOTC to offer Committee assistance	Review progress
Strandings and bycatch levels	Expert group to review (ICG-7, Annex W)	Review expert group report

14. SHIP STRIKES

14.1 Review estimates of rates of ship strikes, risk of ship strikes and mortality

Hill *et al.* (2017) described a study of vessel collision injuries on live North Atlantic humpback whales in the southern Gulf of Maine based upon photographs of 624 individuals from 2004 through 2013. Around 15% of individuals exhibited injuries consistent with one or more vessel strikes. Of these, 29% involved propellers and most were only known to penetrate the skin (29%) or into the blubber (66%). Some 10% of injuries were fresh when first seen, and 29% were in the process of healing, including one that was not considered fully healed until two years later. These results likely underestimate vessel collision rates and impacts because multiple events, events resulting in acute mortality, and those that involved only blunt force trauma could not necessarily be detected. There was only one vessel strike formally reported in the area during the study period, and so these results also indicate that events are underreported.

Attention: G, CC

Noting the difficulties of determining the depth of wounds or detecting blunt trauma from images and the relevance of such information to its work on ship strikes, the Committee ***recommends*** *that a careful examination of stranded carcasses and comparison with catalogues of images, that might include the stranded animal pre-mortem, would be valuable and, in some cases, might assist the determination of blunt force trauma.*

The dynamics of collisions between large ships and large whales was explored using simulations in SC/67a/HIM16. An exploratory analysis assuming a body size and mass typical of a fin whale suggests that only at high vessel speeds or with side-on collisions would the impact energy be in the range required to cause death by blunt trauma. However, even at moderate speeds the collision can impose a lateral bending movement on the whale's spine, sufficient to cause serious or catastrophic spinal injury but not necessarily near the point of impact. Spinal injury that is not immediately fatal may compromise the motility of the whale and render it incapable of feeding, leading to death from malnutrition over time. Carcasses from such delayed deaths may not be readily recognised as ship strike mortalities.

The Committee noted that this study could help refine understanding of the relationship between speed and lethal impacts. The results could also help with advice on identifying whether a ship strike had occurred. For example, sightings of animals in poor body condition or unable to swim effectively, but with no obvious external trauma, could have been compromised by internal injuries from ship strike.

Attention: G, CC

The Committee ***recommends*** *that the work on dynamics of collisions between large ships and large whales, such as that in SC/67a/HIM16 continue, noting its potential to provide advice on mitigation measures. It also* ***encourages*** *the author to discuss with relevant stranding coordinators what type of data could be collected to help improve the models.*

14.2 Mitigation of ship strikes in high risk areas

14.2.1 Review progress towards assessing and mitigating ship strikes in previously identified high risk areas

The Committee has previously noted concern over the impacts of ship strikes around Sri Lanka and reviewed studies related to ship strike risk and mitigation options. In view of these concerns a review of historical information on large whales stranded around Sri Lanka was undertaken (SC/67a/HIM11). Details are presented in Annex J. It was not possible to determine the cause of death for any stranded individual before 2002. The first two large whales that were confirmed deaths from ship strikes were in 2002 and 2003[15]. Determining cause of death was only possible for two of the 54 strandings after 2004 and both were ship strikes. There were 12 additional deaths that were reported as ship strikes but these could not be confirmed due to the limited available details. However, the true number of whales killed from vessel strikes must be much greater than the confirmed number.

Blue whales are an example of a species that have well-defined habitat and are subject to anthropogenic threats. Redfern *et al.* (2017) applied methods for predicting cetacean distributions in data poor ecosystems to blue whales in the northern Indian Ocean. Models based on blue whale sightings from combined California Current and eastern tropical Pacific surveys were used to predict blue whale distributions in the northern Indian Ocean (NIO) because of the potential similarity of blue whale ecology in both regions. Predictions of blue whale habitat in the NIO from these models compared favourably to hypotheses about NIO blue whale distributions, provided new insights into blue whale habitat, and can be used to prioritise research and monitoring efforts.

The authors noted that they were now able to further explore the use of these models to assess ship strike risk in the NIO. In 2016, the Committee had agreed that the results previously presented from this study on large scale distribution patterns, together with those of Priyadarshana *et al.* (2016), covering a smaller area, were sufficiently consistent to support a proposal to IMO to move the shipping lanes off the southern coast of Sri Lanka, should Sri Lanka so wish.

Attention: G, SC, CG-A

The Committee ***agrees*** *that the results presented by (Redfern* et al.*, 2017) on applied methods for predicting cetacean distributions in data poor ecosystems would allow it to provide advice on the relative risks of different routing options south of Sri Lanka.*

[15]Except for one humpback whale entangled in fishing gear in 1981.

The Committee also noted that this approach could be advanced in several possible ways and extended to modelling multiple species as well as expanded to other regions. Telemetry data can also assist in developing models of habitat use. It was noted that the information derived from such models is useful over timescales relevant to managing shipping threats (such as routing measures), but that models could also potentially include further relevant variables associated with climate change to make longer-term predictions.

In February 2017, a dead blue whale carcass was found at Estero Mena, southern Chile with at least four clear propeller cuts on the peduncle and the entire tail missing. The third confirmed case of a dead baleen whale from ship collision in this important feeding area for blue whales and other baleen whales.

Attention: G, SC, CG-A
*The recent reported cases of baleen whale mortalities from ship strikes in Southern Chile raises **concerns** about this threat and the need to take actions to reduce the risk of ship strikes. The Committee **recommends** that modelling work (*cf *Redfern* et al.*, 2017) to identify high risk zones for ship strikes in southern Chile be undertaken so that possible mitigation options might be evaluated.*

SC/67a/HIM03 used Automatic Identification System (AIS) data to reconstruct the track and speed of a container vessel which docked in Colombo, Sri Lanka with a dead blue whale wrapped over the bulbous bow. This incident was reviewed by the Committee in 2013 (De Vos *et al.*, 2013). It had not been possible to match a change in vessel speed with the location of the ship strike in SC/67a/HIM03. However, the Committee had previously considered the potential for 'forensic' use of AIS data and such data are being increasingly used within the Committee. There are several commercial providers who may be willing to provide data for conservation related purposes although access is not always easy. It was suggested that the IWC could pass on data requests in a standardised format which would minimise the work for the data provider. It was also noted that if the IWC was coordinating data requests then any data that were provided could be archived for future use along with the request specification.

Attention: SC, S
*The Committee **agrees** that IWC could play a valuable role in coordinating data requests from scientists to AIS data holders for work agreed useful by the Committee. It **recommends** that the Secretariat and the HIM Convenor explore ways in which this can be achieved, including the developing a memorandum of understanding between IWC and a data provider.*

14.2.2 Consideration of methods to identify 'high risk' areas

In 2013, IUCN established a Task Force (TF) on Marine Mammal Protected Areas (MMPA). As its first major initiative, the TF developed develop criteria for identifying Important Marine Mammal Areas (IMMAs) through a consistent and independent expert process. The objective was to be able provide marine mammal information into existing national and international conservation tools with respect to marine protected areas such as Ecologically or Biologically Significant Areas (EBSAs) under the Convention on Biological Diversity (CBD), and Key Biodiversity Areas (KBAs) identified through the IUCN Standard. The IMMA process also assists in providing strategic direction and priorities to the development of spatially explicit marine mammal conservation measures. Notarbartolo di Sciara, co-chair of the MMPA TF, presented an overview of the IMMA process, and the results of the TF's first regional workshops to identify IMMAs in the Mediterranean Sea (SC/67a/HIM15) and in the Pacific Islands region. Regional workshops submit candidate IMMAs (cIMMAs) to subsequent review by an independent panel. Future workshops are being planned in the North-East Indian Ocean (2018), West Indian Ocean (2019), waters adjacent to Australia and New Zealand (2020), and East Pacific Ocean off Latina America (2021).

The Committee noted that this initiative has the potential to assist the work of the IWC. For example, one candidate IMMA in the Mediterranean coincided with an existing high risk area for ship strikes in the Hellenic Trench where the Committee had considered routing measures. In addition to their potential relevance to ship strikes (e.g. through voyage planning or speed reduction), managers might consider using IMMAs in co-occurrence analyses with fishing, noise (e.g. soundscape) or other spatial threats.

Both the IWC Scientific Committee and the Commission's Standing Working Group on Ship Strikes (SSWG) have recognised that the IMMA process may be of value to the work of the Committee in several ways, but most immediately in assisting to identify potential 'high risk' areas for ship strikes. The Committee agreed that a small group (ICG-6 IMMA historical data, Annex W) should be established to work with IUCN MMPA TF intersessionally in order to provide advice on the most appropriate use of the IWC's (and other) historical datasets in the IMMA consideration process.

Attention: SC, CC
*Both the IWC Scientific Committee and the Commission's Standing Working Group on Ship Strikes (SSWG) have recognised that the IUCN IMMA (Important Marine Mammal Areas) process may be of value to IWC work, most immediately in assisting to identify potential 'high risk' areas for ship strikes. Following the SSWG strategic plan, the Committee **recommends**:*

(1) continuation of the effort to identify IMMAs; and in particular
(2) the establishment of a joint IWC-IUCN TF group to identify those IMMAs which could be taken forward to the IMO in the context of ship strikes, starting with the Mediterranean Sea.

14.3 Co-operation with IMO Secretariat and relevant IMO committees

SC/67a/HIM09 reviewed developments in the marine mammal avoidance provision of the IMO Polar Code, along with a general review of available information on collection of data and mechanisms to convey these data to ships masters. The review highlighted the possible impacts of polar shipping, and the context for the creation of the Polar Code, a provision which calls for current information on marine mammal densities and migratory routes to be considered in voyage planning and routeing.

The Secretariat had been contacted intersessionally with a request for comment and advice related to a proposal for vessel routing measures affecting cetaceans that was intended to be submitted to IMO. The Committee noted that there may be a need to respond to such requests intersessionally, and that there was overlap with providing information to USCG and AWSC in addition to input into the IUCN IMMA process related to shipping.

Rosenbaum provided a description of a cooperative effort, between several NGOs, IGOs and UN member countries, to bring issues of shipping and cetaceans, primarily noise and ship strikes, to the attention of the UN (see Annex J, item 5). The Committee noted that it could potentially provide expertise on this issue but **agrees** that, as the current effort is largely policy oriented, in the first instance the Secretariat should communicate with the authors of the initiative to see what role IWC might appropriately play.

Attention: SC, S, CC

The Committee recognises the importance of being able to provide scientific advice on cetaceans with respect to routing and other shipping measures in response to requests to the IWC. Recognising that this is a substantial undertaking and that an appropriate process needs to be developed, the Committee ***recommends****:*

(1) that information on known cetacean densities and migratory routes in the Arctic and Southern Ocean, including appropriate models of distribution patterns, should be compiled and reviewed by the Committee and made available in an appropriate form to assist the Polar states, IMO, and Arctic Council in the implementation of the IMO Polar Code's marine mammal avoidance provision; and

(2) that information regarding cetaceans in the Western Arctic and Bering Strait migratory routes should also be collated and presented to the United States Coast Guard (USCG) and the Arctic Waterways Safety Committee (AWSC) to support their development of mitigation measures in those waters.

To develop this advice and a general process for responding to such requests, the Committee ***establishes*** *an intersessional correspondence group (see Annex W) to:*

(a) consider how best to respond to requests for advice on routeing measures;

(b) consider how to collate information regarding cetaceans in the Western Arctic and Bering Strait migratory routes; and

(c) provide input into the IMMA process related to shipping.

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15. ENVIRONMENTAL CONCERNS

The Commission and the Scientific Committee have increasingly taken an interest in the environmental threats to cetaceans. In 1993, the Commission adopted a resolution on research on the environment and whale stocks and on the preservation of the marine environment, IWC Resolution 1993-12 (e.g. IWC, 1996; 1997; 1998; 1999; 2010a). As a result, the Committee formalised its work by establishing a Standing Working Group that has met every year subsequently.

15.1 Pollution 2020

15.1.1 Review on intersessional progress

Hall provided a summary on the progress of the intersessional correspondence group for persistent organic pollutants (see Annex K, Appendix 2) under the three items in the work plan.

(a) *Continue modelling of contaminants, including potential addition of PBDEs.* Development and refinement of the individual based model (effectS of Pollutants On Cetacean populations, SPOC) has continued during the intersessional period focusing on uncertainty in the *in utero* transfer parameter and how best to use published toxicological data for PBDEs.

(b) *National and international progress on risk and mitigation for PCBs.* A number of news items reporting the high levels of PCBs in killer whales and other European cetaceans published by Jepson *et al.* (2016) resulted in a call for countries to adhere to the Stockholm Convention on Persistent Organic Pollutants. The Committee suggests that many mitigation methods be explored. The Committee also notes that the SPOC model might be used to estimate the population half-life of PCBs in cetaceans, under different remediation scenarios, to inform managers of how long it would take for any measures to be apparent in a particular population.

(c) *Data integration and mapping.* Work on the contaminant mapping tool continued intersessionally and many of the suggestions and comments provided by the Committee members at SC/66b have now been implemented. It will be available on the website by SC/67b.

SC/67a/E09rev1 presented new information on PCBs in free-ranging common bottlenose dolphins from the Gulf of Trieste, in relation to demographic parameters. Males had significantly higher PCB concentrations than females and nulliparous females had higher concentrations than parous females, due to maternal offloading. A large proportion of the population had levels above the estimated threshold for physiological effects in marine mammals.

The Committee discussed possible sources of PCB pollution into the Adriatic Sea, noting that remediation plans for regions with semi-closed bodies of water should consider the long marine system retention times. Identification of regions where contaminant levels have decreased as a result of remediation actions) could help direct future mitigation recommendations in other regions and this will be examined by an intersessional correspondence group (see Annex W).

PCB monitoring combined with long-term photo-identification and population ecology studies can be highly informative for assessing the impacts of POP pollution, especially as such information is often lacking for wild populations. Such studies could then be compared to predicted model outputs to indicate ongoing or new sources of contaminants to a particular region.

Attention: G, C-A

The Committee ***recognises*** *the important contribution of the Pollution 2020 programme to its ability to provide the Commission with advice on contaminants. The Committee:*

(1) ***thanks*** *Hall for her continued improvements to the contaminant mapping tool and the modelling modifications;*

(2) ***recommends*** *these tools be made available to the public; and*

(3) ***recommends*** *that the proposed model modifications and the population half-life of POPs objectives be progressed next year (SC/67b).*

In addition, the Committee ***draws the attention*** *of the Commission to issues related to PCBs and cetaceans and especially the results of: (a) Jepson* et al. *(2016) regarding* *the high levels of PCBs in killer whales and other European cetaceans; and (b) SC/67a/E09rev1 and the high levels in the Adriatic Sea. The Committee therefore:*

*(1) **endorses** international efforts to reduce PCBs in the environment; and*
*(2) **recommends** that the work of Genov and colleagues in the Adriatic continues, and that their data are integrated into the modelling and mapping work described under Item 15.1.1.*

15.1.2 Receive review on mercury in cetaceans

SC/67a/E08 reported heavy metal concentrations in the tissues of gray whales and Pacific walruses from the coastal waters of the Chukchi Peninsula between 2008 and 2016. The levels of many elements were higher in the liver than the other tissues sampled. The Russian State Maximum Permissible Levels for the various metals were exceeded in very few samples, most notably in the 'stinky' gray whale samples from 2008. The Committee notes that the elevated cadmium and lead concentrations in the gray whales are of interest.

The topic of mercury in cetaceans was placed on the Committee's agenda in response to IWC Resolution 2016-4 from the Commission on the 'Minamata Convention' that 'requests the Scientific Committee to provide at IWC/67 a summary of the current state of knowledge on the presence of heavy metals, with emphasis on mercury compounds, in cetaceans worldwide, and to identify areas of ocean health and human health concerns, and geographic areas where research should be prioritised in this regard'.

SC/67a/E04 provided a summary review of the significant amount of data on mercury in cetacean species that have been reported globally since the first reports in the 1970s. The aim was to provide a snapshot of existing peer reviewed papers and technical reports on levels and trends in various species. The paper provides an additional evaluation regarding which species would be considered more at risk for mercury and which ocean basins.

The Committee thanks the authors for this preliminary review, which helped guide the development of the response to the Commission's resolution and recognises that further synthesis is needed. It notes that data on prey contaminants might be available regionally or nationally and links to such data sources might also be useful.

Attention: C-A, SC, G

In response to the Commission's resolution (IWC Resolution 2016-4) at this stage, the Committee:

*(1) **draws the attention** of the Commission to the preliminary review (SC/67a/E04) of data on mercury in cetacean species that have been reported globally since the first reports in the 1970s;*
*(2) **recommends** that a more in-depth synthesis of available data be undertaken and that experts in mercury cycling and mercury toxicology in cetaceans participate in providing further information with the objective of completing a report for the Commission by SC/67b; and*
*(3) **recommends** that the mercury and selenium levels provided in the presented review, and solicited from additional technical experts, be added to the contaminant mapping tool.*

15.2 Oil spill impacts

15.2.1 Development of information resource and communication strategy

Information on several oil spill planning and preparedness guidance documents that are nearing completion in the US and internationally were presented. In the US, NOAA has completed the National Marine Mammal Oil Spill Response Guidelines for marine mammals and is now developing regional annexes.

Internationally, the first phase of a global oiled wildlife emergency response system (funded by the International Association of Oil and Gas Producers/International Petroleum Industry Environmental Conservation Association (IOGP/IPIECA) Oil Spill Response-Joint Industry Project - Phase II) was completed in December 2016. Funding was also awarded to a cohort of leading oiled wildlife response specialists to develop a 'Good Practice Guide on Wildlife Response Preparedness' which could apply to marine mammal response.

15.2.2 Progress on oil spill science, planning and preparedness

The Committee welcomed SC/67a/E03 which reported information on heavy fuel oil (HFO) and Arctic cetaceans, and updated the Committee on efforts in other international fora to study and mitigate the risk of use and carriage of HFO by vessels in the Arctic. A further update on the work of the Arctic Council to study the impacts of HFO use and past incidents was also presented, including the recent inclusion of concerns surrounding HFO presented in the Fairbanks Declaration of 11 May 2017 (Arctic Council, 2017).

Attention: G, CG-A

*The Committee **draws the attention** of the Commission to the importance of understanding the risks to cetaceans caused by transport of heavy fuel oil in the Arctic and **recognises** the ongoing valuable work taking place in the Arctic Council, Circumpolar Biodiversity Monitoring Program. To complement this, the Committee:*

*(1) **encourages** submissions to future meetings of the Committee under the Item on Pollution 2020 on the impact of heavy fuel oils on cetaceans and on possible mitigation measures; and*
*(2) **recommends** the collection of baseline data on health and contaminant levels for cetaceans in the Arctic, including standardisation of assessment measures among studies of bowhead whales and white whales.*

15.3 Cumulative impacts

15.3.1 Brief update on intersessional progress and plans for 2018

The Committee considered the five research recommendations from the recent report on the cumulative impact of stressors on marine mammals (National Academies of Sciences Engineering and Medicine, 2016). The Committee noted that the 2004 IWC Workshop on Habitat Degradation (IWC, 2006) was also highly relevant to this topic and would provide additional useful guidance for the proposed workshop.

Attention: SC, G

The problem of assessing cumulative and synergistic stressors on cetaceans is long standing. To assist in this effort, the Committee:

*(1) **recommends** the holding of a workshop on cumulative effects (see Item 25); and*
*(2) **endorses** the recommendation from the (National Academies of Sciences Engineering and Medicine, 2016) that future research should focus on efforts to develop case studies that apply the Population Consequences of Multiple Stressors (PCoMS) framework to actual marine mammal populations and that this should be a component of the workshop.*

15.4 Harmful algal blooms

On 7-8 May 2017, a pre-meeting entitled 'Workshop on Harmful Algal Blooms (HABs) and Associated Toxins' was held (SC/67a/Rep09). Experts presented information related to HAB dynamics and drivers, including mechanisms underlying toxin production and detection, as well as major HABs and their toxins of concern for cetaceans.

15.4.1 Synthesis of current state of science and impacts to cetaceans

The Workshop concluded that the global distribution and increasing ubiquity of HABs and their toxins has resulted in an increasing risk to cetacean health at the individual and population levels. It also noted that data from HAB monitoring, marine mammal strandings and toxin analysis in tissues and environmental samples should be integrated at appropriate spatial and temporal scales. There are many resources available online and that a list of contacts in the HAB community by country or region would valuable for cetacean researchers. Two-way communication between stranding responders, oceanographers and the ocean observing community was also suggested.

15.4.2 Health impacts of HABs and their toxins

Investigations of human and cetacean exposure to HABs have similar confounding issues associated with duration of exposure and toxicity of bloom, information on health prior to the exposure, and concurrent exposures to other possible contaminants. Linking HABs and their toxins to cetacean impacts is difficult because of the multiple HAB species that may be involved, the varying oceanographic conditions, varying HAB and cetacean biology, and varying data availability and quality.

The use of 'omics technologies' (from genomics to metabolomics) to investigate toxin exposures and their impacts on individual animal health holds promise for the development of HAB biomarkers, particularly in instances of unexplained mortality events or investigations of the effects of chronic exposures in cetaceans.

15.4.3 Workshop conclusions and recommendations

The Workshop recommended that cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR[16], and other HAB groups, to increase communication and active information exchange between biologists and the HAB community. The Workshop noted the rapid global expansion of aquaculture systems that may alter coastal habitats and enrich nutrients into the marine environment which can increase the occurrence and intensity of HABs. While development of dose-response relationships may not be feasible for any cetacean species, data could be synthesised from multiple sources to estimate dose-response relationships in cetaceans. These sources could include laboratory experiments of other species, measured concentrations from cetaceans and pinnipeds with confirmed acute toxicosis, and control cases without evidence of HAB-related disease. Finally, the Workshop recommended that the development of biomarkers in relevant (and obtainable) tissues and other matrices, both of exposure and of effects, be pursued as a priority.

In discussing the report, the Committee noted that increasing HAB events worldwide are influenced by a variety of factors, including changes in climate and temperature, as well as human activities that result in exponentially increasing inputs of nitrogen and phosphorus into the environment. It also recognised that whilst HABs increase in frequency in many regions of the world, the effects of HABs on cetacean health, both at an individual and population level, are not fully understood. In addition, the ability to assign the cases to a specific cause is hampered by logistics, weather conditions, and resources. The technical expertise necessary to perform post-mortem examinations on cetaceans and to collect appropriate samples is still lacking in many regions of the world. It is likely that the documented HAB-related mortalities reflect only a small proportion of those that are occurring.

The Committee **commends** Hall, Rowles, and the Workshop participants for their hard work and excellent report.

Attention: CG-A, G

The Committee ***agrees*** *that the global distribution and increasing ubiquity of Harmful Algal Blooms (HABs) and their toxins has resulted in an increasing risk to cetacean health at the individual and population levels. The Committee cautions that the documented HAB-related mortalities reflect only a small proportion of those that are occurring. The Committee* ***endorses*** *the recommendations of the HAB Workshop as follows, recognising that some are long-term projects:*

(1) cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR and other HAB groups to facilitate information exchange;
(2) efforts to investigate data that could improve understanding of dose-response functions should be pursued;
(3) toxins in cetacean prey be monitored; and
(4) HAB toxin detection methods be standardised and research into appropriate biomarkers of exposure and response be pursued by researchers in the field.

In addition, the Committee ***advises*** *IWC member governments to support efforts to:*

(1) control nutrient input including reducing use of nitrogen and phosphorous;
(2) support best aquaculture practices[17] and relevant international agreements, initiatives and standards set out by FAO's Fisheries and Aquaculture Department; and
(3) prioritise HAB impacts in their monitoring and research plans, as well as capacity building for stranding response and post-mortem investigation of unusual cetacean events.

15.5 Marine debris

15.5.1 Brief update on intersessional progress and plans for 2018

The Committee noted that the issue of plastic pollution and marine debris will be considered at the Convention on the Conservation of Migratory Species (the Bonn Convention) and marine debris will be a topic at the forthcoming Conference of Parties in October 2017. The Committee looks forward to a report from this meeting next year (SC/67b). The Committee has established an intersessional correspondence group to plan for a future workshop on marine litter and plastics (ICG-27, Annex W).

[16]GlobalHAB - Global Ecology and Oceanography of Harmful Algal Blooms (*http://www.geohab.info/*); ICES - International Council for the Exploration of the Sea (*http://www.ices.dk/Pages/default.aspx*); PICES - North Pacific Marine Science Organization (*http://www.ices.dk/Pages/default.aspx*); SCOR - Scientific Committee on Oceanic Research (*http://www.scor-int.org/*).

[17]*https://bapcertification.org/.*

15.6 Diseases of concern

15.6.1 Progress on website and communications (including quarterly CDOC updates) and plans for 2018

SC/67a/E07rev1 reported the progress made by the IWC intersessional steering group on Cetacean Diseases of Concern (CDoC) between May 2016 and April 2017. During IWC SC/66b, the Commission endorsed a recommendation to continue the work associated with refining the website and making it operational as soon as possible[18]. The main page is open to the public, but disease information pages require login.

The Committee was pleased that changes suggested last year have been incorporated intersessionally (IWC, 2017b). Some concerns were raised about the uncertainty around the time and money spent on website development and management and usage by the community given that the website is not yet available to the community and usage cannot yet be determined.

Attention: SC

The Committee ***recognises*** *the importance of the content on the CDoC website, thanks Simeone for her efforts in improving the design of the CDoC website and updating the website content and notes the potential synergy between CDoC and the Strandings Initiative, especially with respect to Hot Topics, Laboratory List, and reporting portal. The Committee* ***recommends*** *that:*

(1) the CDoC intersessional correspondence group (ICG-24, Annex W) includes members of the Strandings Initiative to evaluate potential overlapping tasks;
(2) the current content of the CDoC site is reviewed by the intersessional correspondence group so that content be made available to users as soon as possible;
(3) HAB experts review the relevant site content, and that the list of international HAB organisations be shared on the CDoC site; and
(4) that the intersessional correspondence group suggests a mechanism to provide relevant disease information to interested parties on a quarterly basis.

15.6.2 New information

SC/67a/E01 compared photographs from bowhead whales of the Okhotsk Sea sub-population with data from the Bering-Chukchi-Beaufort Seas population. Both populations are exposed to entanglement in fishing gear and killer whale predation, however the killer whale injuries are more severe in the Okhotsk Sea. Moult-related skin conditions are unique to the Okhotsk Sea bowheads which also carry a greater body burden of whale lice. These differences may reflect the different marine habitats. The study shows that photographs of bowhead whales can be used not only for photo-identification but also for information on health and human interactions. The status of the Okhotsk Sea sub-population is also discussed under Item 9.3.8 whilst the Bering-Chukchi-Beaufort Seas population is discussed under Item 8.3.1.

15.7 Strandings and mortality events

15.7.1 Short review on intersessional progress and plans for 2018

At its IWC/66 meeting in 2016, the Commission endorsed the recommendations of the Whale Killing Methods and Welfare Issues Working Group (WKM&WI WG) and the Scientific Committee on Strandings, including the establishment of a Strandings Expert Panel and Coordinator post. Following discussion in the WKM&WI WG, the issue of funding for the Strandings Coordinator was referred to the Finance and Administration Committee (F&A). The F&A Committee noted that funding was not allocated to this initiative and that costs might have to be met through voluntary contributions at least initially.

SC/67a/E06 summarised the work carried out by the intersessional steering group (SG-16) on strandings that was tasked during SC/66b with selecting the Expert Panel, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate. The Expert Panel has been selected although efforts are needed to improve representation from Asia and Africa.

The Committee also discussed a draft governance structure developed by the intersessional SG and Secretariat. The Committee agreed that there should be a transition from the intersessional group to a permanent Steering Group to enhance communication between the Expert Panel and the Scientific Committee, Conservation Committee, and the WKM&WI WG. The interim and proposed final reporting structures and activities are shown in figs 1 and 2 of Annex K.

Attention: C-R, CC, WKM&WI

The Committee ***reiterates*** *the importance of the Strandings Initiative as approved by the Commission at IWC/66,* ***thanks*** *Simeone for excellent work leading this effective intersessional effort, notes the need for an emergency response fund and* ***recommends*** *that:*

(1) the intersessional steering group (SG-16) remains and proceeds with the development of the initiative until the Commission appoints the steering group following the process provided in the draft governance and reporting structure (Annex K, figs 1 and 2) and see point (4) below;
(2) the Chair of the Conservation Committee (or his/her appointee) and the Chair of the Whale Killing Methods and Welfare Issues Working Group (or his/her appointee) join the intersessional SG;
(3) the ISG finalises the Expert Panel and select representatives from Asia and Africa from the existing list of nominees if possible;
(4) the Commission establishes a steering group, comprised of members of the Scientific Committee, the Conservation Committee, and the Whale Killing Methods and Welfare Issues Working Group as soon as practical;
(5) as concurrent priorities:
   (a) the Secretariat initiate the process to recruit a Stranding Coordinator as soon as possible;
   (b) the Expert Panel, once finalised, elects a chair, and works intersessionally and virtually;
   (c) the intersessional SG and the Expert Panel, in consultation with the Secretariat, develop a job description and person specification for the Stranding Coordinator - some members of the Expert Panel and ISG should sit on the interview panel; and
   (d) the intersessional SG with the Secretariat develop a funding mechanism for emergency stranding response;
(6) the Expert Panel and the intersessional SG should also work with intergovernmental organisations such as the IUCN Wildlife Health Specialist Group and with the governments of member countries to develop a procedure for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations.

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[18] *https://cdoc.iwc.int/.*

15.7.2 New information
The Committee welcomed SC/67a/HIM02, which described a pilot study that tested the ability of VHR (Very High Resolution) satellite imagery to identify and count stranded whales during the Chilean sei whale stranding event that took place along the mid-Patagonian coast between February to May 2015. The authors concluded that VHR imagery could be an important future tool for detecting stranding events of baleen whales in remote areas and noted that their work is ongoing.

Attention: G, SC
Despite questions of cost and access to images, the Committee ***agrees*** *that:*
(1) the use of VHR satellite imagery to identify and count stranded whales shows promise in areas where clear satellite images can be obtained (e.g. satellite images will not work for areas where carcasses will be obscured such as mangroves);
(2) serial images would further illuminate issues with the timing of whale deposition especially in remote locations where carcasses persistence is unknown; and
(3) continued refinement of this method should occur to fully evaluate its potential, especially for remote areas.

A humpback whale unusual mortality event is occurring along the US Atlantic Coast in which forty-three whales stranded from 1 January 2016 through 5 May 2017. Of the 22 cases examined, 10 cases had evidence of blunt force trauma or pre-mortem propeller wounds indicative of vessel strike. This is well above the 16-year average for vessel strikes of 2.5 whales. The Committee notes that there may not have been changes in vessel traffic, but that the whales feeding behaviour may have changed causing a possible overlap with some shipping lanes.

Attention: CG-R
The Committee ***recommends*** *that studies to investigate the reasons for the increase in vessel strikes to humpback whales on the Atlantic coast of the USA should continue, along with risk assessment analyses and the investigation of potential mitigation measures.*

Carretta *et al.* (2016) used the fraction of carcasses recovered after stranding and abundance and survival rate data from field studies to estimate annual deaths for a population of coastal bottlenose dolphins. During a 12-year period (1995-2006), 327 animals (95% CI=253-413) were expected to have died and been available for recovery, but only 83 carcasses attributed to this population were documented. This estimate will be of additional value in developing carcass recovery correction factors for more pelagic dolphin species in the region that might be less likely to strand.

Although this study did not distinguish between natural and human caused mortality, the correction factor provides a starting place for modelling human-caused effects in subsequent studies (e.g. see SC/67a/Rep07). Inclusion of other environmental factors might provide information on what to expect during a specific ocean regime. Since stranding network effort affects the ability to generate this kind of carcass correction factor, the study also emphasises the importance of increasing and maintaining stranding response capacity.

Attention: CG-R
Estimating numbers of entangled or ship struck whales from strandings data is difficult but important when trying to estimate possible population level effects. The Committee ***welcomes*** *the study of Carretta* et al. *(2016) which has already influenced modelling scenarios (e.g. see Item 10.1.3) and* ***stresses*** *the importance of understanding carcass recovery and how it can be scaled up to the whole population for other situations (e.g. it has practical applications for assessing oil spill damage, and see discussion under Item 13.4).*

15.8 Noise
15.8.1 Update on national and international ocean noise strategies
The Committee welcomed information on ongoing efforts by the USA (including NOAA's Ocean Noise Strategy Roadmap), Canada (Ocean Protection Plan) and IUCN (a resource guide for managers on geophysical and other imaging surveys) to develop strategies for addressing ocean noise issues. It also noted the ongoing development of two new acoustic standards via the Acoustical Society of America's ANSI standards process, covering expert recommendations on standardising industry-related PAM operations and guidance on metadata associated with the collection and analysis of passive acoustic data.

15.8.2 Update on intersessional cooperation with the IUCN WGWAP Noise Task Force
The Committee welcomed the sharing of recommendations from the IWC Acoustics Masking Workshop (IWC, 2017g) and the IUCN WGWAP Noise Task Force in response to a recommendation last year (discussions were initiated in early 2017).

15.8.3 New international and national guidelines and advice (e.g., IMO)
The IWC Acoustic Masking Workshop (IWC, 2017g) (IWC, 2017b, p.617-27) had recommended connecting IWC recommendations on ocean noise with the UN Sustainable Development Goals (SDG14) process to 'Conserve and sustainably use the oceans, seas, and marine resources for sustainable development'. Rosenbaum reported on a side event on ocean noise, shipping and whale conservation that occurred prior to the UN Oceans Conference (February 2017) to discuss implementation of SDG14.

Legislation applied to seismic surveys to mitigate effects on marine mammals in 20 Latin American countries was reviewed in Reyes Reyes *et al.* (2016). Currently, only Brazil and Peru have enacted mandatory guidelines. Some countries and companies have voluntarily adopted mitigation measures legislated by other countries. However, seismic survey mitigation remains unlegislated in most Latin American countries and there is an urgency to increase awareness and urge regulators to enact and enforce proper legislation for marine seismic survey activities.

In addition, the Committee notes that the New Zealand Department of Conservation Guidelines (Department of Conservation, 2005) for minimising acoustic disturbance from seismic survey operations are being revised and looks forward to a presentation of these updated guidelines.

Attention: CG-A, CG-R, SC
The Committee has repeatedly expressed ***concern*** *about the potential impacts of noise on cetaceans. The Committee* ***reiterates*** *this concern and:*
(1) ***welcomes*** *the update on international efforts to develop noise guidelines and acoustic standards;*
(2) ***encourages*** *expanded international coordination regarding assessment and protection of acoustic habitat quality; and*

(3) ***recognises*** *the commonalities identified among recommendations from recent ocean noise workshops and planning documents (e.g. Annex K, Appendix 3) and* ***agrees*** *to continue to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise.*

With respect to seismic surveys, the Committee:

(1) ***reiterates*** *its previous recommendations on seismic survey noise reduction guidelines since 2004 (IWC SC/56, IWC SC/57, IWC SC/58, IWC SC/59, IWC SC/62, and IWC SC/66);*

(2) ***recognises*** *the recommendations from Reyes* et al.*, 2016 and* ***reiterates*** *the need for international guidelines; and*

(3) ***recommends*** *as a matter of urgency that member countries should collaborate regarding implementation of best available practices for minimising the negative impacts of seismic survey exploration on marine mammals and their acoustic habitats, and to promote collaborative efforts among industry partners to reduce the need for multiple surveys within the same habitats.*

Last year (IWC, 2017b, p.53), the Committee recommended a paper for submission to the IMO Marine Environment Protection Committee (MEPC), providing an update of recent information related to the extent and impacts of underwater noise from shipping. This will assist the broader recommendations for enhanced cooperation between IWC and IMO and follows a similar update on ship strikes which was well received by IMO MEPC. The next MEPC meeting, MEPC 71 will be held in July 2017 and at least one paper related to underwater noise from shipping has been tabled at that meeting, and when this is discussed IWC could offer to develop a technical paper on the issue for MEPC 72 (expected in early 2018).

Attention: S

With respect to the development of a paper for submission to the IMO Marine Environment Protection Committee (MEPC), the Committee ***recommends*** *that:*

(1) *intersessional correspondence group (ICG-25, Annex W) provides the Secretariat with a summary of the relevant material and discussions in the form of a paper that could be presented to MEPC 72 with a focus made on the 2016 recommendations and rationale; and*

(2) *that the Secretariat or an expert from the Scientific Committee attends MEPC 71 to offer a technical paper for MEPC 72. This work should be completed by March 2018.*

15.9 Climate change

15.9.1 Brief update on intersessional progress

A new report on the consequences of global warming produced under the auspices of the IUCN was launched at the IUCN World Congress in September 2016 (Laffoley and Baxter, 2016). One chapter (Simmonds, 2016), outlined the potential effects on marine mammals including shifts in feeding and breeding grounds; movement of mobile species into new areas resulting in further conflicts with human activities; mismatches between peak productivity and cetacean migration timings; declines in species with restricted habitats and changes in the balance of species with increasing occurrences of invasive species.

15.9.2 Reconsiderations of this agenda item in light of other items (e.g. Arctic issues, river dolphins)

The Committee discussed how the topic of climate change, which cuts across many agenda items, could be better integrated into its work. There was reference to previous discussions and workshops on this topic and subsequent recommendations from those. A steering group had met in 2014 to make recommendations to direct future considerations of this topic by the Committee.

Attention: SC, C-A

With respect to climate change, the Committee ***agrees*** *that:*

(1) *the impact of climate change should be considered in an integrated manner highlighted when it is a specific driver within the topics being covered; and*

(2) *that the intersessional correspondence group (ICG-26, Annex W) refine ideas for a future workshop and identify relevant climate change issues, noting the discussions under Item 15.10.1.*

15.10 Arctic issues

15.10.1 Progress on priority topics including co-operation with other bodies

Moore provided information on the four priority topics on Arctic Issues endorsed at SC/66b (IWC, 2017b, pp.54-55). The Arctic intersessional correspondence group reviewed recent activities under each topic. Priority one was to provide updates on cetacean species that routinely occur in the Arctic. In the Pacific Arctic, it was noted that while sea ice extent has declined, bowhead and gray whales in the eastern Chukchi Sea have not changed their distributions appreciably over a 34-year sampling period. Seasonal migrant species of baleen whale are now commonly seen north of Bering Strait.

A review of possibilities and constraints in the future harvest of living resources in a changing northeast Atlantic Arctic Ocean was presented in Haug *et al.* (2017). Global warming drives changes in oceanographic conditions in the Arctic Ocean, which may result in favourable conditions for increased biological productivity. However, production in the central Arctic Ocean will continue to be limited by light and vertical stratification. Upwelling conditions and inflowing Atlantic Water may result in high production in areas along the shelf breaks that may influence the distribution and abundance of marine mammals. Both migrant cetaceans and harp seals are likely to follow any receding sea-ice edge, if sufficient food resources become available in the region. Such northward expansions of more boreal marine mammal species are likely to cause competitive pressure on some endemic Arctic species (bowhead whales, white whales, narwhals), as well as putting them at risk of predation and diseases.

Vacquié-Garcia *et al.* (2017) described recent late summer distribution of whales in high Arctic Norwegian waters. Based on line-transect surveys conducted in August 2015, bowhead whales were predominantly seen close to the ice-edge, whereas narwhals were located deeper into the ice. No white whales were observed during these surveys. The results suggest little spatial overlap between the seasonally occurring whales and the narwhals, bowhead and white whales.

Priority topics 2-4 (IWC, 2017b, pp.54-55) focused on aspects of integrating the work of the Committee with various Arctic Council working groups. Topics where synergies may be found include activities related to the Arctic Marine Shipping Assessment (AMSA) and the IMO Polar Code and Voyage Planning activities. In particular, the Bering Strait Port Access Route Study and the Arctic Waterways Safety Committee were noted. With regard to ecosystem assessment activities, the Circumpolar Biodiversity Monitoring Program (CBMP), the State of the Arctic Marine Biodiversity Report (SAMBR), the Ecosystem Approach (EA) to Management, and the Arctic Council Emergency Prevention Preparedness and Response (EPPR) reports seemed the most relevant to the work of the Committee.

Possible changes to the structure of the Committee agenda were also discussed with the objective being to better integrate information flow on impacts to cetaceans of environmental variability associated with climate change, in the Arctic and elsewhere, among the sub-committees and working groups of the Committee.

Attention: SC
The Committee ***agrees*** *that the thematic and focus topics of the Standing Working Group on Environmental Concerns are* *<u>all</u>* *occurring in the context of climate change, as are all other topics considered in several sub-committees of the Committee (e.g. SM, EM). Therefore, the Standing Working Group on Environmental Concerns* ***recommends*** *that Climate Change be better integrated in the work of the full Committee. The Committee* ***agrees*** *that Arctic Issues will no longer be a standing topic in the Standing Working Group on Environmental Concerns agenda and papers would be addressed under the most appropriate agenda items for the issue being presented.*

15.11 State of The Cetacean Environment Report – SOCER

The State of the Cetacean Environment Report was the result of several IWC resolutions including Resolutions 1997-7 and 1998-5, which directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 welcomed the concept of SOCER and requested the annual submission of this report to the Commission. The first full SOCER was submitted in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Mediterranean and Black Seas, Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2017 SOCER (see Annex K, Appendix 5) focuses on the Indian Ocean, summarising key papers and articles published from about 2015 through 2017 to date. Next year the 2018 SOCER will focus on the Mediterranean and Black Seas.

The ‘Ocean Health Index’ rates the Western Indian Ocean with a good score (79 of 100 points), but the Eastern Indian Ocean receives a poor value of 55. Another evaluation, the ‘First Global Integrated Marine Assessment’ conducted by the UN, identified the key Indian Ocean threats as bycatch, habitat degradation and loss, and pollution (including marine debris). Importantly, it outlined the lack of information available on the state of the Indian Ocean and stresses research gaps. One study reported that the Indian Ocean gyre apparently contains more floating debris than both the Southern Pacific and Southern Atlantic gyres combined. Several papers pointed to the threats facing endangered river dolphins in India, Pakistan and Nepal due to various modifications of waterways. Globally, the problem of climate change predominated. Unprecedented levels of carbon dioxide in the atmosphere (410ppm) have been recorded, and it is predicted that global temperatures that have not been experienced in 420 million years will be recorded soon. 2016 was officially the hottest year on record with global temperatures 1.2°C above the average temperatures during the late 19th/early 20th centuries. Further studies on cetaceans exposed to the Deepwater Horizon oil spill demonstrate clear population impacts, including long-term deterioration of cetacean health, a decrease in reproductive rates and an increase in mortality rates in bottlenose dolphins exposed to oil. Further details can be found in Annex K, item 12 and Annex K, Appendix 5.

The Committee notes that the annual SOCER can be downloaded from the IWC website (*https://iwc.int/socer*) and is also published in the Supplement to the *J. Cetacean Res. Manage.* as an appendix to the annex which is the report of the Standing Working Group on Environmental Concerns. Although infectious diseases were not included in the SOCER this year due to the lack of peer-reviewed publications in the focus region, this subject matter has been included in SOCER in previous years. The Committee **thanked** the editors of SOCER for their report and **commended** them on compiling this information.

15.12 Work plan

The proposed work plan is provided in Table 22 and the proposed work flow is provided in Annex K, Appendix 6.

16. ECOSYSTEM MODELLING

The report of the Working Group on Ecosystem Modelling is given as Annex L. This group was first convened in 2007 (IWC, 2008a). It is tasked with informing the Committee on relevant aspects of the nature and extent of the ecological relationships between whales and the ecosystems in which they live.

Each year, the Working Group reviews new work on a variety of issues falling under three areas:

(1) reviewing ecosystem modelling efforts undertaken outside the IWC;
(2) exploring how ecosystem models can contribute to developing scenarios for simulation testing of the RMP; and
(3) reviewing other issues relevant to ecosystem modelling within the Committee.

16.1 Cooperation with CCAMLR on multi-species modelling

16.1.1 Review ecosystem modelling in the Antarctic Ocean

SC/67a/EM14 updated an existing ecosystem model for the Antarctic Ocean (Mori and Butterworth, 2006) to incorporate model improvements and updates of abundance and trend information for krill and predator species. While the updated models presented a better fit than previously, there was more oscillatory behaviour in the trajectories for krill and some of its main predators, probably due to the new approach used to model natural mortality for krill. This may in turn resolve a key mismatch in the model, which predicts Antarctic minke whale oscillations in the Indo-Pacific region to be out of phase with results from a SCAA assessment of these whales.

SC/67a/EM12 illustrated additional models describing a focused spatial ‘Model of Intermediate Complexity for Ecosystem Assessments’ (MICE) for phytoplankton, krill, copepods and five baleen whale species for the Southern Hemisphere. Predicted Antarctic blue, fin, and southern right whale populations are at <50% pre-exploitation numbers (K) in 2100, even given 100 years without catches. Southern right whales were estimated to currently be <11% of their carrying capacity, while humpback whales were predicted to recover to K by 2050. Results demonstrated key differences in population trajectories and estimates between models

Table 22

Summary of the work plan for environmental concerns.

Topic	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Cumulative impacts	Plan the pre-meeting.	Pre-meeting Workshop on modelling cumulative effects and case studies.
Pollution 2020 (including oil spills and mercury)	Finalise Phase 1 of the SPOC model with the recent modifications and make available on the IWC website. Begin Phase 2 to include assessing risks from PBDEs and assess population half-life of POPs in cetaceans.	Report on the SPOC model to include the addition of effects of PBDEs and POP population half-life estimates.
	Make current map available on the IWC website	Report on progress with the contaminant mapping and trends tool development including addition of mercury.
	Synthesise available mercury data and integrate into map.	-
	Identify appropriate IPs for mercury cycling and toxicology.	-
	Produce report on mercury.	Summary report on mercury to Commission.
	Identify PCB remediation courses of action.	Update on progress.
Strandings	Work with Secretariat to develop and implement the International Strandings Initiative.	Update on progress.
SOCER	Produce report.	Mediterranean and Black Seas.
CDoC	Finalise the IWC CDOC website redesign and content, determine best approach to maintain information in website and the consultation/ discussion fora, work with Strandings Initiative.	Update on progress as appropriate.
Noise	Planning for future Workshop on noise.	Update on progress as appropriate.
	Intersessional advisory group to provide Secretariat with summary of shipping noise for MECP 72.	Progress reported.
Marine litter	Pre-planning for marine debris Workshop on marine litter and plastics at SC/68a in 2019.	Working paper outlining the workshop agenda.
Climate change	Discussions of future work including planning for a Workshop.	-

that account for, or ignore, predator-prey linkages. This is a strategic model that provides a platform for exploring additional hypotheses and management strategies.

In discussion, it was noted that while these two ecosystem models have differences in objectives, trophic interactions captured and scales of the models, there are also some synergies. Both are krill-based predator-prey multispecies models, and are naturally underpinned by similar data requirements (though at different scales) and a requirement for a sound understanding of ecosystem function. The need for better data for describing population dynamics of individual species, and for more quantitative information about energy transfer between related trophic levels was emphasised.

16.1.2 Update on cooperation with CCAMLR

Several CCAMLR members were welcomed and thanked for their participation in discussions, including Mark Belchier, current Chair of the CCAMLR Scientific Committee. It was agreed that data sharing, data quality control, and identifying data gaps were key issues to be resolved at an institutional level between the IWC and CCAMLR. Therefore, it is timely that planning is taking place for another IWC-CCAMLR workshop on data requirements for ecosystem models in 2019 (see Item 16.1.3). CCAMLR and IWC share similar goals in terms of developing whole-of-ecosystem modelling approaches, and that this similarity can benefit both organisations.

16.1.3 Update on the plan for joint SC-CAMLR – IWC SC workshops

In 2008, IWC and CCAMLR held a joint Workshop where data holders on krill predators and oceanography came together (IWC and CCAMLR, 2010). A formal proposal is being drafted to develop multi-species models and a joint IWC-CCAMLR workshop has been planned following a 2-step approach (IWC, 2017b, p.56). The first stage is to hold a pre-meeting workshop before SC/67b in 2018 to: (a) review new data (from 2008 when the last Workshop was held); (b) discuss the types of multi-species models to meet the needs of both organisations; and (c) develop a workplan for a second workshop in 2019. The western Antarctic Peninsula will be a focus area for modelling as it is a high priority area for krill management and there are considerable data available. The details of this two-year process are given in Annex L, Appendix 5.

Attention: SC

*The Committee **recommends** that collaboration between IWC-SC/SC-CAMLR continues, and that the revised plan for the workshops on multispecies modelling be implemented (Annex L, Appendix 5).*

16.2 Applications of species distribution models (SDMs) and ensemble averaging

16.2.1 Review progress of guideline for SDMs

An intersessional steering group (SG-20, Annex W) has been operating since SC/65b to develop guidelines and recommendations for best modelling practices for SDMs. It has conducted a preliminary review of SDMs applied to baleen whales and preliminary reviews of machine learning methods, which are commonly used as SDMs. Subsequently, general guidelines for the application of SDMs were developed. SC/67a/EM15 updated this work by integrating a further 12 reviews of new SDM papers. The intersessional SG plans to complete its work prior to SC/67b. The work plan includes the following tasks: (1) revising descriptions of each machine learning method; (2) adding short methods descriptions for boosted regression trees and generalised additive models (GAM); (3) adding a short guideline for GAM, with appropriate citations; and (4) final preparation for journal publication.

The Committee thanked the SG for work during the intersessional period. It was noted that while the focus of the review had been on machine learning methods for SDMs, GAMs were becoming an increasingly useful framework for these kinds of analyses. It suggested that the GAM section of the Guidelines be expanded when possible. The Guideline document for SDMs is intended to be a ‘living’ document that is regularly reviewed and update. It was suggested that the guidelines would benefit from an explanatory application to some real or simulated data.

16.2.2 Review progress of work on SDMs and ensemble modelling

In 2016, another correspondence group, established in 2015, determined that a scaled-down version of the original work plan developed at the preparatory Workshop 'Towards Ensemble Averaging of Cetacean Distribution Models' (IWC, 2016c) was necessary. It decided to focus on the risk of ships striking blue whales off the USA west coast, using only those models that covered the entire USA west coast. The US-CG created a unified grid for all predictions and identified areas where model predictions were similar and where they were different, and developed methods to scale the predictions (e.g. density versus probability of occurrence). Finally, the receiver operating characteristic curve and related metrics were used to explore methods for weighting the predictions in the ensemble. It is expected that this work will be completed in the coming year and a manuscript will be submitted to a peer-reviewed journal.

Redfern *et al.* (2017) focused on the prediction of cetacean distributions in data poor ecosystems, with blue whales used as a case study. GAMs were used to relate the number of blue whales in each transect segment to the habitat variables that identified variations in upwelling, circulation, and water column stratification that may affect forage availability. Four measures of model performance identified a single model that provides the best match to the blue whale sightings in each ecosystem. Model assessment metrics and independent experts identified a single best model that performed better than the ensemble, and that performed consistently well on both quantitative metrics and qualitative expectations. The model was used to predict blue whale distributions, rather than using an ensemble of predictions from GAMs with different habitat variables.

While the methods performed well for these data, the possibility remains that the good performance may be specific to the case in question. Therefore, there was interest in whether selecting a 'best' model may result in uncertainty being under-represented should the method be applied more generally. The broad geographic area of the study region would also likely capture several distinct behavioural states (e.g. transiting and foraging), so different models may be capturing different aspects of behaviour unequally. The methods for combining uncertainty when averaging an ensemble of models are not yet well developed. The Committee **encourages** an update on the progress of this work at future meetings of the Scientific Committee.

16.3 Effects of long-term environmental variability on whale populations

The issue of variability in baleen whale demographics was examined at an MSYR Workshop held in 2010 (IWC, 2011b). Simulation work presented at this meeting (Annex L, Appendix 4) suggested that the trajectories of recovering stocks would be expected to show little signal of environmental variability until they have recovered to about half of carrying capacity or more. As a result, the fact that many populations have shown smooth exponential increase as they have recovered from low levels, does not imply that they will continue to show smooth trends. This is particularly true for the case of the Southern Hemisphere populations.

Attention: SC

The Committee ***agrees*** *to keep the item on the effects of long-term environmental variability on whale populations on its agenda, to be discussed if new analyses are forthcoming. It* ***suggests*** *that efforts be made to include effects of environmental variability in population models, including the individual-based energetic models that are being developed (see Item 5.1).*

16.4 Modelling of competition among whales

Three studies (SC/67a/EM10, SC/67a/EM11 and Weinstein *et al.*, 2017) examined the foraging ecology of humpback and Antarctic minke whales from satellite tagging studies in the waters off the western side of the Antarctic Peninsula. This research is part of the IWC-SORP supported research programme on the foraging ecology of baleen whales in the Antarctic. Movement models were used to understand the influence of environmental parameters (e.g. sea ice) on foraging behaviour, how the foraging ranges of each species was defined and affected by environmental variables, seasonal changes in movement patterns and the overlap between humpback whales and krill fisheries. While an overlap in the core foraging areas of humpback and Antarctic minke whales was identified, the latter had to search far broader areas to find suitable habitat for foraging and predator avoidance. There was no indication that prey was limiting in this ecosystem at this time. However, there was evidence that both whale behaviour and krill catch effort were spatially clustered, with distinct hotspots of the whale activity in the Gerlache and southern Branfield Straits. These areas aligned with increases in krill fishing effort, and present potential areas of current and future conflict.

The Committee **welcomes** this work undertaken under IWC-SORP and looked forward to further updates.

16.5 Update on body condition analyses for the Antarctic minke whales

Following the suggestion of the Committee at last year's meeting, scientists from Australia, Japan and Norway worked to develop a set of models that best capture the Committee's previous recommendations regarding body condition of Antarctic minke whales (IWC, 2017b, p.58), sharing data through Procedure B of the Data Availability Agreement.

SC/67a/EM01-03 used linear mixed effects and penalised regression splines to model total body weight as non-linear functions of body length, time within season, foetus length and long-term trend over year. Four discrete subsets of the JARPA data were examined after exploratory analyses revealed differences in the length-weight relationship between sexes and between those animals considered to have a high or low diatom load. Only for females with high diatom load there was some signal to indicate a decline in body weight. However, the long-term trend was not linear, was not consistently in decline for all animals within the group, and was based on small sample sizes (average 37 samples/year). The authors expressed concern that there were systematic trends in the segment of the population being sampled, as evidenced by changes in ages and sex ratios. As a result, they felt it was difficult to determine whether the apparent changes in body condition in a subset of the models reflected real changes in the population, or whether the changes were an artefact due to variability in the segment of the population being sampled. The authors concluded that there had not been a detectable change in body condition over the course of the JARPA surveys.

SC/67a/EM04, 07-08 and 16 incorporated six response variables: five related to storage of fat: blubber thickness at two sites, half girth at two sites, and fat weight, and an index based on total weight, (which had been suggested by the authors of SC/67a/EM01) to analyse the JARPA data.

A linear mixed effect model intended to incorporate all effects influencing body condition was analysed, and model selection was carried out using the focused information criterion (FIC). The authors concluded that the results were consistent with the conclusion that there had been a decrease in body condition over the 18 years under study, because five out of the six proxies for body condition had clear, negative, significant estimates for the linear effect of year. The exception being the proxy related to total body weight.

There was extensive discussion within the Working Group on Ecosystem Modelling regarding the relative merits of the models presented, with the focus being on three main areas: the appropriate response variable, the statistical merits of each approach and the selection of the data to be analysed. No consensus was reached regarding the choice of response variables, because while some evidence was presented that total weight may not be an appropriate proxy for body condition (Annex L, Appendix 2), there was also the contention that the concordance between fat weight and total weight lent considerable support to the proposal that total weight was an appropriate measure of body condition. There was agreement on the general merits of the various approaches, but disagreement that the inclusion of spatial covariates by the authors of SC/67a/EM04, 07-08 and 16 resulted in confounding with time, and that the model selection process may have introduced variability into the estimates of the standard deviation, which has the potential to bring results into question. No consensus was reached regarding the spatial covariates, but the role of the model selection process was explored (Annex L, Appendix 3), although it was determined that a full exploration of these effects could not be carried out during the meeting. The models in SC/67a/EM04, EM07-08 and EM16 were applied to the four discrete subsets of the JARPA suggested by SC/67a/EM01-03 (Annex L, Appendix 3). The results of these supplementary analyses did not lead to agreement.

The Committee recognises that, thanks to the collaborative effort, considerable progress had been made in achieving convergence on the question of how to analyse for trends in body condition and/or blubber thickness in the JARPA data. The Committee recognises that the estimating changes over time is complex, because of the need to take account of additional components of variance which are partially confounded with the realised sampling design, and which had not been taken into account on the initial analysis (IWC, 2015c).

Attention: SC

The Committee ***agrees*** *that the estimation of changes in body condition data over time is more complex than had originally been assumed. Nevertheless, there was no clear majority opinion to change the conclusion reached by the Scientific Committee in 2014 that a 'decline in blubber thickness and in fat weight that was statistically significant at the 5% level had occurred during the JARPA period.' (IWC, 2015c, p.46).*

16.6 Other

16.6.1 Stable isotope analysis

SC/67a/EM05-06 found that faecal material could be used to validate stable isotope sampling techniques, because the stable isotope values of krill remained unaltered by their passage through the digestive tract. The contribution of krill in the digested food of baleen whales was estimated to be substantial, which demonstrated that: (i) results from macroscopic gross analysis of faeces may be misleading because less digestible components, such as fish bones, may be overrepresented; and (ii) that faecal stable isotope values contribute significant information to the assessment of short-term diet. All baleen plates, independently of their position in the filtering apparatus, size or coloration, grow at the same rate and display similar stable isotope values and oscillations. Therefore, position of sampling along the baleen plate row should not be a reason of concern when conducting stable isotope studies. The authors considered that these results are applicable to other species, such as Antarctic minke whales.

16.6.2 Review the information on krill distribution and abundance by NEWREP-A

SC/67a/EM09 reported krill and oceanographic surveys in the Antarctic Area V-W during 2016/17 austral summer season as a part of second NEWREP-A dedicated sighting survey. Two research vessels were engaged with krill acoustic survey and net samplings by small ring nets and an Issak-Kid Midwater Trawl (IKMT) for species identification and size compositions of plankton at 32 stations and 13 stations, respectively. Oceanographic observations using CTDs and water sampling were also conducted coincidentally. Krill and oceanographic data are currently being examined, and results obtained in the 2016/17 season will be presented to a CCAMLR specialists' workshop. Feedback from the specialists will be reflected in the planning of the 2017/18 survey.

16.6.3 Review of other topics related to Ecosystem Modelling

SC/67a/EM13 took note of IWC Resolution 2016-3 'Cetaceans and Their Contribution to Ecosystem Functioning'. In the resolution, the Commission asked '*the Scientific Committee to screen the existing research studies on the contribution of cetaceans to ecosystem functioning to develop a gap analysis regarding research and to develop a plan for remaining research needs*'. SC/67a/EM13 was intended to help this process and provided a bibliography of relevant scientific publications and suggestions for further research to help fill knowledge gaps. In response to a request for advice on how to build hypotheses into quantitative models, advice was presented on the use of tools such as EcoSim, as well as other papers and projects on animal movement and habitat use that speak to how and where animals can be part of ecosystem models using data, rather than simulations. The Committee **encourages** relevant submissions in the future, especially considering Resolution 2016-3.

Attention: SC, CC

The Committee ***agrees*** *that its Working Group on Ecosystem Modelling is the proper place to bring forward work focused on biological hypotheses relevant to IWC Resolution 2016-3 'Cetaceans and Their Contribution to Ecosystem Functioning'. An intersessional correspondence group was established (ICG-28, Annex W) to further develop proposals for a way forward in SC/67b, and how to best integrate this stream of work into the Scientific Committee.*

16.7 Work plan

The work plan on ecosystem modelling is provided in Table 23.

17. SMALL CETACEANS

17.1 Review of taxonomy and population structure of bottlenose dolphins (*Tursiops* spp.) in the East Pacific and western North Pacific oceans

17.1.1 Introduction

In 2014 (IWC, 2015c) it was agreed that the Committee would undertake a review of taxonomy and population structure in the genus *Tursiops*, over several meetings.

Table 23

Summary of the work plan for the EM working group (ISG=Intersessional Steering Group; ICG=Intersessional Correspondence Group).

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
(1) Cooperation with CCAMLR on multispecies modelling.	Prepare a pre-meeting Workshop under an ISG (see Annex W).	Pre-meeting Workshop to review the status of multispecies models and data series (see Appendix 5).
(2) Applications of species distribution models.	ICG activity (see Annex W).	Review progress.
(3) Effects of long-term environmental variability on whale populations.	Continue further analyses.	Review progress.
(4) Further investigation of individual-based energetics models.	Continue further analyses.	Review results.
(5) Modelling of competition among whales.	Continue further analyses.	Review results.
(6) Update of information on krill distribution and abundance by NEWREP-A.	Conduct a survey by consultation of CCAMLR specialists.	Review results of the survey and analysis.

Understanding whether there is any consistency in the derivation of various local forms across the range, and to which taxonomic or population unit(s) they belong, has been challenging, and the taxonomy of the various forms is still unresolved. An additional aim of this exercise was to develop a widely applicable taxonomy assessment framework for small cetaceans.

Bottlenose dolphins are among the most widely distributed cetaceans. Factors contributing to taxonomic uncertainty in this genus include a wide distribution across highly variable environments, variability within locally adapted populations, sympatry of various forms in some regions, a lack of specimens from many regions, and differences in research methods and designs. In many regions where bottlenose dolphins occur, different forms (ecotypes/morphotypes) have been described, based on distribution (e.g. offshore *vs* coastal differentiation), morphology, and genetic profiles. Worldwide, more than 20 different *Tursiops* species have been described historically but only two (*T. truncatus* Montagu 1821 and *T. aduncus* Ehrenberg 1832) are widely recognised.

17.1.2 Summary of the 2015 review for the Indo-west Pacific Ocean and Oceania

In the first phase of reviewing the Indo-west Pacific Ocean and Oceania (IWC, 2016e), outstanding taxonomic and population distinction issues concerning bottlenose dolphins were highlighted. In the Indo-West Pacific, *T. aduncus* and *T. truncatus* are clearly distinguishable. However, *aduncus*-type dolphins exhibit considerable regional variability. It was difficult to resolve the taxonomic status of *T. australis* (a species recently described from south Australian waters) in part because of discordance in results using different genetic markers, and morphometric analyses did not show a difference between putative *T. australis* specimens and *T. truncatus* (Hale *et al.*, 2000; Jedensjö *et al.*, 2013; Kemper, 2004). However, the lack of morphological distinctiveness relative to *T. truncatus* could be related to the distinctions between species being blurred by convergence.

17.1.3 Summary of the 2016 review for the Atlantic Ocean and the Mediterranean and Black Seas

Only one recognised species, *T. truncatus*, is present throughout the Atlantic Ocean and the Mediterranean and Black Seas, and the Black Sea population is recognised as a subspecies, *T. truncatus ponticus*. The 2016 review (IWC, 2017b) showed that two distinct morphotypes of *Tursiops* are present in the western North Atlantic. Morphological and ecological (diet preferences, parasite loads) differences have been documented between a smaller coastal form and a larger offshore form, and genetic analyses revealed significant genetic differentiation for a wide range of molecular markers. Significant morphological differentiation in the western South Atlantic between a large coastal form and a smaller offshore form may be indicative of species or subspecies-level differences; the two morphotypes are parapatric along the coast from southern Brazil and sympatric in northern Argentina. The Committee considered whether there was sufficient evidence to elevate the coastal form in the Western South Atlantic to species status (as *T. gephyreus*), but concluded that there was not enough evidence to draw firm conclusions. In addition, it stressed the necessity of evaluating the genetic context before proposing new species. However, the significant morphological differentiation between the large coastal form and a smaller offshore form (a single, but strong line of evidence) is consistent with subspecies-level differences. The 2016 review further illustrated the need to standardise and widen the types of markers (morphological, genetic, ecological and behavioural/acoustic) used to define groups.

17.1.4 Summary of the 2017 review for the eastern north Pacific (ENP), eastern south Pacific (ESP) and western North Pacific (WNP)

This year, the Committee considered published information on bottlenose dolphin distribution and potential taxonomic (species, subspecies) distinctions in the eastern north Pacific (ENP), eastern south Pacific (ESP) and western North Pacific (WNP). Newly available information on *Tursiops* from areas covered in 2015 and 2016 was also reviewed. In all the areas considered during the three-year review, sizeable areas have almost no information, thus presenting major challenges in understanding bottlenose dolphin diversification worldwide. From this review, it was clear that well differentiated morphotypes of *T. truncatus* are present in the ENP, while in the WNP, the presence of the two recognised species is well documented. In the ENP, both morphological and genetic data provide convincing evidence for the presence of two distinct morphotypes of *T. truncatus*, with a level of genetic differentiation consistent with long-term separation. In California, the 'coastal morphotype' (originally described as *T. gilli* 1873) is restricted to waters within 1 km of the coast from at least Ensenada, Mexico to San Francisco, California. Coastal and 'offshore' morphotypes (originally described as *T. nuuanu* 1911) are also present in the Gulf of California and there appears to be significant genetic differentiation between the Gulf of California and California coastal populations, but a comprehensive morphological analysis comparing the two has not yet been performed. In the Gulf of California, the coastal morphotype is restricted in range to the upper portion of the Gulf and may be of conservation concern given documented bycatch in fisheries.

In the ESP, morphological data support the presence of two morphotypes in Peru, Ecuador and Colombia. Only the offshore morphotype and a small, possibly hybrid group are documented in Chilean waters. Further work is needed to determine whether the coastal morphotype is present in Chile. In addition, it was noted that there is a possibility that *Tursiops* moves around the tip of South America and comparisons of morphological and genetic data between both sides of the continent will be valuable. Sample sizes in most of the studies have been relatively low and that increased sampling throughout the region would be helpful. Further work is needed to determine whether the coastal morphotype is present in Chile.

Attention: SC, G
So that the taxonomic status of the different bottlenose dolphin morphotypes in the eastern Pacific can be better resolved, the Committee ***recommends*** *that a wide range of data (morphological, genetic and other) from the northern and southern regions be compared so that the ranges of any potential taxonomic units in the eastern Pacific can be fully explored.*

In contrast to the eastern Pacific, current WNP data do not support the presence of multiple morphotypes of *T. truncatus* (although population genetic differentiation is documented). Both *T. aduncus* and *T. truncatus* appear to co-exist throughout much of the range examined, however, sample sizes in published morphological studies are small and it is not yet possible to rule out the presence of multiple morphotypes of *T. truncatus* in the western North Pacific.

17.1.5 Process to conclude the review
To conclude this taxonomic review, a workshop will be conducted prior to SC/67b (see Item 25) that will focus on the relative importance of morphology, behaviour, mtDNA and nuclear genetic data for consideration of differences at the specific, sub-specific and population levels. In addition, the strength of evidence for taxonomic status of *Tursiops* in various localities, using the information compiled from the three years of meetings, will be evaluated and hypotheses on taxonomic status will then be formulated. At SC/67b, a summary table of the available types, amount, and strength of the evidence available for each taxonomic 'contrast' will be presented. The Committee will then also be presented with recommendations that identify important outstanding areas for further research in addition to recommendations on how standard genetic markers, morphotypic analyses and behavioural data should be integrated so that a consistent classification system for *Tursiops* can progress.

17.2 A review of small cetaceans in rivers, estuaries and restricted coastal habitats in Asia, *Platanista* spp., *Orcaella* spp. and *Neophocaena* spp.

17.2.1 Coastal finless porpoise
The Indo-Pacific finless porpoise (*Neophocaena phocaenoides*) occurs on both west and east coasts of India. The species is more common on the west coast, where there is contiguous availability of preferred habitat. Stranding records indicate that entanglement in fishing gear remains a major threat to this species. Gillnets, purse seine nets and shore seine nets are known to catch finless porpoise with a minimum of 10-12 individuals reported as bycatch every year from at least two areas. Recent surveys of the Sindhudurg coast offshore areas show seasonal differences in finless porpoise occurrence, with higher densities in the wet season (October-February). Passive acoustic monitoring (CPOD) at Sarjekot also shows seasonal and diel patterns of occurrence in nearshore waters, again with peak occurrence throughout the wet season and beyond (October-June). Only small portions of the vast India coastline have been surveyed for finless porpoise and there are large data gaps, e.g. the Sundarbans. Some samples are collected from by-caught porpoises but this is not consistent and more collaboration between states is required. It is thus difficult to draw firm conclusions concerning finless porpoise population structure and abundance or the scale and sustainability of bycatch in India. Acoustic monitoring offers a potential way of assessing distribution and perhaps relative abundance.

In the Malaysian state of Sarawak, finless porpoises are the second most frequently observed cetacean with the highest encounter rates in the Bintulu-Similajau region. Abundance estimates (as yet not validated by the Committee, see Item 12) are only available from Kuching Bay 74-246 (CV=31%). Abundance varied seasonally, with higher densities observed between March and May, when most new calves were observed and feeding was the dominant behaviour. The shallow inshore waters of Kuching Bay are an important feeding and calving area for finless porpoise in Sarawak. There is intense fishing activity within the porpoise preferred habitat, and interviews with the local fishing communities indicate that 93% of fishermen recall up to five cases of bycatch in their village within the past year, and 35% of fishermen accidentally entangled (either live or dead) one porpoise per year. Although the areas studied in Sarawak are small, relative to the total coastline of north Borneo, it appears that this area does report a high number of finless porpoise when compared to the other Malaysian states of coastal Borneo.

Attention: SC
Given the poor level of information available to evaluate the status of the Indo-Pacific finless porpoise, the Committee ***recommends*** *that:*

(1) *surveys for (relative) abundance, habitat use and distribution of Indo-Pacific finless porpoise be carried out with emphasis on areas where the least is known (e.g. India, Indo-Malay Archipelago, Arabian/Persian Gulf); and*
(2) *efforts be made to improve bycatch monitoring (ideally with onboard observer programmes, and at a minimum with stranding notification, investigation, sampling and reporting) in all areas of known overlap between finless porpoise occurrence and fishing activity (especially gillnetting).*

17.2.2 Yangtze finless porpoise
Information from the current *ex situ* conservation efforts for the critically endangered Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) indicates that populations within three managed reserves are successfully reproducing. One of these reserves had sufficient individuals to transport some to a new *ex situ* area and it is hoped that this will continue in the long term so that genetic heterozygosity might be maintained across these geographically isolated reserves. The People's Republic of China has formally recognised the risk the Yangtze finless porpoise population faces and has greatly increased resources for research, enforcement of regulations, and public awareness activities. The Government has also increased restrictions of various activities, e.g. fishing and sand mining, in several areas throughout the porpoise's natural habitat.

Attention: SC, CG-A
The Committee has expressed its ***great concern*** *over the status of this critically endangered subspecies and welcomed the new information presented at this meeting.*

The Committee:

(1) ***welcomes*** *the information that a fishery ban in the entire Yangtze basin by 2020 has been proposed and* ***agrees*** *that, at a minimum, enforcement of a fishing ban at least throughout all finless porpoise reserves is required;*
(2) ***notes*** *that the programme for translocating finless porpoise appears to be effective, and* ***commends*** *the Chinese Government, Prof Wang Ding and his colleagues for the progress they have made in this regard;*
(3) ***agrees*** *that a few areas of particularly high-quality habitat (e.g. oxbows along the main channel of the Yangtze) should be identified, and that the suitability of such areas as* ex situ *reserves be carefully assessed prior to any porpoise being introduced; and*
(4) ***re-iterates*** *its previous recommendation that primary conservation actions should focus on restoring and maintaining suitable habitat for porpoise throughout the Yangtze River and associated lakes - this includes maintaining a network of in situ reserves, making efforts to ensure that genetic diversity is preserved and limiting harmful human activities.*

17.2.3 Riverine Irrawaddy dolphin

Irrawaddy dolphins (*Orcaella brevirostris*) are restricted to coastal waters near river mouths, three large rivers and three large lagoons or sounds within South East Asia. The species is listed as Vulnerable on the IUCN Red List and five of the six demographically isolated 'subpopulations' are IUCN listed as Critically Endangered. These include all three riverine populations - Ayeyarwady River in Myanmar, Mahakam River in Indonesia and Mekong River in Cambodia and Laos, as well as sub-populations in Songkhla Lagoon in Thailand and Malampaya Sound in the Philippines. The sub-population within the Chilika Lake, India, is listed as Vulnerable by IUCN.

17.2.3.1 IRRAWADDY DOLPHINS IN THE MEKONG RIVER, CAMBODIA AND LAOS

The Mekong River dolphin population has been in decline for many years and is now believed to number between 64-1,001. There is a high mortality of neonates and young calves, although recent observations by WWF-Cambodia note eleven calves in 2016, of which two have known to have died. During the first 5 months of 2017, five calves have been recorded. Mekong dolphins face many threats, including bycatch in gillnets, illegal and destructive fishing practices, i.e. explosives, electricity and poison, as well as increased boat traffic in the river. Of special concern is the construction of hydropower dams both upstream of their range and soon possibly within it. The Government of Cambodia, in collaboration with WWF and development partners, have taken several steps to protect the dolphins, including wildlife law amendments, which includes the establishment of an office within the Department of Fisheries Conservation, specifically for the management and conservation of marine mammals. In 2012, the Mekong River Dolphin's Protection and Management Area was created and 72 river guards are permanently based at 16 outposts to enforce a gillnet ban. The Government of Cambodia, again in collaboration with WWF, has hosted a series of expert workshops on Mekong River dolphin conservation and research efforts that aim to foster valuable international collaboration on research methods and conservation approaches, e.g. threat identification, evaluation of sources of mortality and enforcement methods. Implementation of recommendations from the workshops has significantly contributed to a reduction in illegal fishing activities and a corresponding reduction in dolphin mortality from gillnet entanglement, greater survival of calves (a continuing concern) and an improved understanding of the dolphins' behaviour.

Despite the recent progress in successful management and conservation actions, the population is now fragmented within a 180km segment of the Mekong mainstem between Kampi and the Khone water falls, at the Cambodia-Lao PDR border. Their distribution is concentrated in nine deep pools where the dolphins reside in the dry season, although there is interaction between the adjacent pools, except one, in the wet season. One of these pools, the transboundary pool at the Lao PDR/Cambodia border, is separated from the nearest downstream pool by 60km of rapids, which prevents this group interacting with other groups downstream.

Four major dam projects are of extreme concern and are expected to have significant impacts on Mekong river dolphins by:

- fragmenting of populations, by creating impassable barriers to interchange;
- inducing loss of habitat and microhabitats, both through siting of structures and changes to the very specific conditions riverine dolphins use to survive in constant river flow;
- provoking loss of prey through fish declines;
- creating disturbance, both short-term during construction and long-term during operations; and
- direct mortality or debilitation from exposure to construction noise and explosions.

It is believed that if built, these dams will increase extinction risk for the entire Mekong dolphin population. The Don Sahong dam, within Laos but adjacent to the Cambodian border, has been under construction since 2014, despite protests from the governments of Cambodia, Thailand and Vietnam. It is located several hundred meters upstream of the pool in which dolphins are isolated. Since the construction began, the transboundary population has declined from five to three individuals. Sediment load from construction is also making the trans-boundary pool shallower and the remaining dolphins now move regularly outside the pool, however, are prevented from moving completely away by the downstream rapids. Interviews with fishermen indicate that fish stocks in the deep pools are diminished and fish migrations have been disturbed. In addition, fishermen displaced from the dam site, are now fishing in the deep pool area, contributing to an increase in illegal fishing activities. The reduction in numbers and isolation of this group and the ongoing pressures they are facing, has raised the question of whether translocation of these animals to another area of population concentration should be explored as a conservation measure.

The proposed new dams, the Sambor, Stung Treng and Sekong dams, are all within or adjacent to the dolphins remaining core habitat. If these proposed dams were constructed, it is likely that the entire population of Mekong dolphins will be lost. The proposed Stung Treng dam would cut off the transboundary dolphin subpopulation from any possibility of contact with downstream subpopulations.

A recommendation concerning these activities is provided below.

17.2.3.2 IRRAWADDY DOLPHINS IN THE MAHAKAM RIVER, INDONESIA

This population inhabits a 420km stretch of the Mahakam River, Indonesia. The most recent abundance estimate (as yet not validated by the Committee, see Item 12) of 69-81

(CV 7%) individuals. The population has been declining since at least 2005. At least 4-6 calves are born every year and an average of four stranded specimens are recovered every year.

17.2.3.3 IRRAWADDY DOLPHINS IN THE AYEYARWADY RIVER, MYANMAR

There remain three apparently disjunct populations of dolphins in the Ayeyarwady River, estimated to total 60-70 individuals. The main threats to Ayeyarwady dolphins are gold mining, entanglement in gillnets and electric fishing. A Management Plan for the Ayeyarwady Dolphin Protected Area (ADPA) has been developed by the Myanmar Department of Fisheries, in collaboration with WCS, although little is known of it efficacy.

17.2.3.4 IRRAWADDY DOLPHINS IN BANGLADESH

The waterways of the Sundarbans Reserved Forest in Bangladesh are the only place where Irrawaddy and Ganges River dolphins (*Platanista gangetica*) occur in the same habitat. In 2002, the abundance of Irrawaddy dolphins was estimated (as yet not validated by the Committee, see Item 12) at 451 (CV=9.6%). Over the past ten years, 49 Irrawaddy dolphin carcasses have been recovered with most mortality attributed to gillnet entanglement. In 2012, the Government of Bangladesh declared three Wildlife Sanctuaries in areas of high Ganges dolphin density, however, these areas encompass habitat in which both species occur. As yet, little is known of it efficacy of this management action.

Attention: S, SC, CG-A

*The Committee is greatly **concerned** at the status of riverine populations of Irrawaddy dolphins and **welcomes** the report of the 2017 international expert workshop (WWF and FiA, 2017) and **endorses** its principal conclusions, summarised below. The Committee:*

*(1) **agrees** that gillnets continue to represent a primary and ongoing threat and therefore, continued implementation of a suite of measures to address this threat is required;*

*(2) is **concerned** that the construction of dams on the Mekong poses a serious threat to the survival of Mekong dolphins through population fragmentation, habitat destruction, limitation of prey availability, and changes in water levels;*

*(3) **agrees** that if the proposed construction of large hydropower projects on the Mekong mainstem in Cambodia proceeds, almost all of the dolphins' habitat in the Mekong will be modified or eliminated and the risk of extinction will be greatly increased;*

*(4) **recommends** that the IWC Secretariat write to the Cambodian Council of Ministers and relevant Cambodian Ministries expressing the Committee's grave concerns regarding the impacts on Mekong dolphins of the proposed multiple dam construction; and*

*(5) **recommends** that any effort to assess the conservation value and feasibility of translocating these individuals to another social group of dolphins downstream in Cambodia include consideration of the likely social and genetic consequences of such a move for the overall population (this includes determination of the age and sex of each dolphin in the transboundary pool through available information and tools, e.g. analysis of existing photo-id data, genetic analyses of skin samples collected by biopsy, and photogrammetry).*

17.2.4 Indus River dolphin (bhulan)

The Indus River dolphins (*Platanista gangetica minor*) study presented to the Committee was funded from the IWC Small Cetacean Voluntary Fund (Item 17.7). The work was conducted in 2017, and provides critical information which contributes directly to this Committees work. The Indus dolphin is listed as Endangered by IUCN and has been a global conservation priority for nearly half a century. The linear extent of their range has reduced from an historic 3,500km of river to 1,000km. This has been caused by habitat fragmentation and degradation due to the construction of dams and barrages across the Indus and its tributaries. Dolphins frequently become stranded in irrigation canals isolated from the main river, which slowly shrink during the dry season and, without translocation, the dolphin dies. There has been a substantial increase in fishing pressure in core dolphin areas, which has not only increased fishing-induced mortality, but also reduced prey availability. Use of illegal fishing practices (e.g. poison, small mesh size, over-night setting of gear) also contribute to dolphin mortality.

The total population of the subspecies in Pakistan is divided by six irrigation barrages into five largely discrete subpopulations, the largest of which occurs between the Guddu and Sukkur barrages in Sind Province and this area, Indus Dolphin Game Reserve, is protected under RAMSAR. Despite the threats these subpopulations face, surveys to estimate abundance (as yet not validated by the Committee, see Item 12) suggest that the total population size has increased; 1,200 (2001), 1,550-1,750 (2006), 1,450 (2011) and 1,800-1,900 (2017). It was noted that a small isolated population (18-35 individuals - as yet not validated by the Committee, see Item 12) of Indus dolphins existed some 600km upstream of this area, in India. In late March 2017, the flow of the river in this area in India was stopped for barrage maintenance and most of these dolphins have now disappeared[19]. The dolphins in Pakistan are now believed to be the only remaining population of this sub-species.

Planned research and conservation priorities are aimed to strengthen efforts to rescue dolphins from canals, continue population monitoring, assess and reduce fishery-caused mortality, and promote and support community-based conservation actions. A national action plan is required which would unite current conservation and management efforts and laws must be amended so that a common conservation framework for the entire country can be implemented. If dolphins are to be rescued, capture and translocation methods should be further developed. The potential value of tagging rescued dolphins and monitoring them after release was recognised. This would serve as a way of determining post-release survival and facilitate the study of home range areas (including movement through barrages). It was noted that a single river dolphin has been successfully radio-tagged and this provided the first direct evidence of a dolphin moving through barrage gates, in both up and down-stream directions.

Attention: SC, CC, CG-R, G

*The Committee is **concerned** over the status of the Indus River dolphin (Annex M, item 7.3.6) and **recommends** that:*

(1) the Pakistan Government and NGOs that are involved in Indus River dolphin monitoring, research and conservation in Pakistan to strengthen and scale-up the dolphin monitoring and rescue network with the involvement of local communities and local authorities, so that it covers the entire range of the subspecies;

[19]*http://www.iucn-csg.org/index.php/2017/05/08/lost-indus-dolphins-in-the-beas-river-india/.*

(2) *the aims of this work should be the collection of information on habitat loss, fishing-induced mortality, illegal hunting, and strandings and the support of the programme of rescuing dolphins that have become trapped in canals; and*
(3) *a programme of focussed research should be developed on dolphin movements through barrages, including collection of tissue samples from canal-entrapped animals, to assess population structure and genetic connectivity of Indus dolphin subpopulations.*

17.2.5 Ganges River dolphin
17.2.5.1 INDIA
The Committee has previously expressed serious concerns over the potential impacts of the Indian Waterways Development Plans to the Ganges River dolphin (*Platanista gangetica gangetica*). After major dredging began in 2014, in areas within and adjacent to the Vikramshila Gangetic Dolphin Sanctuary, a marked decline in dolphin occurrence was observed. Dolphins avoided dredging sites and displayed evasive behaviour.

The initial results of this study indicate that there are negative, and potentially stressful, impacts of waterways development activities on river dolphins. In response to global concern, including a letter written by this Committee, the Indian Waterways Authority have agreed to conduct a new assessment of waterways impacts on river dolphins. Nevertheless, dredging and shipping activities continue in the Ganges, and there are multiple ongoing threats to the dolphin population.

Multi-stakeholder engagement has improved as evidenced by a joint workshop, supported by industry, academic institutions and conservation NGOs. The Workshop, held in March 2017, brought together 12 researchers from six wildlife conservation organisations and provided insights to and assessment training on river hydrology, population estimation and ecology, acoustics, threat assessment, and conservation approaches for dealing with diverse threats at multiple scales (e.g. fisheries, pollution, irrigation, water demands). This Workshop offered a good opportunity for direct dialogue with the National Thermal Power Corporation Ltd., one of the main industry stakeholders of the waterways project, and it greatly increased awareness of the potentially harmful impacts of the waterways plans on dolphins.

17.2.5.2 NEPAL
The few remaining Ganges river dolphins in Nepal are currently restricted to only three river systems with a best total estimate of <28 individuals. Both the abundance and range of dolphins have declined sharply in all the river systems of Nepal due to environmental and anthropogenic threats, which include the presence of barrages which have fragmented natural populations and regulated natural flows. Declining public and government concern over the dolphins' status, reduced awareness of the dolphins' existence in Nepal, and the advancement of investment and development strategies that conflict with the protection of dolphin habitat are detrimentally impacting the dolphins continued survival in Nepal. The complete disappearance of Ganges dolphins from Nepal is inevitable unless meaningful conservation measures are initiated and sustained. International support, both technical and financial, will be required for such work to move forward.

Attention: SC, CC
The Committee continues to have grave ***concerns*** *over the status of the Ganges River dolphin.*

(1) *For India, the Committee:*
   (a) ***encourages*** *further systematic monitoring of underwater noise in the dolphins' habitat;*
   (b) ***notes*** *with concern the evidence of local population decline in areas of dredging; and*
   (c) ***urges*** *further, larger-scale efforts to monitor the impacts of such development.*
(2) *For Nepal, the Committee* ***recommends:***
   (a) *urgent action and communication of recent research findings to the Government of Nepal, mainly to prioritise maintenance of ecological flow regimes, river restoration and community-based fishery regulations to prevent further habitat degradation and bycatch of the remaining small populations upstream of river barrages on and near the India-Nepal border; and*
   (b) *trans-boundary surveys by India and Nepal to assess threats to the meta-populations of which Nepal's sub-populations are a part.*

17.2.6 Coastal Irrawaddy dolphins
In India, the range of the coastal Irrawaddy dolphin (*Orcaella brevirostris*) extends from Visakhapatnam in the south-east to west Bengal and the Sundarbans. The largest known, and best studied, 'subpopulation' consists of more than 100 individuals in Chilika Lake. This population faces pressure from entanglement in fishing gear and disturbance from increasing dolphin watching operations.

In Sarawak, Malaysia, a small population of dolphins (approx. 150) reside with Kuching Bay. There is a high degree of site-fidelity. The dolphins prefer to be closer to river mouths, when compared to finless porpoise in the same bay, The Small Cetacean Voluntary Fund supported a study focused on dolphin-fisheries interactions, showed that there is an extensive overlap of artisanal fisheries activities and dolphin occurrence and interview surveys confirm that accidental bycatch is prevalent.

Attention: SC, CC
With respect to the coastal populations of Irrawaddy dolphins, the Committee ***recommends****:*

(1) *continued dedicated surveys to monitor distribution, habitat use, threats and population trends in areas such as Sarawak and Chilika lagoon - survey effort should be extended to cover gap areas, such as other coastlines in the Indo-Malay Archipelago, the Sunderbans of West Bengal, and the coast of Orissa and West Bengal in India. Passive acoustics and/or photo-identification should be used where feasible; and*
(2) *heightened cooperation between local authorities, researchers, and the tourist industry at Chilika lagoon, India, - dolphin protection should be strengthened through better documentation of dolphin occurrence and movements, training of dolphin watch operators on dolphin watch guidelines, as well as management efforts to address the impact of fishing on the dolphins.*

17.2.7 Australian snubfin dolphin
The snubfin dolphin (*Orcaella heinsohni*) was described in 2005 and occurs in northern Australia and southern Papua New Guinea (PNG). Studied 'populations' are typically smaller than 100 individuals and no population studied to date is estimated at more than 250 mature individuals. Genetic studies indicate that snubfin dolphins live in small,

relatively isolated populations with limited gene flow among them. Habitat degradation and loss are ongoing and expected to increase across the species range. Bycatch in the Queensland shark control programme and in commercial fisheries also occurs. A continuing decline in the number of mature individuals is anticipated. New information was presented to the Committee on the genetic identity of the *Orcaella* spp. that occur in southern PNG that confirmed, for the first time, that those populations are *O. heinsohni*. There are no confirmed records of *Orcaella* sp. from other regions of the Pacific Islands or other parts of New Guinea. The demarcation between *O. heinsohni* and *O. brevirostris* therefore remains unknown. The viability of the small, apparently isolated snubfin dolphin population in southern PNG is uncertain but it is threatened by entanglement in fishing gear and possibly by directed catch.

Attention: SC, CC
The Committee ***encourages*** *several research and other actions for the Australian snubfin dolphin, including:*

(a) dedicated multi-year studies on the distribution, abundance and habitat use;
(b) an expansion of current biopsy sampling efforts;
(c) the collection of samples from stranded carcasses;
(d) organisational and nation-wide collaborations for the timely retrieval and necropsy of stranded and by-caught specimens;
(e) capacity building and partnerships with Australian and PNG Indigenous communities; and
(f) an evaluation of the efficacy and safety of tag attachment procedures for snubfin dolphins and once determined to be effective and safe, the use of satellite tagging to determine movements, home range and habitat preferences.

The Committee ***recommends*** *that baseline surveys be conducted of specific areas (judged to be ecologically similar to areas known to be inhabited by the species in Australia and southern PNG) around New Guinea and the eastern Indonesian Archipelago (particularly Sulawesi, Maluku and Nusa Tenggara) and northern Timor-Leste to determine the extent of occurrence of snubfin dolphins.*

17.2.8 Conclusions and recommendations

Attention: SC, CC
The Committee ***recognises*** *that fisheries bycatch, particularly in gillnets, continues to compromise the survival of cetaceans in freshwater, estuaries and restricted coastal habitats. In addition, for freshwater cetaceans, waterways development projects, such as the construction of dams, barrages and waterways, can lead to fragmentation, degradation or destruction of their habitat.*

The Committee ***expresses*** *deep concern that the continuation and projected increases of these threats will likely lead to regional decline and extirpation of some Asian cetacean populations.*

The Committee ***recommends*** *that targeted conservation actions be directed toward reducing the impact of fisheries bycatch and water development projects on Asian freshwater, estuarine, and coastal cetaceans to ensure their long-term survival.*

The Committee ***encourages*** *integrated research on habitat loss, stranding in irrigation canals, fisheries bycatch mortality, and possible combined impacts of these threats. It also* ***encourages*** *collection of specimens and samples from stranded or bycaught animals for taxonomic studies and population structure. This Committee further* ***encourages*** *increased liaison with other committees, such as E, to determine what additional samples may be of interest to their work.*

17.3 Poorly documented hunts of small cetaceans for food, bait or cash and changing patterns of use

It was agreed last year (IWC, 2017b) to conduct a series of regional workshops that aimed to explore the global wild meat[20] issue. The first workshop, held in November 2016 in Thailand, focused on data sharing and the development of a toolkits of investigative techniques relevant to documenting wild meat trade in Asia. It also provided an opportunity to conduct the first Asian IWC Entanglement Response Training Workshop (led by Mattila). The workshop had some 24 attendees representing 12 countries and included scientists, stranding programme co-ordinators, wildlife managers, law enforcement agencies and NGOs. The multi-stakeholder group invited to the workshop is now better informed about cetacean issues in the region and links have been made to the Asian terrestrial wild meat issue community. It is hoped that liaison and collaboration with terrestrial wildlife trade researchers will accelerate progress for cetaceans. Annex M, item 8 discusses the possibility of developing a cetacean database on this issue similar to one developed for terrestrial animals. Two more regional workshops are also planned intersessionally and will be held in South America (late 2017) and Africa (immediately prior to SC/67b). Next year, all three workshop reports (Asia, South America and Africa) and a report of intersessional work on the boto/piracatinga issue in the Amazon, will be tabled for discussion and review.

Attention: SC, CC
The Committee ***agrees*** *that an intersessional group (SG-30) would work, with the input of the GDR Convenor, to consider the possibility of a cetacean wild meat database in line with the guidelines and pro forma for IWC databases considered under Item 22 for discussion at SC/67b.*

Further to last year's recommendation that working relationships between the IWC and other international bodies be pursued, the Committee ***agrees*** *to provide updates on this issue to the Aquatic Working Group of the Convention on Migratory Species, who also works on wild meat and related issues.*

17.4 Small cetacean task team

Task Teams are created to provide timely advice on situations where a population of cetaceans is known or suspected to be in danger of significant decline that could lead to extirpation or extinction, with the ultimate aim of ensuring that this does not occur. The first Task Team was established for the franciscana in 2015-16. The Franciscana Task Team consists of local experts (coordinated by Zerbini) produced a draft proposal specifying urgent actions to be reviewed by the Task Team Steering Committee. The project proposal was approved and attracted significant funding from the governments of Brazil and Italy. As the rapid action part of this process is now complete, which facilitated the establishment of the franciscana as the subject of a Conservation Management Plan under the CMP Committee, the Franciscana Task Team work is now successfully completed. It was agreed that

[20]This term has been accepted by this Committee and other IGO's, e.g. CMS, who work on this issue.

the next candidate for development of a Task Team will be the South Asian River dolphin. The Steering Committee is currently establishing a team of experts to develop a project description and initiate activities intersessionally. Progress on this will be reported at SC/67b.

17.5 Status of the voluntary fund for small cetacean conservation research

In 2016, donations for the Voluntary Fund for Small Cetacean Conservation Research were received from the Governments of France, Italy, the Netherlands, Switzerland and the United Kingdom as well as from the Animal Welfare Institute, Cetacean Society International, Environmental Investigation Agency, Humane Society International, International Fund for Animal Welfare, Legaseas, OceanCare, ProWildlife and Whaleman Foundation.

The Committee **expresses** its sincere gratitude for these contributions and noted that these funds support critical conservation research projects of direct relevance to the work of this sub-Committee.

Last year, this Committee recommended several projects for and these were included in the Scientific Committee's budget as given in its report to the Commission. This budget was approved and funding for five projects was confirmed intersessionally (see Table 24).

Three of these projects were initiated in 2017 and progress summaries were received from all PIs. The main objective of Heinrich's project is to estimate the population size of the Chilean dolphin throughout its predicted range in the Ecoregion Chiloense. The first surveys, covering approximately a third of the total surveys area, recorded 47 groups of Chilean dolphins, 23 groups of Peale's dolphins and one group of Burmeister's porpoise. The main objective of Lai's project is to investigate the occurrence of small cetaceans for sale in fishmarkets in China, using posts on social media to identify which areas frequently feature marine mammal products on display. Two markets were visited, in Zheijing and Guangxi Provinces, one of which reported cetacean meat for sale. Progress on the *Abundance Survey for Indus River Dolphin* was presented in Annex M. Full reports shall be provided to the Committee upon each project's completion. It is anticipated that a new call for proposals will be announced after the 2018 Commission Meeting.

17.6 Review takes of small cetaceans

17.6.1 New information on takes

The Committee received the summary of takes of small cetaceans in 2016 extracted from this year's online National Progress Reports and prepared by Hughes of the IWC Secretariat (see Annex M).

17.6.1.1 DIRECT TAKES

No direct takes of small cetaceans were reported in the 2017 National Progress Reports. The Committee **notes** that it would be helpful if the Secretariat encouraged all member countries and IGOs (e.g. NAMMCO) to submit information on direct takes as a routine procedure.

The content of the Japan Progress Report on Small Cetaceans, a public document available from the website of the Fishery Agency of the Government of Japan[21], was summarised. It was noted that two new species had been proposed for quotas: the rough-toothed dolphin with a proposed quota of 46 and the melon-headed whale with a proposed quota of 704. A public review is currently underway in Japan regarding this proposal.

SC/67a/SM06rev1 reviewed available information of southern form short-finned pilot whales which are smaller than the northern form. The southern form occurs in high density in two areas, which are believed to be geographically isolated. The population structure of bottlenose dolphins within these areas is understood to be similarly divided. Current abundance estimates do not account for this separation in either species and there is concern that without consideration of population structure, the Japanese pilot whale and bottlenose dolphin fisheries assessment will not accurately reflect impact on these populations. Most of the short-finned pilot whale quota is allocated to the Taiji drive fishery in Wakayama. There has been a marked decline in catches of the southern form short finned pilot whales from this area, with concomitant increase in catches of other species, which the authors interpreted as an indication of a decline of the southern form short-finned pilot whale coastal population.

17.6.1.2 LIVE CAPTURES

According to official reports, 21 killer whales were captured in the western Okhotsk Sea between 2012-16. Thirteen of these were exported to China and three are still on display in a facility in Moscow. The fate of the remaining animals is not known. Although no mortality during capture or captivity has been officially reported during this period, the lack of any regulatory monitoring of the operations does not compel the companies involved in the capture/captivity industry to provide accurate reports. The Committee has previously expressed concern over the capture of live killer whales as current quotas consider all killer whales in the Okhotsk Sea as one stock, however, there are known to be both transient (mammal-eating) and resident (fish-eating) killer whales. The transient killer whale stock, which is the targeted by the live capture industry, is estimated to number less than 300 individuals and the current rate of removals from a population of this size is almost certainly unsustainable.

In discussion, it was noted that Russian fisheries authorities do not currently recognise different ecotypes of killer whales in the Sea of Okhotsk. According to Filatova, the Ministry of Natural Resources is reviewing the Russian Red Book listing and the status of Russian Far East killer whales is currently under discussion. A question was raised as to how the total allowable catch of killer whales is calculated, but no explanation could be provided by those in attendance. The Russian delegation noted that information presented by an Invited Participant does not reflect the official position of the Russian Federation.

Japan and the Russian Federation stated that takes or captures of small cetaceans in both countries are strictly regulated by appropriate governmental bodies, in accordance with scientific basis and national regulations, and quotas are allocated according to the latest confirmed scientific information on respective stocks.

Attention: C-A, CG-A

The Committee ***reiterates*** *its long-standing recommendation that no small cetacean removals (live capture or directed harvest) should be authorised until a full assessment has been made of their sustainability. This is especially important for killer whales because populations are generally small and have strong social bonds and removals have unknown effects on their demographic structure.*

The Committee expresses ***concern*** *that removals of Okhotsk Sea killer whales have continued from this population since it received its last update on this situation (IWC, 2015e). With regard to killer whales in Russia, the Committee* ***recommends*** *that: (a) the two ecotypes of killer whales should be recognised; and (b) they are managed as distinct units.*

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[21] *http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h26.pdf; http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-4.pdf.*

Table 24

Summary of projects commissioned by the Voluntary Fund for Small Cetacean Research, and their Principal Investigators (PI).

PI	Project title
Heinrich	First region-wide estimates of population size and status of endemic Chilean dolphins (*Cephalorhynchus eutropia*) in southern Chile (I).
Lai	Assessment of online information as a tool to improve the documentation of the availability of marine mammals for consumption and other uses in southern China (I).
Khan	Abundance survey for Indus River dolphin (I).
Weir	Assessing the conservation status of the Atlantic humpback dolphin (*Sousa teuszii*) in the Saloum Delta, Senegal (P).
Sanjurjo	Business model to save vaquita from extinction while improving fishermen livelihoods in the Upper Gulf of California (P).

Key: I=work has been initiated; P=work is pending.

17.7 Progress on previous recommendations

17.7.1 Māui dolphin

SC/67a/SM15 provided the annual update of New Zealand's management measures as well as data collection and research activities over the past year for Māui dolphins (*Cephalorhynchus hectori maui*). Measures to protect this sub-species as part of the New Zealand Threat Management Plan include a range of regulations and prohibitions that cover threats such as set net, trawl and drift net fishing, seismic surveying and seabed mining. A program of on-going research is underway to inform a review of the Threat Management Plan, scheduled to commence in 2018. The Ministry for Primary Industries is finalising an updated marine mammal risk assessment, which will be submitted to the Scientific Committee in 2018. More details on this can be found in Annex M. Also, further background on the status of Māui dolphins can be found in previous years' Scientific Committee reports.

Attention: SC, CC, G-A

*The Committee **notes** that no new management action regarding the Māui dolphin has been enacted since 2013. It therefore **concludes**, as it has repeatedly in the past, that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expresses continued grave **concern** over the status of this small, severely depleted subspecies. The human-caused death of even one individual would increase the extinction risk. In addition, the Committee:*

*(1) **welcomes** the update on research on Māui dolphins provided and looks forward to receiving the final report on the updated marine mammal risk assessment in 2018;*

*(2) **notes** with interest the reported fishing industry initiatives to reduce the use of potentially entangling gear in the range of Māui dolphins, which are discussed in the SC/67a/HIM12 (see Item 13.5.1);*

*(3) **re-emphasises** that the critically endangered status of this subspecies and the inherent and irresolvable uncertainty surrounding information on most small populations, point to the need for precautionary management;*

*(4) **reiterates** its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins, including closures of any fisheries that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries) within the range of Māui dolphins;*

*(5) **notes** that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20 n.miles, and it includes harbours - within this defined area, fishing methods other than set nets and trawling should be used; and*

*(6) **respectfully urges** the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation, and again respectfully requests that reports be provided annually on progress towards the conservation and recovery goals.*

17.7.2 Vaquita

Rojas-Bracho reviewed and reported on developments in vaquita conservation in Mexico since SC/66b. Two meetings of the *Comité Internacional para la Recuperación de la Vaquita* (CIRVA) have been held since SC/66b, CIRVA-8 in November 2016 (SC/67a/SM11) and CIRVA-9 in April 2017 (SC/67a/SM14rev1), both in La Jolla, California, USA. A summary of the reports of these two meetings can be found in Annex M.

Attention: S, SC, CG-A, CG-A, C-A, C-R

*The Committee **expresses** its disappointment and frustration that, despite almost two decades of repeated warnings and the significant efforts made to protect vaquitas, the species continues to be on a rapid path towards extinction. The Committee **is gravely concerned** about the estimate that only 30 individuals remained as of November 2016, the news that 5 dead vaquitas were recovered during March/April 2017, and the fact that conservation measures have been ineffective and insufficient. Therefore, the Committee **repeats the recommendations** it made in 2016 and **unreservedly endorses and adopts the recommendations** made in the CIRVA-8 and CIRVA-9 reports (see SC/67a/SM11 and SC/67a/SM14).*

Given the extreme urgency of the situation, and the immediate extinction risk to the vaquita, the Committee:

*(1) **recommends** that the Government of Mexico ensures that the current ban on gillnets in the northern Gulf of California does not lapse, is effectively enforced and is made permanent, and that this ban is extended to include the possession and sale of gillnets throughout the immediate area;*

*(2) **recommends** that the appropriate authority in Mexico further develop and permit the use of 'vaquita safe' fishing gears as a matter of urgency, and provide incentives for their immediate and full uptake;*

*(3) **commends** the Government of Mexico for its attention and response to the CIRVA findings and respectfully **requests** that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards conservation and recovery goals for the vaquita;*

*(4) **requests** that the Secretariat write to all IWC Commissioners to: (a) provide an update on the vaquita situation (including describing the species' status based on information reviewed by the SC at SC/67a); (b) re-emphasise the commitments made under IWC*

Resolution 2016-5; (c) summarise the recommendations made by the SC over the last 20 years; and (d) urge them to raise this issue as a matter of urgency through the appropriate diplomatic channels;

(5) ***recommends*** *that members liaise with their Governments to raise the profile of the vaquita and identify and pursue wider international engagement opportunities such as through efforts to achieve the UN Sustainable Development Goals (SDG14); and*

(6) ***noting*** *that the demise of the vaquita is being driven by the high demand for totoaba swim bladders in international markets,* ***requests*** *that the IWC Secretariat send a written appeal to the CITES Secretariat to facilitate immediate action in addressing the illegal international trade in swim bladders from totoaba, an Appendix I species, as a matter of utmost urgency.*

The evolution of the vaquita issue raises questions on how the recommendations of the Scientific Committee are communicated and implemented and how the Scientific Committee can work together with other bodies of the Commission in order that the IWC, as an organisation, can operate in a co-ordinated and coherent way to facilitate urgent conservation action.

Attention: SC, CC

The continued decline of the vaquita raises fundamental questions on how the recommendations of the Scientific Committee are communicated. The Committee ***recommends*** *that the joint Conservation Committee/Scientific Committee Working Group considers the challenges associated with effectively communicating and implementing urgent conservation recommendations, particularly with respect to vaquita.*

Time Is Running Out

In summary, the vaquita is the world's smallest cetacean, inhabiting a very limited range in the upper Gulf of California, Mexico. The population was being steadily reduced by lethal entanglement in fishing gear for decades before a recent surge in illegal fishing for totoaba began, fuelled by the demand for swim bladders in China and Hong Kong. Previous estimates of abundance were 567 (95% CI 177-1,073) in 1997, dropping to 245 (95% CI 68-884) in 2008, to 59 (95% CRI 22-145) in 2015, and to around 30 remaining in November 2016 (95% CRI 8-96). Now, after another massive illegal totoaba fishing season during the first five months of 2017, with six documented vaquita deaths in that period, the vaquita population has been even further reduced and species extinction is imminent. If the current illegal fishery for totoaba continues unchecked in 2018, the vaquita will be gone. It will have followed the same course as China's Yangtze River dolphin (the baiji) and become the second species of small cetacean to be lost in the early 21st century.

17.7.3 Amazon riverine dolphins (boto and tucuxis)

Concerns over the increased use of dolphins from the Amazon River (botos *Inia geoffrensis* and tucuxis *Sotalia fluviatilis*) as bait for piracatinga (*Calophysus macropterus*) fishery in the Amazon Basin has been expressed previously by this Committee. The Brazilian Government provided a progress report on the effectiveness of the 5-year moratorium on the piracatinga fishery (from 1 January 2016). The report focused on one of priority areas of the Evaluation Monitoring Plan, i.e. monitoring trends in abundance of Amazon River dolphins. More details on this can be found in Annex M. The intersessional working group (convened by Zerbini) established to assist the Brazilian government in evaluation and reporting procedures, identified new information, which indicated that the river dolphin/piracatinga issue is escalating in these neighbouring countries due to the regional increase in trade and demand for this fish. This group proposed that an intersessional workshop to facilitate communication and collaboration among the countries which are all part of the boto/piractainga issue would be timely.

Attention: SC, CC, CG-A

The Committee has previously expressed ***concern*** *over the increased use of dolphins from the Amazon River (botos and tucuxis) as bait for the piracatinga fishery in the Amazon Basin. This year, the Committee:*

(1) ***thanks*** *the Brazilian Government for the update on their efforts to combat the use of Amazon riverine dolphins as bait for the piracatinga fishery;*

(2) ***welcomes*** *the update provided by the Brazilian Government on the newly initiated Evaluation Monitoring Plan (EMP) which includes the identification of sustainable fishing methods for the piracatinga fishery, inspection and control strategies, and efforts to understand and curtail the international market demand for piracatinga;*

(3) ***respectfully requests*** *that Brazil provides detailed information to the next meeting of the Scientific Committee on the implementation of all five elements of the EMP;*

(4) ***encourages*** *collaborative efforts among the states in which the dolphins occur;*

(5) ***respectfully requests*** *information from Bolivia, Colombia, Ecuador, Peru and Venezuela in line with its recommendation last year (IWC, 2017b); and*

(6) ***endorses*** *the proposal for an intersessional workshop in Brazil in 2018.*

17.7.4 Taiwanese humpback dolphins

Proposed large-scale offshore windfarm developments threaten the fewer than 75 remaining Taiwanese humpback dolphins (*Sousa chinensis*) inhabiting the limited shallow (<30m) waters along Taiwan, China's heavily industrialised west coast. An expert panel met in Taipei from 17-21 April 2017 to address this threat, which is in addition to the others this population already faces: fisheries interactions, habitat degradation and destruction, air and water pollution, freshwater diversion from major estuaries, and noise disturbance.

In 2014, at SC/65b, the Committee briefly discussed three candidate windfarms planned for the Eastern Taiwan Strait, one of which was to overlap the northernmost range of the Taiwanese humpback dolphin. However, the most recent industry proposals, discussed at the Workshop in April, are for up to 600 turbines in multiple windfarms, involving several companies, with several overlapping the core, as well as the northern and southern ends of, the dolphins' range. Construction and operational noise and disturbance are expected to be severe; the installation of a single test wind turbine recently within Critical Habitat for the Taiwanese humpback dolphin entailed nearly 3,000 pile driving strikes.

The Committee considered marine renewables at its 2012 meeting (IWC, 2013a, p.47) and endorsed the recommendations of the marine renewables Workshop (which included offshore wind) held just prior to thiat meeting. These recommendations included: (1) developing a strategy to minimise risk; (2) pursuing a broad, staged approach to management; (3) conducting 'fundamental' research; (4) evaluating threats; and (5) monitoring impacts (IWC, 2013a, p.47). Taiwan, China already has fundamental research results (see Wang *et al.*, 2016) and there have been several thorough evaluations of threats (Ross *et al.*, 2010; Slooten *et al.*, 2013; Wang *et al.*, 2016).

Attention: CG-R

Given this proposed large-scale offshore windfarm developments threatening the Taiwanese humpback dolphins the Committee ***recommends*** *that authorities of Taiwan, China: (1) develop an overall and comprehensive strategy to minimise risk to this species from the proposed windfarm development; (2) pursue a broad, staged and adaptive approach to management (e.g. there are now two test turbines in place and about to start operation – data from the construction should be thoroughly evaluated, reviewed by international experts, and used to identify effective mitigations for future turbine instalment); and (3) closely monitor acoustic, chemical, physical and biological features of the area before, during and after construction, as well as the impacts on the dolphins during construction activities.*

The Committee also ***reiterates*** *its previous recommendation that a precautionary approach should be used when installing windfarms within critical cetacean habitat (IWC, 2013a, p.49), such as the core range of the IUCN critically endangered Taiwanese humpback dolphin.*

The Committee once again highlights the critically endangered status of the Taiwanese humpback dolphin and ***endorses*** *the recommendation of the expert Workshop, held in Taipei 17-21 April 2017, to expand the currently proposed boundaries of 'Major Wildlife Habitat' (the formal term under Taiwan ROC's domestic legislation) north and south and to proceed as soon as possible to formal declaration under the Wildlife Conservation Act.*

17.8 Work plan
The work plan on small cetaceans is given as Table 25.

18. WHALEWATCHING

18.1 Assess the impacts of whalewatching on cetaceans
18.1.1 Review work plan on Modelling and Assessment of Whalewatching Impacts (MAWI)

An intersessional Workshop on the Modelling and Assessment of Whalewatching Impacts (MAWI) was funded by the IWC and is now scheduled to occur in late 2017 or early in 2018 (SC/67a/WW08). The Workshop will define the key research questions that are required to understand the potential impacts of whalewatching. Several potential participants were identified and Workshop attendance could be maximised and cost reduced if the chosen venue coincided with a major marine mammal science meeting. Individuals should be invited to participate in the Workshop who work in or represent countries or regions with emerging whalewatching industries where MAWI might initiate studies, such as Oman, Africa or Brazil. The Workshop might also benefit from a list of critically endangered cetacean populations that are subject to whalewatching that was compiled for SC/65b (Gleason and Parsons, 2015; IWC, 2016i).

18.1.2 Review specific papers assessing impacts

SC/67a/WW04 reported on a land-based study conducted in Maui, Hawaii, USA, to determine whether local vessel traffic, including whalewatching activities, affects the behaviour of humpback whales. The preliminary results showed that animals changed aspects of their behaviour, including increased swim speed, decreased dive times and direction of travel, with respect to the presence and distance of vessels. The authors suggest a continued precautionary approach be undertaken in relation to vessel traffic and whalewatching activities for this region, including slow speeds when approaching groups of cetaceans. It was noted in discussion that the shorter dives may indicate disrupted resting behaviour and that the Committee's earlier definition of 'high speed' in relation to whalewatching vessels - 13 knots or greater (IWC, 2005, p.331) - was confirmed at last year's meeting (Currie *et al.*, 2015). The study will continue over the next two years and a future paper using multivariate analyses and generalised linear models will be submitted. Discussions about these analyses will continue between the authors and Committee members intersessionally. The Committee **welcomes** the overall design of this study, as land-based observations of vessel disturbance remove the potential that a research vessel can confound results of such studies.

Attention: SC, CC

The Committee ***reiterates*** *that the definition of 'high speed' in relation to whalewatching vessels is 13 knots or greater. This definition should be used when referring to high speed vessels within the framework of MAWI and subsequent Committee discussions.*

Since 2004, the Committee has welcomed a useful review summarising recent whalewatching research (Parsons *et al.*, 2004). SC/67a/WW05 provided this year's review; the Committee again thanks the authors. Recent studies on impacts on cetaceans from whalewatching are summarised in table 1 of Annex N.

Pagel *et al.* (2016) provided insights on behaviours of wild and unhabituated killer whales toward human divers and snorkelers in Norway. Observations were made from 58 opportunistic underwater video recordings. No aggressive, threatening or sexual behaviours were identified. Results should be viewed with caution due to the small sample size and the fact that the video footage was not originally taken for scientific purposes, while in discussion it was also noted that the ethogram could be improved. Video can be valuable when the study area is remote or weather or daylight restricts data collection.

18.1.3 Consider documented emerging areas of concern (e.g. new areas/species, new technologies, in-water interactions) and how to assess them

Vail (2016) compiled a compendium of negative interactions between people and bottlenose dolphins in Florida (USA). Impacts included fatal injuries to dolphins from several causes. The author suggested that the proximity and encouragement of direct and close interaction with dolphins has eroded the 'protective barriers that once existed between wild dolphins and the general public'. In discussion, it was noted that these types of serious, human-inflicted injuries could be considered a newly identified, indirect, impact of whalewatching. It was also noted that whalewatching and dolphin feeding may have resulted in habituation of dolphins to people, which might have contributed to dolphins' negative interactions with people involved in other pursuits.

Table 25
Summary of the work plan for small cetaceans.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Global *Tursiops* taxonomy	Intersessional Workshop *Tursiops* taxonomy.	Report to sub-committee
Boto	Intersessional Workshop boto/piracatingua.	Report to sub-committee
Poorly documented takes	Email group to plan and conduct South American and African Workshop (SG-21, Annex W).	Report to sub-committee
Small Cetacean Task Team	Work on South Asian River dolphins.	Report to sub-committee

Attention: CC, WKM&WI, SC
Vail (2016) identified negative impacts on dolphins, including fatalities, that may have arisen indirectly from whalewatching activities and cetacean habituation to humans. Given the potential management implications, the Committee ***recommends****:*

(1) that the paper be brought to the attention of the Conservation Committee and that its Standing Working Group on Whalewatching should include the potential for these types of injurious and fatal interactions in its discussion about management actions;
(2) that the paper should also be brought to the attention of the Working Group on Whale Killing Methods and Welfare Issues; and
(3) that the issue of cetacean habituation (and sensitisation, a related condition), especially as it relates to whalewatching, should be considered at SC/67b based upon the work of an intersessional correspondence group (ICG-32, Annex W).

SC/67a/WW02 (see discussion under Annex H, item 4.2) presented the results of a telemetry study in Chile on fin whales that identified some areas (e.g. near Coquimbo and Valparaiso) that the authors concluded may be suitable for the development of whalewatching.

SC/67a/WW03 updated information on whalewatching targeting endangered Arabian Sea humpback whales. Guidelines for whalewatching in Oman were developed in 2013/14 as part of an IWC-supported project. This project also included awareness-raising and initial training of tour operators and vessel captains in key locations to minimise negative impacts of whalewatching on Arabian Sea humpback whales and to highlight business approaches for whalewatching in Oman (an objective relevant to the Conservation Committee). A Workshop is planned in Oman by the end of 2017 to address some of those issues and to provide outreach materials. The authors noted that the current level of impacts is considered to be low, although no formal studies have been undertaken. Draft national regulations for whalewatching have been prepared based on the guidelines referred to above. The most likely reason for operators 'harassing' cetaceans was ignorance and the deliberate involvement of the whalewatching community in developing management proposals was key to improving the situation. It was also suggested that limiting the number of operators through regulation might become necessary to mitigate impacts on cetaceans. A final point was that this region could be suitable for developing methods to assess cumulative impacts from anthropogenic activities on an endangered population of large whales.

Attention: C-A, CC, CG-R, SC
The Committee ***welcomes*** *the substantial progress outlined in SC/67a/WW03 with regards the whalewatching activities in Oman targeting endangered Arabian Sea humpback whales that was responsive to previous Committee requests and recommendations (IWC, 2016e, p.68; 2017f, p.395). It also* ***expresses*** *appreciation to the Commission for providing funding for producing whalewatching guidelines for Oman and providing initial training of tour operators and vessel captains. The Committee also:*

(1) ***recommends*** *that this update is forwarded to the Conservation Committee's Standing Working Group on Whalewatching; and*
(2) ***endorses*** *the authors' recommendations, given in Annex N, Item 2.3; and*
(3) ***agrees*** *that this area and species should be included in the upcoming MAWI Workshop (see Item 18.1.1).*

18.2 Five-year strategic plan and joint work with the Conservation Committee

18.2.1 Develop procedures to provide scientific advice as requested in the plan (including the online Handbook) and make the Scientific Committee more effective at providing information to the Commission

18.2.1.1 ADDRESSING MANAGEMENT ISSUES WITHIN THE SCIENTIFIC COMMITTEE AND SYNERGY WITH THE CONSERVATION COMMITTEE

The IWC passed Resolutions 1993-9 and 1994-14, directing Member States to submit information on whalewatching. With Resolution 1996-2, it directed the Scientific Committee to begin examining whalewatching and its impacts. The first report from the Sub-Committee on Whalewatching was in 1998. At that meeting, Terms of Reference for the Sub-Committee on Whalewatching were:

(1) scientific protocols for research on the effects of whalewatching;
(2) the scientific basis for management;
(3) research on the effectiveness of management; and
(4) criteria for selection of suitable areas for long-term studies on the effects of whalewatching on cetaceans.

These original terms of reference show that the scientific basis for management and the effectiveness of management (e.g. mitigation measures) are within the remit of the Committee.

There was some discussion (see Annex N, item 4.1) about transferring management-related topics to the Conservation Committee's Standing Working Group on Whalewatching (SWGWW). Several members expressed concern about transferring such topics before the SWGWW has capacity to address them, given its present expertise and the short (sometimes only half a day every two years) time available for discussion.

Attention: C-A, C-R, SC
The Committee ***agrees*** *that topics related to the science of whalewatching (e.g. impacts of cetaceans, assessments and effectiveness of mitigation measures) should remain within its remit, noting the opportunities also to invite outside experts and the use of joint workshops with the Conservation Committee to address topics of common interest.*

The Committee ***recognises*** *that some issues and studies addressing management and mitigation of impacts of whalewatching will be within the realm of the social sciences, because whalewatching involves people. Therefore, the Committee* ***recommends****:*

(1) pursuing periodic joint intersessional workshops with the Conservation Committee's Standing Working Group on Whalewatching (SWGWW), to which social scientists would be invited to participate in discussions about relevant topics; and

(2) that the two Committees should begin planning and pursuing an initial workshop of this nature within two years.

One application of the Committee's expertise would be to 'ground-truth' the work begun by Carole Carlson to compile global guidelines and regulations, some of which are without an empirical basis. Many management regimes are based on information that is specific for one species or area, and it may be that what works for one species does not work for another. The compilation could also be used by the Conservation Committee to recommend needed adjustments to help managers tailor guidelines or regulations for each target species and habitat.

18.2.1.2 NEXT ITERATION OF THE CONSERVATION COMMITTEE'S FIVE YEAR STRATEGIC PLAN FOR WHALEWATCHING

SC/67a/WW01 was discussed in a joint session with the *ad hoc* Working Group on Interactions between the Scientific Committee and the Conservation Committee (see Annex T and Item 26.1). It presented an update on the Five Year Strategic Plan for Whalewatching developed by the Conservation Committee's SWGWW. This Strategic Plan covers the period 2011-16. Core principles of the plan include:

(1) the IWC should play an advisory role, with management responsibility remaining with national governments or their subsidiaries;

(2) the Strategic Plan should recognise that local issues require local solutions;

(3) the Strategic Plan should help facilitate responsible whalewatching practises; and

(4) the Strategic Plan should be a resource for industry, governments, and stakeholders.

The Strategic Plan has five equally important objectives: (1) Research; (2) Assessment (Monitoring); (3) Capacity Building; (4) Development; and (5) Management. Within the framework provided by these objectives, the Strategic Plan identifies a suite of actions, time lines, and responsible parties, which are summarised in Appendix I of the first Five Year Strategic Plan[22]. The Scientific Committee is identified as being a responsible party for addressing the objectives of Research and Assessment, and co-responsible for some Capacity Building, and Management objectives.

The original time period for the Strategic Plan closed last year. At IWC/66, the Commission agreed to develop a revised Strategic Plan for the period 2018-24. The Committee was asked by the Conservation Committee to review the existing Strategic Plan and provide advice on whether these actions remain valid or require revision or additions.

Discussions focussed on whether the objectives and actions of the Strategic Plan needed to be changed or updated (Annex N, item 4.1.2). The Committee agreed that a full review would require an intersessional or pre-meeting. It was suggested that a joint intersessional meeting of 2-3 days' duration, with results to be presented at SC/67b, would facilitate the Committee's ability to provide useful recommendations. This would allow the Committee to produce timely and constructive recommendations and advice, recognising that the revision of the Strategic Plan is the task of the Conservation Committee.

Attention: C-R, SC, CC

The Committee ***recommends*** *that a joint (Scientific Committee and the Standing Working Group on Whalewatching) intersessional meeting be held well in advance of SC/67b, to discuss and draft structured and specific recommendations and advice on any revisions for the 2018-24 Five-Year Strategic Plan for Whalewatching. These draft recommendations would form the basis of discussions at SC/67b so that the Committee's recommendations can be submitted to the Joint Meeting of the Conservation and Scientific Committees to be held directly after SC/67b. The budget request for this meeting is considered under Item 25.*

18.2.1.3 ONLINE WHALEWATCHING HANDBOOK

SC/67a/WW01 also provided an update on development of the online Whalewatching Handbook. The Handbook is intended to provide advice on governance, capacity building, monitoring, compliance, business, community and education/training/communication. It will also identify examples of demonstrated best practice.

IWC/66 endorsed a series of recommendations from the Conservation Committee's SWGWW, including securing a dedicated individual to complete the Handbook by the 2018 Commission meeting (IWC/67). In February 2017, funding was secured through voluntary contributions from the UK and USA, and an offer came from the Convention on Migratory Species to translate the Handbook into French and Spanish.

Gianna Minton has been appointed to complete the Handbook. This is a large project with a tight timeframe and support from the Committee will be crucial to its success. The areas for which advice will be required are outlined in Annex N, item 4.1.2.

Attention: CC

The Committee ***recommends*** *that the list compiled at SC/65b (Gleason and Parsons, 2015); see Item 18.1.1) of IUCN endangered and critically endangered cetaceans subjected to whalewatching should be included in the Whalewatching Handbook and forwarded promptly to the Conservation Committee for that purpose.*

18.2.1.4 VOLUNTARY CONSERVATION FUND

There was discussion about how to fund whalewatching initiatives, including intersessional workshops and meetings, directed research responsive to the sub-committee agenda, and increased attendance of invited participants. Funds for invited participants are available equally to all sub-groups each year. As for directed research, the recently established Voluntary Conservation Fund, is open to whalewatching researchers to apply. Any entities or Member States that would like to support whalewatching research can contribute to this fund.

Attention: C-R, S

The late Carole Carlson once said 'It is my goal to encourage and facilitate a continued legacy of innovative education, outreach and research in a collective effort to promote

[22]*https://iwc.int/whalewatching*.

the protection and conservation of cetaceans and marine environments for future generations'. In her memory, to help enshrine her legacy and in recognition of Carole's long and important association with whalewatching work at the IWC, the Committee:

(1) ***recommends*** *the establishment of a voluntary 'Carole Carlson Memorial Whalewatching Fund' to: (a) support research, education and outreach in the context of whalewatching activities; and (b) ensure that whalewatching is sustainable, educational and humane;*
(2) ***recommends*** *that the fund be administered by the Secretariat, with advice from the Committee's sub-committee on whalewatching (cf the process for the Small Cetaceans Voluntary Fund); and*
(3) ***requests*** *that the Secretariat advertises the launch of the fund at an appropriate time and reports back on progress to SC/67b.*

18.2.1.5 INVITED PARTICIPANTS

The Committee has rarely requested funding for whalewatching invited participants; the annual digest of whalewatching research (e.g. SC/67a/WW05) has been used to provide information on the most recent relevant research, but it could also be used as a tool to identify potential invited participants. The digest should continue to be prepared and made available to the Conservation Committee as an information tool.

18.2.1.6 TERMS OF REFERENCE FOR THE SUB-COMMITTEE ON WHALEWATCHING

At SC/66b, the Committee agreed it would seek to enhance its capacity to address scientific and technical aspects of whalewatching and closely coordinate and cooperate with the Conservation Committee and its SWGWW, including through the Joint Conservation Committee and Scientific Committee Working Group. During discussions about the Five-year Strategic Plan (see Item 18.2.1, above), draft Terms of Reference (ToR) for whalewatching were reviewed, in an effort to clarify and align them more directly with the objectives and actions of the Conservation Committee's Strategic Plan for Whalewatching. This process would also aid in clearly distinguishing the roles and responsibilities of the two groups. The draft ToR are provided in Annex N, item 4.6.

To manage the workload these revised terms of reference imply, it might be necessary to focus discussions on a subset each year. Clearly to finalise these draft ToR, work must be done intersessionally and at next year's meeting.

Finally, the Committee noted that the interchange between its sub-committee on Whalewatching and the SWGWW is a positive example of building collaborations and synergies between the Scientific Committee and the Conservation Committee.

Attention: SC, C-A

The Committee ***agrees*** *to seek comment from the Joint Meeting of the Conservation and Scientific Committees on the draft ToR.*

18.3 Platform of opportunity data

18.3.1 Provide advice and recommended practice

SC/67a/WW07 reported on one year of cetacean sighting data from Maui, Hawaii, USA, to demonstrate the capabilities of the 'Whale and Dolphin Tracker' application. These data can provide valuable information on distribution of sightings at a scale impossible to achieve from a single research platform.

In discussion, it was noted that the principal advantage of this application over line transect surveys is that there will be a far greater number of observer-hours, which will result in a greater number of detections of more species inhabiting a large, mixed-species area.

18.4 Progress on scientific recommendations

18.4.1 Swim-with-whale operations

The intersessional correspondence group on swim-with-whale operations concluded that additional data on the capacity of swim-with-whale operations should be collected (Annex N). Working with the Conservation Committee to contact the ministries/secretaries of tourism or environment in each Member States might improve the response to the questionnaire it had developed. The Secretariat has an email list for all Commissioners and could assist in increasing questionnaire returns by contacting them with a request for assistance.

Other on-going efforts to review or conduct surveys of swim-with-marine life/whales programmes include the Convention on Migratory Species (CMS) and the World Cetacean Alliance (WCA). The WCA is collecting names and contacts from respondents, which could facilitate additional dialog with operators and participants in these activities. The IWC Secretariat can assist with contacting the Secretariats of CMS, IORA and ACCOBAMS (which also has a whalewatching working group) to request assistance in collecting additional information or points of contact about swim-with-whale operations.

Finally, the intersessional group had considered how and where new field studies might be initiated to evaluate impacts of swim-with-whale operations on the behaviour of the target species. Kaufman reported that he will report on a study of whale reactions to swimmers in Hervey Bay, Australia, probably in 2019. Other projects could be pursued in this location and the Australian government could be approached for funding.

Several other research funding sources were considered, including the Committee's general research funds; development of a specific fund for whalewatching, similar to the research fund for small cetaceans; the Commission's Voluntary Conservation Fund; and the Global Environment Facility[23] under their Healthy Oceans and Wildlife for Sustainable Development focuses. Whalewatching operators themselves could also be a funding source. It was noted that MAWI should also consider research on impacts from swim-with-whale activities in its discussions and planning.

Attention: SC, C-R, CC

Given the increasing prominence of the topic of swimming with large whales, the Committee ***recommends*** *that:*

(1) this topic should be added as an agenda item for SC/67b;
(2) the intersessional correspondence group (ICG-30, Annex W) on this topic: (a) increases its efforts to obtain a higher response rate to its questionnaire survey; (b) obtains updates from the World Cetacean Alliance on its survey; and (c) reviews progress on field research on the impacts of swim-with activities on large whales from sites in Australia;
(3) funding be made available from the Voluntary Conservation Fund for pursuing well-designed impact studies by qualified researchers on swim-with-whale programmes; and

[23]*www.theGEF.org.*

(4) it works closely with the developer of the online Whalewatching Handbook to ensure co-ordination of all IWC outreach efforts to whalewatching operators and other parties regarding the questionnaire survey.

18.4.2 Communication with the Indian Ocean Rim Association (IORA)

Simmonds provided an update on the Indian Ocean Rim Association (IORA) whalewatching network initiative to build sustainable whale and dolphin watching in the Indian Ocean region. The initiative was the result of a Workshop (Government of Australia, 2016) co-organised by the IWC that was reported last year (IWC, 2017b, p.69). Simmonds noted that now that the network has been formally established, the Committee should consider how to support it. This will be discussed further at the Joint CC/SC Working Group meeting at the end of SC/67a. Many members of IORA are not members of the IWC, making communication and linkages more challenging. The Secretariat will continue to work to improve linkages and synergy between IORA and the IWC. Scientists participating in the IORA effort should be invited to participate in the sub-committee. The convenor for the intersessional advisory group should transfer to someone on the sub-committee from that region to improve coordination and communication between the organisations. Sarah Ferriss of the Secretariat volunteered in the interim to serve as convenor.

18.4.3 ACCOBAMS

Under ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area), several resolutions and actions dealing with whalewatching activities have been approved in recent years. See Annex N, item 5.3 for more details.

18.5 Work plan

18.5.1 Update on dolphin-watching in Bocas del Toro, Panama

The Committee received information that several projects have been initiated to evaluate the population status of the common bottlenose dolphins in Bocas del Toro and the impact of boat traffic on dolphin behaviour. Some results are to be presented at SC/67b. Several other initiatives are discussed in Annex N, item 6.1.

Attention: CG

*The Committee **welcomes** the Government of Panama's increased responsiveness to protect the local dolphin population by minimising negative impacts from dolphin-watching.*

18.5.2 Tracking progress on previous recommendations

The Committee has identified the need to establish a procedure to follow up on the implementation of previous recommendations and last year, Gleason (2016) reviewed the implementation of previous Committee recommendations and the dissemination of the IWC's guiding principles for whalewatching. It is important to evaluate whether the Committee's science-based management recommendations are effective.

Attention: SC, CC, S

*The Committee **agrees**:*

(1) that it should receive at least biennial reports on the progress of previous recommendations and the utility of the IWC Guiding Principles on whalewatching. Parsons will provide an updated report to SC/67b;

(2) that the Secretariat investigate ways to update the Compilation of Worldwide Whalewatching Guidelines and Regulations; and

(3) that it should form a joint intersessional correspondence group with the Conservation Committee to discuss and develop better methods for disseminating recommendations and advice on whalewatching (Annex W).

18.6 Work plan

The work plan is shown in Table 26.

19. SPECIAL PERMITS

The Chair of the Scientific Committee brought to the attention of the Committee new information on relevant outcomes from the last Commission meeting, including the establishment of a Standing Working Group on Special Permit Programmes and some necessary amendments to the existing Annex P (see Item 26.4 for all details).

The Chair of the Scientific Committee also requested advice from the Chair of the Commission on the approach to use for evaluating special permit proposals given that: (a) the review process for NEWREP-NP has already commenced; and (b) Resolution 2016-2 requests the Scientific Committee to provide its evaluation in the same year that the Commission meets.

The Chair of the Commission responded as follows.

> There is no opportunity for the Commission to meet to discuss this question. In the absence of being able to obtain advice from the Commission the Chair of the Commission discussed the issue with the Vice-chair and Secretary and provided the Scientific Committee the following instruction:
>
> We recognize that two documents form the basis of the Special Permit discussions at the 2017 Scientific Committee (SC/67a). The first document is Annex P as it stands which sets out a process, agreed by the Commission for the Scientific Committee to conduct its discussions regarding Special Permit reviews. The second document is Resolution 2016-2 which was adopted by vote in accordance with standard Commission procedures. We recognize some Contracting Governments have expressed concerns with this resolution. However, the Scientific Committee should not attempt to resolve the issues of different positions and interpretations regarding this Resolution. Differences of opinion about the Resolution are the responsibility of the Commission, although the Scientific Committee may wish to record the positions of its members if they wish. Nonetheless the Scientific Committee is bound to follow any instructions transmitted to it in the form of a Resolution. Consequently, the Scientific Committee is required to incorporate the relevant provisions of Resolution 2016-2 into Annex P by the 2018 Scientific Committee meeting.
>
> Therefore, at the present meeting, the Scientific Committee must conduct is scientific discussions based on materials submitted to the Committee and the comments/views/suggestion expressed on those materials by its members. Both agreements and differences among members should be recorded in the usual way and a full report prepared and adopted as is regular Scientific Committee practice.
>
> Once the report has been adopted by the Committee it will be made available to all Commissioners, Contracting Governments and Observers within two weeks of the close of the meeting. The Chair of the Scientific Committee will provide the findings contained in the report, along with those from the 2018 Scientific Committee, to the next Commission meeting which is planned for 2018.

19.1 General considerations on improving the evaluation process

The Committee discussed general issues related to evaluating management-related benefits of scientific research studies and Special Permit programmes in particular (see Annex D, item 2.4). The Committee recognises that the present situation has been frustrating to both proponents and reviewers as

Table 26

Whalewatching work plan.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
(1) Impacts to cetaceans from whalewatching.	ICG-30 on swim-with-cetaceans.	Review new information.
(2) Modelling and Assessment of Whalewatching Impacts (MAWI).	SG-25 MAWI Workshop.	Review report from the intersessional Workshop.
(3) Collection of cetacean data from Platforms of Opportunity.		Review new information.
(4) Whalewatching in east Africa and wider Indian Ocean.		Review available information.
(5) Strategic Plan on Whalewatching and Whale-watching handbook.	Meeting and SG-25 to conduct reviews.	Finalise review and provide recommendations.
(6) Emerging issues of concern.	ICG-32 on habituation of cetaceans to whalewatching activities.	Review new information.
(7) Previous recommendations.	Create a ICG with Conservation Committee.	Update on intersessional work.
(8) Provide scientific and technical advice to external organisations, as requested.	ICG-31 on IORA.	Update on intersessional work.

witnessed by comments in Panel reports and in responses to those by proponents. In principle, it would be useful, for both proponents and reviewers, if there was general guidance on the type and level of information to be provided to show quantitatively that a given proposed research will have management benefits. Some members noted their view any guidelines that might be developed would only be applicable to future proposals, after Annex P is modified.

Attention: SC

Whilst the Committee ***agrees*** *that it is not reasonable to 'accept' either a general assertion that there will be benefits to management from a research programme or to 'require' a formal demonstration with 100% certainty that there will be an improvement, it recognises from the discussions of the papers at this meeting that developing consensus on what constitutes 'sufficient' information will be difficult. It therefore:*

(1) ***agrees*** *that the topic should be given priority at next year's meeting; and*

(2) ***encourages*** *members to develop discussion documents (and where possible to draft potential guidelines) to address this issue and submit them for consideration, well in advance of next year's meeting.*

The Proponents drew the Committee's attention to their view that some of the 'recommendations' in Panel Reports are actually only suggestions for further analyses to help the proponents as they conduct future work, and do not imply fundamental flaws of the Special Permit programme. Although recent Panels have tried to categorise their recommendations, the Proponents requested that additional clarity is provided in future to avoid misunderstandings of Panel Reports arising.

In discussion, the Committee noted that the review of a Special Permit programme was a review of the full programme, not just the lethal component, recognising that meeting objectives and sub-objectives often involved integrating data from both lethal and non-lethal components.

Attention: SC

The Committee ***recommends*** *that future Panel Reports separate out more clearly:*

(1) 'recommendations' which comprise either:

(a) tasks that the Panel considers need to be completed (and reviewed where necessary) before the lethal component of a programme is initiated; or

(b) tasks required for non-lethal components of the programme to be better achieved; and

(2) 'suggestions' which comprise tasks that are desirable to enhance the value of the research, but are not considered essential for the programme.

19.2 NEWREP-A

19.2.1 Report on ongoing research

SC/67a/SCSP05 reported the results of biological sampling of the Antarctic minke whale during the NEWREP-A survey conducted in Areas III-E and IV, south of 60°S during the 2016/17 austral summer season. It also reported the results of the sighting surveys, photo-ID and biopsy sampling of large whales conducted by the sighting sampling vessels (SSVs). Three SSVs and one research base vessel were engaged in the survey from 15 December 2016 to 7 March 2017. The sampling survey was started on 15 December 2016. A total of 311 primary sightings of Antarctic minke whale (involving 526 individuals) were made during 3,274 n.miles of searching distance. A total of 333 Antarctic minke whales (178 females and 155 males) was sampled; biological samples and data required for the two main objectives of NEWREP-A were obtained from each whale taken. Earplugs for age determination were collected from all whales. The Antarctic minke whale was the most sighted species in Area IIIE, while the humpback whale was the most sighted species in Area IV followed by the Antarctic minke whale. Twenty humpback and four killer whales were photo-identified. Biopsy samples were collected from four humpback whales. The samples and data collected during this survey are available, for interested national and international scientists, under the guidelines for research collaboration available on the website of the Institute of Cetacean Research.

SC/67a/ASI07 reported the results of the 2016/17 NEWREP-A dedicated sighting survey in Antarctic Area V, south of 60°S. Two dedicated sighting vessels (SVs) were engaged in the survey for 33 days, from 13 December 2016 to 14 January 2017 in the western sector of Area V. The sighting survey followed the guidelines adopted by the Committee. The total searching distance was 2,937.1 n.miles, including 1,542 n.miles covered in passing mode and 1,395.1n.miles covered in independent observer mode. The survey coverage was 77% in the northern stratum and 91% in the southern stratum. Five baleen whale species were sighted: blue (11 schools/13 individuals), fin (21/67), Antarctic minke (115/223), southern right (1/1) and humpback (253/516) whales. At least three toothed whale species were sighted: sperm (30/30), southern bottlenose (4/8), and killer (4/26) whales. Angle and distance experiments were conducted as in previous years. Photo-id data of 9 blue, 1 southern right and 10 humpback whales were obtained. Ten biopsy samples were collected from 2 blue, 1 southern right and 7 humpback whales. Eight examples of marine debris were observed on the sea surface. The sighting data were validated and have already been submitted to the IWC Secretariat. During this survey, feasibility studies on telemetry and biopsy sampling of Antarctic minke whales were conducted as planned, and details are shown in the appendices of SC/67a/ASI07.

The authors of SC/67a/SCSP05 and SC/67a/ASI07 were thanked for providing this information to the Committee.

19.2.2 Progress with previous recommendations

SC/67a/EM09 reported on results from krill and oceanographic surveys conducted during the 2016/17 austral summer season as a part of NEWREP-A (see Annex L, item 6.1). Two vessels were engaged the surveys. Last year, the Scientific Committee recommended use of nets with finer mesh size, and this recommendation was implemented. The technical comments were received on SC/67a/EM09, but the results will be presented to the CCAMLR EMM meeting to get feedback from krill experts, and reflect them in the plan for following surveys as needed.

SC/67a/ASI04 described the research plan for the NEWREP-A dedicated sighting survey in the 2017/18 austral summer season (see Annex Q, item 5.3 for technical comments). The research plan was prepared considering the suggestions and recommendations from the NEWREP-A Review Panel regarding sighting surveys (recommendations 6 and 7), krill surveys under NEWREP-A (recommendation 15), and feasibility studies on non-lethal methods (recommendations 4 and 5) - see details in IWC (2016b) and Government of Japan (2015). The main objectives of the survey are the systematic collection of sighting data to produce abundance estimates for Antarctic minke whales and other large whale species for management and conservation purposes. This information will contribute to building ecosystem models as well as providing direct input for the SCAA and the RMP. After validation by ICR, sighting and associated data will be submitted to the IWC Secretariat. Other data and samples obtained during the survey will be available to Committee members through the Data Availability Agreement Procedure B. A cruise report will be prepared just after the survey is completed and will include a list of the samples and data collected during the survey. The cruise report will be presented to the 2018 IWC SC meeting. An oversight report will be presented as an appendix to the cruise report

In response to a question from a member on why only Antarctic minke whales (and not other large whale species) were being targeted for telemetry studies, the proponents stated that Antarctic minke whales are the focal species of the NEWREP-A research programme and that the Expert Panel requested these trials. They noted that the use of small inflatables (e.g. Zodiacs) was not feasible because of safety concerns with their use under typical conditions far-offshore. The proponents also noted that while conducting the survey earlier in the year might potentially provide more opportunities for tagging whales, the proposed period was selected for reasons of consistency and comparability with previous surveys, with the main components of the programme in mind.

Attention: SC

The Committee ***welcomes*** *the proposed multi-disciplinary surveys on cetaceans, krill, and oceanographic conditions, which will also conduct biopsy and tagging experiments. The Committee* ***endorses*** *the proponents' approach (see SC/67a/EM09) including discussion with outside experts (e.g. CCAMLR). Tamura indicated that he will act as the focal point for receiving suggestions.*

SC/67a/SCSP12 presented the proponents' report on their progress in addressing the recommendations on NEWREP-A made by the Committee. These recommendations are related to need for lethal sampling, justification of sample sizes, stock structure, effects of catches on stocks, sighting survey design, feeding ecology and ecosystem modelling, krill survey, development of new non-lethal techniques, mechanisms for co-operative research and research program management. The proponents stated that they initiated the NEWREP-A after concluding that they had completed addressing the recommendations they considered most relevant to the need of lethal sampling and sample size (recommendations 1 and 26) to a reasonable level (IWC, 2017b, pp.72-90). SC/67a/SCSP12 reported the progress relative to other relevant recommendations that are being addressed during NEWREP-A. Details of the work being conducted on some of the recommendations are provided SC/67a/EM09, SC/67a/EM14 (Annex L, items 4.1 and 6.1) and SC/67a/ASI04, SC/67a/ASI07 (Annex Q, item 5.3). The proponents explained that they had assigned low priority to a few recommendations and these will not be considered further.

The first table in Annex P5 summarises the progress on the proponents' responses to Panel and Committee recommendations.

In relation to SC/67a/SCSP12, de la Mare noted that no new analyses related to recommendations 1 and 26 had been received by the Committee even though it had been agreed that further work was needed (IWC, 2017b, pp.72-90). He stated that these recommendations are central to NEWREP-A, because they address the justification for the programme and the selection of sample size. In relation to recommendation 1 (see Annex P5), he drew attention to establishment by the Committee of an intersessional Advisory Group to "*… provide advice to the proponents with respect to the mathematical specifications concerning the recommendations made by the Expert Panel and the Committee*" (IWC, 2017b, p.74). He noted that no progress has thus far been reported. For recommendation #26, he referred to the Scientific Committee's agreement in 2016 that "*[t]here is now a need for the proponents to apply the approach of Annex T5 to the full data set and not just the censored data set in the original analysis*" (IWC, 2017b, p.74). De la Mare stated that despite the suggested time required to complete this analysis, results have not been presented.

The proponents responded that the work under consideration with regard to recommendation #26 relates to 'some further refinements', thus the suggested timeline for the original recommendation is not applicable any more. They also drew attention to their response to an earlier enquiry about Recommendation 1 from the convenor of the Advisory group that the work requested was considerably advanced and in their view near completion.

They reiterated that as noted in SC/67a/SCSP12, they believed work on the *original* recommendations of the Expert Panel had been completed to a reasonable level. Regarding the *additional* recommendations agreed to by the Committee last year (such as recommendation 26), Pastene noted that whilst work was underway, these had been given a lower priority by the proponents and, as such, would be completed at a later (but as yet unspecified) date during the programme.

The Committee noted that no new analyses regarding recommendation 26 had been submitted to the Committee at this year's meeting.

19.3 JARPN II

19.3.1 Report on ongoing research

SC/67a/SCSP04 was the cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North. Pacific (JARPNII) in 2016 (part I) for the offshore component. The 15th and last cruise was conducted in sub-areas 7, 8 and 9 of the western North Pacific. The two main research components were whale sampling survey and dedicated sighting survey. A total of five research vessels was used: two sighting/sampling vessels (SSVs) (whale sampling survey component), one research base vessel (Nisshin Maru, NM) (whale sampling survey component) and two dedicated sighting vessels (SVs) (dedicated sighting survey component). The whale sampling survey was carried out from 13 May to 26 July 2016. A total of 2,662 n.miles was surveyed in a period of 67 days by the SSVs. A total 444 sei, 104 Bryde's, of two common minke, 147 sperm, three blue, 15 fin and 26 humpback whales were sighted by the SSVs. A total of 90 sei and 25 Bryde's whale was sampled and biological surveys were conducted on board of NM. In May and June, sei whales fed mainly on mackerels followed by Japanese sardine, copepods and krill in sub-areas 8 and 9. Bryde's whales fed mainly on krill in sub-areas 8 and 9 in July. A dedicated sighting survey was carried out from 29 July to 6 September. A total of 3,185 n.miles was surveyed during the survey by the two SVs. Data obtained during JARPNII will be used in to elucidate the role of whales in the ecosystem through the study of feeding ecology in the western North Pacific.

SC/67a/SCSP03 reported the results of the coastal component (off Sanriku) of the Japanese whale research program under special permit in the western North Pacific (JARPNII) in 2016. The survey was carried out on the Pacific coast of Japan (the sub-area 7CS) from 9 April to 25 May 2016. The research took place in coastal waters within 50n.miles from Ayukawa Port in Miyagi Prefecture in the Sanriku district of Japan using four small-type whaling catcher boats as sighting and sampling vessels. A total of 5,432.7 n.miles (560.5 hours) was surveyed. Sixteen animals were sampled from 28 schools (28 individuals) of primary sightings of common minke whales. Density index (the number of primary sightings of schools per 100 n.miles searching) of common minke whales within and outside of Sendai Bay were calculated as 0.45 and 0.57, respectively, and those of humpback whales were calculated as 0.41 and 0.50, respectively. The density index of common minke whales within Sendai Bay in 2016 was approximately 30% less than that before 2009, and the same as levels outside of Sendai Bay for 2009-16, while humpback whales gradually increased in all research areas after 2008. During the survey, a biopsy experiment was conducted using the Larsen system for 74 hours ten minutes. One sample was collected in five trials. Average body length of the whales was 5.75m (min.=4.74m, max.=7.90m, SD=1.21m) for males, and 5.55m (min.=4.03m, max.=7.98m, SD=1.24m) for females. In males, two of seven individuals (29 %) were sexually mature, and in females, two of nine individuals (22 %) were sexually mature. Regarding dominant prey species found in the forestomach, three prey species were identified in the stomach contents of 14 individuals. Adult sand lance (50.0%) and Japanese sardine (50.0%) were observed from those killed within Sendai Bay, whereas only Japanese sardine (100.0%) was observed from those killed outside of Sendai Bay. Over the last decade, the distribution (individual/m^3) of juvenile Japanese sand lance within Sendai bay in January after 2013 was apparently lower than before 2012, and was distributed in only the near shore area. The reasons for the decreasing number of sighting and sampling of common minke whale after 2013 may be caused by increasing numbers of humpback whales in Sendai Bay and/or decreasing recruitment of sand lance.

SC/67a/SCSP07 summarised the cruise report of the JARPN II coastal component off Kushiro, northeast Japan (middle part of the sub-area 7CN), which was conducted from 5 September to 31 October 2016. The survey was conducted using four small-type whaling catcher boats as sampling vessels in coastal waters within 50 nautical miles from Kushiro port. All the whales collected were landed at the JARPN II research station for biological examination. During the survey, a total of 6,051.6 nautical miles (622.9 hours) was searched and the 39 schools (40 individuals) of common minke whales were encountered. Sightings of 39 schools (64 animals) of humpback whales, of two schools (three individuals) of fin whales, a Bryde's whale, and of five schools (11 individuals) of sperm whales were also obtained. Of 40 common minke whales encountered, 21 animals were collected. One Bryde's whale was mistakenly shot. Average body length of male common minke whales collected was 7.09m (SD=0.53, Range=6.00-7.75m, n=8) and 7.07m (SD=1.01, Range=5.07-8.85m, n=13) for females. Seven animals out of 8 males were sexually mature and 6 of 13 females attained to sexual maturity. The three mature females were pregnant. Dominant prey species detected from whale forestomach was Japanese sardine (*Sardinops melanostictus*, 38.1%), followed by walleye pollock (*Theragra chalcogramma*, 28.6%) and mackerels (*Scomber japonicus* and *S. australasicus*, 28.6%). Japanese anchovy, which was one of the major prey species in the previous surveys off Kushiro, was not found from whale forestomach. The observation coincided with an increase in catch of Japanese sardine by fisheries around Kushiro, where the species was much caught after an interval of around 30 years. During the surveys, faecal searching was made for 20.3 hours on 35 animals encountered, but excretion was not observed. A total of 62.3 hours (10.0% of a total searching efforts) was allocated to the dedicated sighting surveys for biopsy sampling. An animal encountered were targeted, however no sample was collected.

SC/67a/SCSP11 contained an update of analyses on efficiency of biopsy sampling for sei, Bryde's and common minke whales, based on data and samples obtained during the 2014-16 JARPNII surveys. To refine the preliminary analyses regarding success proportions of biopsy and lethal sampling for sei, Bryde's and common minke whales based on the JARPNII data for 2014-16 submitted to the Expert Panel Review Workshop for NEWREP-NP, the differences between the two approaches were assessed using a generalized linear model (GLM) for the response variable adjusting for potential covariates (sampling method, research year, Beaufort scale and visibility at experiment and sampling vessels) based on these data. The analyses show that the success proportions for biopsy sampling were significantly lower than for lethal sampling for all whale species. Explanatory variables in the best fitting model for sei and Bryde's whales included only 'method', and that for common minke whale included 'method' and 'vessel', indicating that environmental covariates had no significant effect. In common minke whales, only two biopsy specimens could be sampled in 14 trials, suggesting biopsy sampling is not feasible for these whales in the coastal components of the program. On the other hand, it has been noted that experience and training can play an important role in the efficiency of biopsy sampling following introduction of the Larsen system for the 2015 JARPNII. For this system the shooters would benefit from more experience and training time. These results and conclusions support the preliminary analyses submitted to the Expert Panel Workshop.

The Committee discussed the Panel's recommendation regarding the feasibility of biopsying common minke whales in the coastal component of the programme. The Panel had recognised, as does the Committee, that biopsy sampling common minke whales was more difficult than for larger whales, but had stated that, from the information presented by the proponents, it was premature to conclude that it was infeasible, for several reasons including: (a) the lack of biopsy experience of the crew; (b) the small number of attempts; and (c) the short time allocated to the experiment for biopsy sampling compared to that for lethal sampling. The Panel then provided advice on how to conduct such an experiment (SC/67a/Rep01, item 3.3.4), including the need to use experienced biopsy samples, a balanced experimental design, consideration of vessel type, weather conditions and sea state etc.

There was considerable discussion of this issue within the Committee and statements on this are given in Annex P (Annexes P1 and P2). Some members stated their view that the analysis in SC/67a/SP11 for common minke whales was inappropriate given the unbalanced design and small sample size, as had been noted by the Expert Panel. Other members commented that their experience was that obtaining large numbers of biopsy samples of common minke whales was not feasible, but thanked the proponents for their proposal to conduct additional studies to improve technical aspects of biopsy sampling equipment. The proponents stated that it was their view that in the context of their programme, biopsy sampling had been demonstrated to be infeasible by appropriate statistical analyses.

Attention: SC
The Committee ***recognises*** *that advice on the feasibility of biopsy sampling common minke whales (regardless of stocks and research areas) was of general scientific as well as specific interest in the context of special permit programmes and comparisons with lethal sampling approaches. It* ***agrees*** *to establish an Advisory Group under the Chair (see ICG-33, Annex W) to provide advice on developing an experimental protocol for ascertaining whether it is possible to reliably biopsy common minke whales and, if so, under what circumstances (experience, vessel type, equipment, environmental conditions, etc.). The Group could use as its starting point the advice provided by the Expert Panel (SC/67a/Rep01).*

19.3.2 Progress with previous recommendations
SC/67a/SCSP09 presented the proponents' report on their progress in addressing the recommendations on JARPNII made by the Committee. The 2016 report of the Expert Panel final review of JARPNII (IWC, 2017a) provided several recommendations for additional analyses related to the main three objectives of the JARPNII. These recommendations, which were endorsed by the Committee last year, are related to sampling design and sample size, stock structure, feeding ecology, ecosystem modelling, environmental pollutants, and whale ageing. The Committees agreed on a timeframe to complete the additional analyses. The proponents stated that while the final review of the JARPNII program in accordance with Annex P was duly completed in 2016, continuing work in response to additional recommendations will refine their analyses on the main objectives of JARPNII. Details of the work being conducted on some recommendations are provided in SC/67a/SDDNA01, SC/67a/SDDNA05 and SC/67a/SDDNA07 (see Annex I, item 2.2). A synthesis of the additional analyses will be presented when they are completed in line with the Committee-agreed timeframe e.g. by the 2019 meeting. A few recommendations were considered of low priority by the proponents and will not be considered further.

The second table in Annex P5 summaries the progress on Panel and SC recommendations with respect to JARPNII.

19.3.3 Committee review
The Committee noted the discussions of SC/67a/SDDNA01 and SC/67a/SDDNA05 within the Working Group on Stock Definition and DNA with respect to western North Pacific common minke whales (Annex I, item 2.2). The Committee welcomed these analyses recognising that questions about the stock structure of minke whales in the western North Pacific may not be fully resolved, particularly in the absence of knowledge about the location of breeding grounds. The Committee noted the importance of evaluating the evidence at hand with respect to the stock structure hypotheses under consideration and highlights the proposed intersessional workshop focussing on stock structure issues and western North Pacific common minke whales (see Item 25).

Attention: SC
The Committee ***agrees*** *that the results of the kinship analysis presented in SC/67a/SDDNA01 are inconsistent with the mixing matrices associated with Hypothesis C as currently implemented (IWC, 2014c) in the* Implementation Simulation Trials *(isolation between sub-areas 7CS-7CN and 8-9) for western North Pacific common minke whales.*

19.4 NEWREP-NP

19.4.1 Expert Panel Review report and progress with recommendations
The Committee reviewed Tables 27a-d that summarise recommendations from the Expert Panel, progress relative to those recommendations, and the responses by the proponents. The proponents submitted further information and explanation in SC/67a/SCSP01, SC/67a/SCSP10 and SC/67a/SCSP13. Some members requested information about changes to the proposal and what they considered to be the limited response to the recommendations of the Expert Panel. The proponents stated that some 'Secondary' objectives had been changed to 'Ancillary' objectives and commented that in their view they had satisfactorily addressed the questions and suggestions of the Expert Panel.

[Tables 27a-d are on pp.79-85]

Table 27a

Summary of the Panel's conclusions in light of Annex P – Part 1. PO=Primary Objective; SO=Secondary Objective. NB: items that are crossed out refer to sub-objectives in the proposal reviewed by the Panel that have now become ancillary objectives in the revised proposal submitted at the present meeting.

Lethal	Importance: scientific prospective	Importance: conservation and management	Achievable with non-lethal methods	Equivalent objectives that can be achieved non-lethally?	Lethal components: magnitude and relevance for conservation and management	Design and implementation reasonable to achieve objectives?
PO I: Contribution to optimising the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan						
Y	Yes	Yes	In part (see below)	-	-	-
SO I (i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status						
Y	Yes, particularly given availability of age struc-ture. New compared to past programmes.	Not needed to run *CLA*, but increase accuracy of ISTs.	Currently not feasible, but current developments may change the situation in near future.	Replacing age with length is possible but not as precise.	Magnitude and relevance of improving and understanding of spatial and temporal occurrence of J stock is useful but lethal components contribution not likely to be as substantial for overall management as addressing stock structure un-certainty and improving estimates of abundance.	The inshore sampling design makes analysis challenging and this has not been addressed. Field and laboratory implementation is reasonable.
SO I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan						
-	Yes	Yes, for *CLA* and ISTs	NA	NA	NA	Yes. The split of abundance estimate to stock depends on appropriate modelling framework that includes stock structure.
SO I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan						
Y	Yes	Yes, for ISTs	Yes	NA	Substantial impact. The performance of few RMP variants are critically dependent on whether there are one or two O stocks.	The design of the sampling scheme does not max-imise the information available to assess whether there is a stock structure within O stock. The analysis of more genetic loci on the existing samples is more likely to meet the objective then additional sampling.
SO I (iv): Improve RMP trials by incorporating age data in their conditioning						
Y	Yes	Yes, for ISTs	Much of the age data already exist but has not been included in past ISTs. Age data for the future currently not feasible, but current developments may change the situation in near future.	The past age data could be included without collecting additional lethal samples.	Unclear because there are substantial historical samples which may be sufficient to improve conditioning without additional samples being collected.	Yes, this is a modelling exercise.
~~**SO I (v): Investigation of the influence of regime shift on whale stocks**~~						
~~Y~~	~~Yes for understanding responses of environ-mental change.~~	~~Not important~~	~~No~~	~~No~~	~~Little importance~~	~~Major concerns because of small sample sizes for common minke whales offshore, timescale of pro-gramme against possible regime shifts occurring and requirement for better sampling of prey availability.~~
PO II: Contribution to the RMP/IST for North Pacific sei whale						
Y	Yes	Yes (eventually)	Yes	-	-	-
SO II (i): Abundance estimates for North Pacific sei whale taking account additional variance						
-	Yes	Yes, for IA	NA	NA	NA	Yes
SO II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*						
Y	Yes	Yes, for developing models for this species and IA.	Considerable age data already exist. Age data for the future but currently not feasible, but current developments may change the situation in near future.	The past age data could be included without collecting additional lethal samples.	Unclear because there are substantial historical samples which may be sufficient to improve conditioning without additional samples being collected.	Yes
SO II (iii): Study of the pattern of movement of whales of the 'pelagic stock' within the feeding grounds and between feeding and breeding grounds [Note: this objective was refined from 'Additional analyses on stock structure in North Pacific sei whale for RMP *Implementation*']						
~~Y~~	~~*Very limited.*~~	~~*Yes, for IA*~~	~~*Limited*~~	~~*Yes*~~	~~*No*~~	~~*Yes*~~
SO II (iv): Specification of RMP *ISTs* for North Pacific sei whale						
-	Yes	Yes		Yes	NA	NA
~~**SO II (v): Investigation of the influence of regime shift on whale stocks**~~						
~~Y~~	~~Yes for understanding responses of environmental change.~~	~~Not important~~	~~No~~	~~No~~	~~Very little.~~	~~Major concerns because of timescale of prog-ramme against possible regime shifts occurring and requirement for better sampling of prey availability.~~

Table 27b

Summary of the Panel's conclusions in light of Annex P – Part 2. PO=Primary Objective; SO=Secondary Objective.

Lethal	Degree of coordination with related projects?	Effects of catches on stocks	Intermediate targets	Any other relevant matter for the SC
PO I: Contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan				
Y	-	-	-	-
SO I (i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status				
Y	Build extensively on JARPN II	Not fully evaluated. If it is a single O stock the effect of catches is minimal. However, the analysis presented did not consider possibility of two O stocks.	Unclear the intermediate target for biopsy sampling feasibility study	Unlikely to be used for the 2018 *Implementation Review* but it could feed into that in 2024
SO I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan				
	Yes	NA	Sufficient	Abundance relevant to much SC work. Surveys could provide information on other species.
SO I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan				
Y	Builds extensively on JARPN II	If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.	OK if sufficient analyses are carried out.	Small NEWREP-NP sample are expected to be available to be used for the 2018 IR, but it could feed in the 2024 IR.
SO I (iv): Improve RMP trials by incorporating age data in their conditioning				
Y		If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.	Sufficient	This require coordination with the SC in the upcoming *Implementation Review*
~~**SO I (v): Investigation of the influence of regime shift on whale stocks**~~				
~~Y~~	~~Partial. Potential for coordination with many other initiatives.~~	~~If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.~~	~~Reasonable~~	~~Data could be relevant to EM~~
PO II: Contribution to the RMP/IST for North Pacific sei whale				
Y			-	-
SO II (i): Abundance estimates for North Pacific sei whale taking account additional variance				
	Yes	NA	Sufficient	Abundance relevant to much SC work. Surveys could provide information on other species.
SO II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*				
Y	Yes	Negligible	Adequate	-
SO II (iii): Study of the pattern of movement of whales of the 'pelagic stock' within the feeding grounds and between feeding and breeding grounds [Note: this objective was refined from 'Additional analyses on stock structure in North Pacific sei whale for RMP *Implementation*']				
~~Y~~	~~*Yes*~~	~~*Negligible*~~	~~*Adequate*~~	-
SO II (iv): Specification of RMP *ISTs* for North Pacific sei whale				
	NA	NA	Adequate	-
~~**SO II (v): Investigation of the influence of regime shift on whale stocks**~~				
~~Y~~	~~Partial. Potential for coordination with other initiatives.~~	~~Negligible~~	~~Reasonable~~	~~Data could be relevant to EM.~~

Table 27c

Summary of highest priority recommendations relevant to NEWREP-NP.

No.	Panel recommendations	*Panel comment/timeline* **SC 2017 comments**	Proponent response/comments
1	The Panel **recommends** that a more thorough quantitative review of the relative contribution of those data types that can only be obtained by lethal sampling to the ability of the proponents to meet their primary objectives is warranted for a full evaluation of options in terms of lethal *vs* non-lethal methods in relation to the objectives.	*Panel: Required for any revised proposal* **SC 2017: Different opinions, need for more discussion (see Annex D, Item 2.4, p.4).** **See discussion under Item 19.1 on the development of draft documents on guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits.**	Already responded for Antarctic minke whale (Government of Japan, 2016). See SC/67a/SCSP01, pp.6, 10-14; SC/67a/SCSP13, pp.2-5.
~~6~~	~~To demonstrate the feasibility of meeting the Secondary Objective related to regime shift, the Panel **recommends** that the proponents specify more fully:~~ ~~(a) quantitative criteria with respect to identifying [major] environmental change and potential responses by whales;~~ ~~(b) the adequacy of the methods and effort to specify the distribution, seasonality, and precision of the environmental data, for the regions in which the whales being studied are feeding; and~~ ~~(c) taking into account uncertainty, conduct a power analysis to determine the sample sizes/effort for the characterisation of the environment and whales (including distribution and prey use) needed to determine if there are changes before and after a major environmental change occurred, should one occur during the programme.~~	~~*Required for any revised proposal if the proponents wish to continue with this Secondary Objective for either or both species.*~~ **SC 2017: This recommendation is no longer valid. This objective has been changed into an Ancillary one and its scope has been revised.**	To be treated as ancillary objective (see SC/67a/SCSP10).
12	*Offshore component*: During the workshop, the proponents provided the Panel with the sampling strategy (samples by month, year, and sub-area) and the Panel **recommends** that this information be included in the version of the proposal that is provided to the Scientific Committee. The Panel also **recommends** that tables of past samples in the same format as the new samples should be included in a revised proposal to place the new samples in a spatio-temporal context.	*Panel: Required for any revised proposal* **SC 2017: Historical samples of minke whale (SC/67a/SCSP10, pp.86-87) and of sei whale (see SC/67a/SCSP10, p.111) have been included.**	Not important because it is not relevant to the justification of lethal sampling of NEWREP-NP (this recommendation is related to data archiving and compilation). The additional information on sampling strategy provided to the Panel will be included in any final research plan.
13	The Panel **recommends** conducting analyses in which the historical age-composition data are downweighted by various levels.	*Panel: Required for any revised proposal* **SC 2017: No progress as proponents disagree with Panel.**	Disagree with Panel (see SC/67a/SCSP01, p.15).
15	Given the discussion under Item 3.3.4, the Panel **recommends** that a properly designed experiment to assess the efficiency of biopsy sampling of common minke whales be undertaken (there is already sufficient detail on catch to render additional capture experiments unnecessary). This should incorporate at least: (a) the use of the expected vessels in the programme (i.e. the small type whaling vessels); (b) the use of vessels (that may be different from the expected vessels) considered suitable by scientists already experienced with biopsy sampling this species; (c) suitable levels of effort to allow a statistical comparison (effort for biopsy sampling should be measured or converted to the same units used for examining catching efficiency); (d) effort should be carried out in various environmental conditions (e.g. sea state, swell, visibility) up to the maximum conditions that would apply to whaling; (e) advice and training from invited experienced minke whale biopsy samplers (e.g. Christian Ramp or Lars Kleivane); and (f) analyses that provide a proper comparison of biopsy sampling and catching (including time to process samples under various variables such as experience of sampler, vessel, equipment, effort under similar conditions). The Panel **reiterates** its comments that the proponents must ensure that data are promptly analysed to ensure a meaningful mid-term review – it also refers to its comments about providing adequate resources into work on common minke whale biopsy sampling as soon as possible to facilitate the prompt use of non-lethal techniques.	*Panel: High priority to begin as soon as possible this year* **SC 2017: No progress as proponents disagree with Panel.** **Advisory Group established regarding biopsy sampling. See discussion under Item 19.3.1.**	Not important because it is not relevant to the justification of lethal sampling of NEWREP-NP (this recommendation is related to the design of the experiments of biopsy sampling). Disagree with Panel (see SC/67a/SCSP01, p.3). See also Yasunaga *et al.* (2017).

No.	Panel recommendations	*Panel comment/timeline* **SC 2017 comments**	Proponent response/comments
21	*Sample size (potential reduction of lethal sample size)*: An important component of determining appropriateness of techniques is determination of sample size - as non-lethal techniques become appropriate, non-lethal and lethal sample sizes will need to be recalculated to ensure that objectives are met. The Panel noted there was no discussion in the proposal as to what the strategy would be to determine sample sizes or how the current methods that determine sample sizes might be modified to determine the new sample sizes. The Panel **recommends** this issue be considered by the proponents and a strategy to be included in the project proposal before the start of the fieldwork.	*Panel: Required for any revised proposal* **SC 2017: The possibility for further work has been considered (SC/67a/SCSP10, p.39).**	Not important because it is not relevant to the justification of initiation of lethal sampling of NEWREP-NP (this recommendation is related to future consideration of sample size). Agree with the Panel in principle but see SC/67a/SCSP01, p.16. See 'Possible modification of lethal sample sizes' section in SC/67a/SCSP10, p.39.
22	*Sample size (in general)*: The Panel **strongly recommends** that the Proponents take full advantage of existing materials and data to assess the suitability of the planned efforts under NEWREP-NP to resolve the current stock structure hypotheses in the targeted species, before collecting more samples. Simulation studies based upon data collected from the current samples are recommended to adjust the experimental design to address the targeted levels of population divergence/heterogeneity. Such simulations may reveal that an increase in data from existing samples may prove beneficial over collecting additional samples.	*Panel: Required for any revised proposal* **SC 2017: The proponents made available additional microsatellite data (10 loci) for small subset of data. The proponents also presented additional analysis (i.e. kinship, STRUCTURE) in SC/67a/SD-DNA01 and SC/67a/SD-DNA05. See discussion under Item 19.3.2 and in Annex I, item 2.2.**	Not important because it is not relevant to the justification of lethal sampling of NEWREP-NP (this recommendation is related to genetic information, but genetic information is not the basis of sample size and sampling design) Disagree with Panel (see SC/67a/SCSP01, p.17). Also see SC/67a/SCSP13, p.5 for split samples into coastal and offshore.
23	In relation to the impact of catches on common minke whales, the Panel **recommends** that the assessment of the effects of catches on stocks be based on a subset of the trials on which the 2013 *Implementation* was based (including two levels for MSYR and all three stock hypotheses) as this will better account for uncertainty regarding current abundance and future bycatch, as well as time-variation in the J-O mixing proportion. The trials will also be able to account for the location (sub-area) and timing (month) of future catches. However, the trials on which the 2013 *Implementation* was based consider $MSYR_{mat}$=1%, whereas the Scientific Committee has agreed that the lower bound for MSYR should be $MSYR_{1+}$=1% (IWC, 2014a).	*Panel: Required for any revised proposal* **SC 2017: Major concerns by the Panel were addressed by the proponents. See Item 19.4.2.2.**	Partially agree with Panel (see SC/67a/SCSP01, p.18 and SC/67a/SCSP13, Section 4, p.45-52).
24	Furthermore, the analyses for common minke whales did not use the most recent estimates of abundance. Thus, before a full consideration of the effects of the catches can be concluded, the Panel **recommends** that the proponents update the trials so that trials are conducted for $MSYR_{1+}$=1% and $MSYR_{mat}$=4% are fit to the most recent estimates of abundance. The Panel **recognises** that modifying trials is a substantial undertaking (and must be accompanied by evidence of satisfactory conditioning) and it may not be possible to update even a subset of the trials prior to the 2017 Annual Meeting. However, the Panel it **stresses** the importance of this being completed before the programme commences.	*Panel: Required for any revised proposal* **SC 2017: Major concerns by the Panel were addressed by the proponents. See Item 19.4.2.2. More information on technical details is recommended (see Annex D Item 4.1 p. 10-11).**	Disagree with Panel (see SC/67a/SCSP01, p.18 and SC/67a/SCSP13, Section 4, pp.45-52)
25	In relation to North Pacific sei whales, the Panel **recommends** that the proponents consider additional analyses in which current abundance is assumed to equal to the lower 95% confidence bound for the current estimate of abundance and present results for $MSYR_{1+}$=1% and $MSYR_{mat}$=4%, as these are the values selected by the Scientific Committee (IWC, 2014a).	*Panel: Required for any revised proposal* **SC 2017: This recommendation has been met (see Annex D, Item 4.2, p.11-12).**	Addressed in SC/67a/SCSP13, Section 4.

Table 27d

Summary of high priority recommendations relevant to NEWREP-NP.

No.	Panel recommendations	*Panel comment/timeline* **SC 2017 comments in bold**	Proponent response/comments
3	*Sexual maturity:* The Panel **recommends** that levels of progesterone in blubber and serum should be compared with sexual maturity and reproductive status of examined females. This comparison is valuable for assessing the efficacy of biopsy sampling for assessing reproductive status.	*Panel: Add to the research protocols for any revised proposal.* **SC 2017: The Proponents demonstrated intention to include analysis of blubber for progesterone, but there are few details of how.**	See 'Sexual maturity' section in SC/67a/SCSP10, 3.1.1 (p.25).
4	*Sightings surveys*: The Panel highlighted several issues that must be considered when designing line transect surveys that are expected to provide abundance information to address multiple objectives. The Panel **recommends** that these issues related to survey design, data collection protocols and priorities, data analyses and coordination are included in the plans to be submitted to the Scientific Committee for approval, before the surveys start. The main additional issues that should be covered in the proposals for surveys submitted to the Scientific Committee are: (a) **Evaluation of past surveys' analytical difficulties.** These new surveys provide an important opportunity to evaluate and potentially add/modify the variables or values of variables that are collected. Evaluating the shortcomings of previous surveys (for example, sample size issues and the amount of effort expended, problems that arose in analyses of past data) could suggest ways to supplement the future surveys. (b) **Appropriate temporal stratification** of the surveys. (c) **Appropriate direction of travel** for the survey vessel(s) and direction of track lines to account for migrating animals. (d) **Use of independent observer (IO) mode**, especially in the offshore waters where the weather and sea state conditions are poorer. (e) **Use of passive independent observer mode** with abeam closing to get the benefits of estimating $g(0)$ and also improving the precision of the group sizes. (f) **Development of protocols/priorities for biopsy-related activities**. (g) **Evaluation of additional variance analysis and spatial model methods** to determine which is preferred or whether both methods are investigated. (h) **'Regime shift'-related aspects** require that consideration should be given to whether sampling of prey is possible during the line transect surveys - obtaining simultaneously collected prey and whale data seems ideal, however logistically challenging.	*Panel: Address in individual survey plans submitted to the Scientific Committee* **SC 2017: New survey plan was presented to the SC by the proponents (SC/67a/ASI6, appendix 1). The plan was endorsed. Matsuoka IWC oversight.**	See SC/67a/ASI06.
5	Care is required during sub-sampling of prey in whale stomachs to ensure that the sample is representative when stomach volumes are large and prey diverse: the Panel **recommends** that the proponents specify how this is to be achieved in the field protocols.	*Panel: Add to the research protocols for any revised proposal* **SC 2017: This recommendation referred to the former secondary objective that has been transformed into an ancillary objective. The information provided is sufficient.**	See 'Stomach contents/tissue sampling' section in SC/67a/SCSP10, Annex 17 (pp.126-127).
7	In order to achieve aim of research item (i) the Panel **recommends** that any immune function assays used should be those already established for cetaceans (Schwacke *et al.*, 2012) so that the results are comparable to published studies.	*Panel: Add to the research protocols for any revised proposal* **SC 2017: This recommendation has been met.**	See 'Laboratory and analytical works' section in SC/67a/SCSP10, Annex 18 (p.135).
8	Following previous expert panel recommendations, the Panel **strongly reiterates** that all lipophilic compounds being measured must be reported on a lipid weight and not a wet weight basis.	*Panel: Add to the research protocols for any revised proposal* **SC 2017: This recommendation has been met.**	See 'Laboratory and analytical works' section in SC/67a/SCSP10, Annex 18 (p.135).
10	The Panel **recommends** coordination with IWC-POWER with respect to sightings surveys, biopsy sampling and photo-ID for large whales to ensure consistent data collection and processing, as appropriate. The Panel also **recommends** information on these species are included in annual reports to the Scientific Committee to encourage collaboration with scientists involved with research on these two species.	*Panel: Preparation for sightings surveys and presentation of results* **SC 2017: This recommendation has been met.**	See 'Photo-identification and biopsy sampling' in SC/67a/SCSP10, 3.1.1 (p.126).

No.	Panel recommendations	*Panel comment/timeline* **SC 2017 comments in bold**	Proponent response/comments
11	*Coastal component*: The Panel **recommends** that analyses be conducted, before the start of the programme, to assess the extent of loss in power and precision due to the sampling strategy for the objectives related to common minke whales and the implications for meeting Secondary Objectives. The experience/data gained from JARPN II should be used by the proponents to investigate issues (a)-(c) below: 1. the design would lead to oversampling of the areas close to ports (the Panel was informed that an additional land-based station may be established in the northern Sanriku to better cover sub-areas 7CS and 7CN); 2. the boats can search freely once they reach 30 n.miles from port if no whales have been encountered *en route* from port, which means the design is not fully specified in terms of the catches by the port-based boats; and 3. the Nisshin Maru will conduct sampling if the number of common minke whales caught does not reach the target number, but no sampling plan for this contingency is provided.	*Panel: Add to the research protocols for any revised proposal* **SC 2017: No progress as proponents disagree with Panel.**	Disagree with Panel (see SC/67a/SCSP01, p.8).
17	Rather than set an arbitrary number of telemetry tags for deployment, the Panel **recommends** that the number, location and timing of tag deployments should reflect the questions being addressed.	*Panel: Add to protocols for any revised proposal* **SC 2017: This recommendation has been partially met.**	See SC/67a/SCSP10, (p.105 for minke whale; p.120 for sei whale).
27	Although a new graduate analyst has been appointed, the Panel **remains concerned**, that as has been the case for all previous special permit programmes undertaken by Japan, field and laboratory work and laboratory analyses have been allocated much higher priority than analyses and modelling. This has been reflected in the long times taken to complete analyses (some of which remain incomplete). The Panel **strongly recommends** the recruitment of sufficient highly trained and qualified analyst/modellers to improve NEWREP-NP study design, data analysis and review.	*Panel: Prior to undertaking the programme* **SC 2017: It is not clear that additional qualified personnel have been hired.**	See section on 'Description of overall project management including personnel and logistic resources' in SC/67a/SCSP10, 5.2 (p.43).
28	Additional information on sample and data archiving, relational database(s) as noted by previous expert panels would be welcome.	*Panel: Include as part of any revised proposal* **SC 2017: The proponents partially addressed this recommendation for DNA data and associated biological information, as used in SC/67a/SD-DNA01 and SC/67a/SD-DNA05.**	See section on 'Description of overall project management including personnel and logistic resources' in SC/67a/SCSP10, 5.1 (p.43). See also relational data set presented to the JARPNII review meeting.
29	The proponents recognised the need for a backup contingency plan in the event of disruption of the programme. The primary contingency is for the cruise leader to adjust sampling efforts and locations, if necessary, for example due to bad weather preventing the collection of data in a certain location. The Panel **agrees** that contingency plans are needed, but noted that the proponents have not yet developed a more detailed plan/protocol, *a priori*, for how research will be modified in the event of disruption. It **recommends** that this be done.	*Panel: Add to protocols for any revised proposal* **SC 2017: This recommendation has been partially met.**	See section on 'Adjustments of research protocols at the scene and in the year of disruption' in SC/67a/SCSP10, 5.3 (p.44).

Table 27e

Summary of other recommendations relevant to NEWREP-NP.

No.	Panel recommendations	*Panel Comment/timeline* **SC 2017 comment**	Proponent response/comments
2	The Panel **recommends** that any Special Permit programme should include a specific Primary Objective to continually review new techniques as these become available to facilitate discussions of methods and samples sizes at milestones such as the mid-term reviews. *If* present data do not allow for this, a focussed pilot study to enable a full and proper evaluation of lethal vs present non-lethal methods integrated across objectives should be undertaken, prior the full programme starting; where such data already exist then the desktop-study evaluation should be undertaken *before* the permit programme begins. Such evaluations could be undertaken in light of an expanded framework as recommended under Item 3.3.4 and must be properly designed to enable more effective reviews of sample sizes/methods during mid-term reviews.	*Panel: Whilst relevant to the proponents, this is directed primarily at the Scientific Committee and linked to Recommendation 19* **SC 2017: Not considered in the new proposal.**	Not applicable
9	Research item (iii) relates to novel compound exposure and indicates that the levels of polybrominated diphenyl ethers (PBDEs) and other flame retardants would be quantified in blubber, prey and marine debris (presumably micro- and macro-plastics found in whale stomachs). However, there is no indication of how these results would be related to 'adverse effects' as stated in the objective. The Panel therefore **recommends** an integration and combined analysis of the results obtained by all three research items (i.e. relating exposure to polychlorinated biphenyls, flame retardants and novel compounds from plastics to responses) such as immune function and enzyme induction, including controlling for any effects of age (emphasizing the need to use the age estimates obtained from the earplugs rather than body length) and nutritional condition. This would require samples from the same individuals to be included in each of the three research items.	*Panel: Recommendation for analyses of results relevant for any mid-term review* **SC 2017: This recommendation has been partially met as partially reflected in SC/67a/SCSP10; additional details are needed.**	See section on 'Laboratory and analytical work' in SC/67a/SCSP10, Annex 18 (p.133).
14	The Panel **recommends** the implementation of biopsy sampling to reduce the lethal sample size as soon as it is deemed feasible rather than wait until the mid-term review.	*Panel: As soon as feasible*	Disagree with Panel [see also SC/67a/SC SP10, Fig 2 'Use and evaluation of new non-lethal techniques (field and analytical) on common minke whales in NEWREP-NP' (p.27)].
16	The Panel **recommends** the proponents attend the IWC-ONR joint Workshop on Tag Development, Follow-Up Studies and Best Practices to be held in September 2017 in Silver Spring, MD (USA) to become acquainted with the most current tagging technologies and deployment methods.	*Panel: September 2017* **SC 2017: This recommendation has been met, as reflected in SC/67a/SCSP10.**	See section on 'satellite tagging' in SC/67a/SCSP10, Annex 9 (p.105-106).
18	Once a suitable tag is developed, the Panel **recommends** tagging North Pacific common minke whales within the study area to address stock structuring within the NEWREP-NP study region. Again, tag deployment location and tag design should be tailored to the question being addressed.	*Panel: As soon as practical* **SC 2017: The proponents provided a few details in SC/67a/SCSP10.**	See SC/67a/SCSP10 (p.105 for minke whale).
19	The Panel **recommends** using the extensive amount of data in age-related methylation in mammal model species (e.g. humans) where thousands of CpG sites have been identified in which the level of methylation correlates with age, similar to the approach taken by Polanowski *et al.* (2014) who assessed 37 CpG sites originally identified in humans. Once putative aging CpG sites have been identified among the candidate CpG sites observed in humans, a more targeted approach may be developed by identifying the homologous loci in the minke whale genome, thereby presumably increasing the precision of methylation-based aging in North Pacific minke whales. This work should be undertaken in the context of whether the technique shows a suitable level of precision for meeting conservation and management objectives requiring age data, not whether it achieves a comparable level of precision to ear plug readings.	*Panel: Can start with existing data* **SC 2017: No new information has been presented, but this recommendation is highly relevant in the context of age determination by non-lethal methods.**	Agree partially with Panel (see SC/67a/SC SP01, p.16). Will be considered when the feasibility study on Antarctic minke whale is completed.
20	The Panel **recommends** that the similar data/results from the Icelandic sampling programme are incorporated in the analyses. The Panel **reiterates** that non-lethal techniques should be incorporated into the programme as soon as they are deemed plausible.	**SC 2017: This recommendation has been partially met as partially reflected in SC/67a/SCSP10.**	SC/67a/SCSP10, Fig 2 'Use and evaluation of new non-lethal techniques (field and analytical) on common minke and sei whales in NEWREP-NP' (p.27).
26	The Panel **recommends** that the proponents collaborate with wildlife immunologists and immunotoxicologists to assist them as optimising, validating and interpreting the results from any immune assays requires specialist skill and knowledge; it is **not** a trivial undertaking.	*Panel: Prior to undertaking the immune function analyses* **SC 2017: This recommendation has been met, as reflected in SC/67a/SCSP10.**	See section on 'Expected outcomes and future plan' in SC/67a/SCSP10, Annex 18 (p.133).

19.4.2 Committee review

Attention: SC
The Committee **agrees** *that, overall, the Expert Panel had conducted a detailed, fair and thorough review of the NEWREP-NP proposal. The Committee* **endorses** *the recommendations of the Panel, recognising that it was based on the information available at the time, although the proponents stated that they did not agree with all the recommendations. The proponents also stated that they had provided substantial new information at this meeting in responding to the Panel's report that in their view responded adequately to its recommendations. Several members stated their view that the additional information had responded to the important recommendations of the Panel.*

The Committee **agrees** *that its advice to the Commission from its consideration of the Panel conclusions will occur at next year's meeting. Nevertheless, there was discussion of several aspects of the Expert Panel's report and the proponent's response as summarised briefly below.*

19.4.2.1 IMPROVEMENT IN MANAGEMENT PERFORMANCE
The Committee received updated information from the proponents on the basis and analytical methods related to the selection of the sample sizes for common minke and sei whales (SC/67a/SCSP13), which the proponents stated had demonstrated by quantitative simulation of how estimation of population trends can be improved by using age data. Some members of the Committee asserted that the link between the collection of age data and improvement in management performance (such as use of age date increased catches given pre-specified levels of risk) was not provided in the proposal nor in SC/67a/SCSP13. Other members responded that this level of analysis was not required for evaluation of a Scientific Permit proposal and that analyses presented to the 2016 meeting of the Committee (Government of Japan, 2016b) had provided sufficient indications that a revision to the *CLA* that uses age data will lead to improved management performance. They also added that age data can be used to improve estimates of natural mortality (*M*) for North Pacific sei whales, which is related to the size of expected catches.

Further documents presented to the Committee examined the Panel conclusions on the potential reliability of estimates of *M* using statistical catch at age (SCAA) models and the likely utility of such estimates in providing information relevant to trials for the RMP. The Committee was unable to address fully the implications raised in the information presented on the management related benefits of the proposed research at this meeting. There are widely different opinions on the issues, which meant that achieving consensus was not possible at this meeting (see Annex D, item 2.4 for further details).

19.4.2.2 EFFECTS OF CATCHES
The Committee reviewed new information from the proponents on the effects of proposed NEWREP-NP catches on stocks. It recognised the great efforts of the proponents to respond to the recommendations of the Panel in a short time, particularly for the more complex case of the western North Pacific common minke whales.

Attention: SC
The Committee **agrees** *that the analyses address the major concerns the Panel had with the material presented on the effects of catches on the stocks in the proposal presented to the Panel at the review meeting, and as reflected in Panel recommendations 23 and 24.*

With respect to the western North Pacific common minke whales, the Committee:
(1) **agrees** *that the analyses based on bycatch data are suggestive of $MSYR_{1+}$ >0.01 and that the close-kin data suggest that a hypothesis of two O sub-stocks with different breeding grounds is implausible;*
(2) **recognising** *that there was insufficient time to fully evaluate the technical basis for the former of these analyses, it* **recommends** *that the full set of equations on which the analyses in Section 4 of SC/67a/SCSP13 be provided for review next year and possible use in revised* Implementation Simulation Trials*; and*
(3) **notes** *that the poor fits to the bycatch rates by sub-area mentioned in SC/67a/SCSP13 also support the need to revise the* Implementation Simulation Trials *for the western North Pacific minke whales.*

With respect to the North Pacific sei whales, the Committee **agrees** *that the proponents have adequately addressed the recommendations by the Panel and that the proposed catch levels will not harm the stock.*

19.5 General statements
Two general statements were presented (Annex P3 and P4) without any substantial debate on the contents.

In Annex P3, some members stated their view that lethal sampling of NEWREP-A and NEWREP-NP had not been justified and should be halted at least until more research has been conducted, noting that 'the additional work performed since publication of the two panel's reports [for the two programmes] has not yielded results that change the situation'.

In Annex P4, the proponents stated their view, supported by some others, that they had 'demonstrated the justification for lethal sampling sufficiently for both NEWREP-NP and NEWREP-A', by: (i) responding in good faith to all the recommendations by the NEWREP-NP Panel; and (ii) responding sufficiently to those of the NEWREP-A Panel's recommendations that the Panel had thought should be addressed prior to the start of the programme.

20. WHALE SANCTUARIES
No information was submitted on existing or proposed IWC Sanctuaries this year.

21. IWC LIST OF RECOGNISED SPECIES
Cooke proposed to synchronise the updating of the IWC list with the ongoing IUCN process of cetacean species and populations revision. He will revise the list, in the form of a working document, when the ongoing IUCN review is concluded, before next year's meeting.

22. IWC DATABASES AND CATALOGUES
The reports of the *Ad-Hoc* Working Groups on Global Databases and Repositories and on Photo-identification are given in Annexes R and S, respectively.

22.1 Guidelines for IWC catalogues and photo-identification databases
Over the past year, the *ad hoc* Working Group on Photo-identification (Annex S) developed guidelines in support of the IWC's work conducting cetacean population assessments through photo-identification databases. The objective was to provide guidance for photo-identification catalogues contributing photos and data to the IWC and/or being funded in part or wholly by the IWC. Catalogues must adhere to

common standards at a level sufficient to allow the IWC to meet its population assessment goals. The Committee noted that in future years, technical appendices may be added.

Attention: SC, S
The Committee ***recommends*** *that the 'IWC guidelines for photo-identification catalogues' provided in Annex S are adopted, placed on the IWC website and brought to the attention of the relevant catalogue holders.*

22.2 Progress with existing or proposed new catalogues

22.2.1 Integration of eastern South and Central Pacific Blue, Humpback, and fin whale photo-catalogues

SC/67a/Rep03 summarise the proceedings of a Workshop held in 2016 in Valparaíso, Chile, following the Biennial meeting of the Society of Aquatic Mammal Experts of Latin America (SOLAMAC). The aim was to communicate the goals and intent of the IWC population assessment process to regional researchers and to facilitate blue, humpback and fin whale photo-identification standardisation and integration. Participants focussed on humpback whales agreed to collaborate on developing new population estimates of abundance for Breeding Stock G humpback whales (IWC, 2017b, p.30). A strategy for combining photo-identification catalogues to support a mark-recapture analysis and to determine population connectivity from the eastern South Pacific and the Antarctic Peninsula was agreed upon. All blue whale research groups present agreed to collaborate and to contribute catalogues towards a southeast Pacific assessment. Four research groups with fin whale photographs from South America agreed to coordinate efforts toward a unified catalogue. Due to the success of this Workshop it was recognised that 'piggy-backing' workshops onto regional meetings is a productive way to assist regional researchers in achieving population assessment goals important to the IWC Scientific Committee.

22.2.2 Southern Hemisphere and Indian Ocean humpback whales: Catalogues

22.2.2.1 ANTARCTIC HUMPBACK WHALE CATALOGUE (AHWC)

SC/67a/PH03 reported on the AHWC, which has been maintained (with funding from the IWC) by the College of the Atlantic since 1987. A total of 820 individual humpback whales were catalogued in the last year. The total numbers of whale identifications are now 7,476 (fluke), 414 (left side) and 408 (right side). The database contains records of 514 individuals identified in more than one year and 274 individuals identified in more than one region (including breeding and feeding areas). A total of 23 individuals have been identified over a period of over 20 years; the longest span is 36 years. AHWC tested the utility of the Happywhale[24] (first discussed last year and see below) automated image recognition system and found a high matching success rate (81%) for high quality photographs. The use of future automated matching will facilitate the comparison of large numbers of photographs and across wider geographic ranges, potentially yielding information pertinent for population assessments.

SC/67a/PH02 presented an update on the web-based marine mammal photo-identification crowd-sourcing platform known as 'Happywhale'. As of April 2017, the system had been online at Happywhale.com for 20 months. The system is in continued development, pursing the complementary goals of engaging citizen scientists and using that engagement to generate high quality, low cost photo-identification data to marine mammal scientists. Individual identification efforts have been focused on humpback whales in collaboration with Cascadia Research Collective, College of the Atlantic, and the Alaska Whale Foundation. The site currently displays 4,813 individual humpback whales. Development has been focused on the implementation of an automated individual identification image recognition algorithm for humpback fluke matching. The system has found long-distance matches between catalogues that would not otherwise have been compared, and has also contributed to entanglement response efforts by identifying whales along the California coast.

[24]*http://www.happywhale.com.*

22.2.3 Southern Hemisphere Antarctic and pygmy blue whales: Catalogues and databases

22.2.3.1 SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE (SHBWC)

SC/67a/PH04 provides a progress report of the SHBWC between June 2016 and May 2017. It now includes a total of 1,520 individual blue whale photo-identifications from areas off Antarctica, Chile, Peru, Ecuador-Galapagos, eastern tropical Pacific, Australia, Timor L'este, New Zealand, Southern Africa, Madagascar and Sri Lanka. Overall, 17 blue whale research groups from all regions are contributing to the SHBWC. In 2016-17, the catalogue increased 13% with the addition of new identifications. To date matches have only been found within regions (Chile, Australia, and Antarctica) but not between regions. Work in the next year will focus on within region comparisons to be used for assessment purposes while between region comparisons to investigate migration and connectivity will be considered a second priority. The relevance of the catalogue to population assessments is discussed in Annex H Item 9.2.2.

22.2.3.2 ANTARCTIC BLUE WHALE CATALOGUE (ABWC)

SC/67a/PH01 described the results of the comparison of new Antarctic blue whale identification photographs to the ABWC. Twenty-five new individual blue whales were identified: sixteen from the South African Antarctic Blue Whale Survey 2013/14 (Findlay *et al.*, 2014) and nine from the personal photographs of Paul Ensor (Cruise Leader, IWC/SOWER). There were no matches within or between the two photo collections or the Antarctic Catalogue. The total number of identified Antarctic blue whales is now 441, represented by 321 right sides and 336 left sides. This is 15-19% of the most recently accepted abundance estimate of 2,280 from 1997/98 (CV=0.36; Branch *et al.*, 2007). To date 3% (14/441) of whales have been re-sighted inter-annually. The low re-sighting rate may be explained by an increasing population size (Branch *et al.*, 2007). The current 3% re-sighting rate is too low to produce a precise abundance estimate in a capture-recapture model. The relevance of the catalogue to population assessments is discussed Annex H, item 9.2.3.

Attention: SC, S
The Southern Hemisphere photo-identification catalogues for humpback whales and blue whales are potential sources of data for estimating abundances and examining connectivity between feeding and breeding grounds. The Committee:

(1) ***recommends*** *the continuation of these catalogues;*
(2) requests the Secretariat sends the curators of these catalogues the newly agreed 'IWC guidelines for photo-identification catalogues' (Annex S); and
(3) ***encourages*** *regular communication between curators of the Antarctic Humpback Whale Catalogue and the Committee.*

Table 28

Database usage by the Scientific Committee, any database development and data entry required, and the priority to complete that work.

Database	Status	Use by Scientific Committee	Work required	Priority to complete
Progress reports	Live	Time series data on bycatch and entanglements and other anthropogenic impacts on large and small cetaceans	Complete changes agreed at SC/67a (Annex R, table 4)	**High** Approx. 1.5 weeks developer time
SH blue whale catalogue	Awaiting development	MR abundance estimate for population assessments, population structure	Server setup and deployment – SC budget allocated	**High**
Individual Catch Database	Live	Population assessments, catch limits, distribution and movement	Online portal. Idiosyncrasies within data. Creation of a database accounting for differences between total catches and those with individual data. Requires full documentation.	**High**
Catch Summary Database	Live	Population assessments, catch limits, distribution, movement	Online portal	**High**
Entanglement response	In planning	Develop best practice, information sharing and capacity development	Develop database; funding already available.	**High** Final proposal will be presented at SC/67b
JCRM submission site	Live	*JCRM* journal management system (submission to publication)	Customise some features	**Medium**; current system functional
Ship strikes	Live	Time series data of ship strikes on large whales	Migration script or brute force data entry of 100+ records from another repository	In progress by Secretariat
IWC photographic cruise database and archive	Live	Keyworded data archive linked to cruise records, e.g. photo-ID, biopsy, scarring, health status etc.	Updates only	In progress by Secretariat
IWC biopsy sampling database	Under development	Facilitate stock structure analyses	Updates only	In progress by Secretariat
Document web archive	Live	For everything	Updates only	In progress by Secretariat
Bibliographic reference database	Live	Scientific Committee reports, communication	Updates only	In progress by Secretariat
New integrated sightings, photo-ID, biopsy	Under development, SC Steering Group	Population assessments, abundance estimation	Updates only once developed	In progress by Secretariat, funding available
Cetacean diseases of concern	Intranet in development		Finalise website	Part of document archive; complete at SC/67b
Whalewatching handbook	In development		Finalise website, develop database	Part of document archive; in progress by Secretariat
IWC database of recommendations	In planning	Communication with Commission, assessment of progress/response	Develop database	Proposal will be presented at SC/67b
WNP gray whale catalogue	Under construction	MR abundance estimation for population assessments, population structure	Possible migration to new system	Process to be specified
Research requests	Live	Portal to request data or samples held by the IWC	None required	N/A
Discovery Marking Data	Live	Population structure and movement, catch allocation	None required	N/A
Sightings Data (IWC-DESS)	Retired (see below)	Population assessments, abundance estimation	Data will be integrated into the new sightings, photo-ID database	N/A
Small cetaceans catches (bycatch and direct)	Retired	Not used currently	None	N/A
Compendium of whalewatching regulations	Outdated	Global comparison of whalewatching regulations, assessment of best practice	None – not a database	N/A

22.3 Progress with existing IWC databases

22.3.1 IWC databases

The Secretariat currently holds or is developing 18 databases as well as three web applications which include databases. The Committee reviewed these databases focussing on the technical and financial support required. Annex R summarises the future work required and high priority tasks.

Attention: SC, S, CG

The Committee ***recommends*** *that the following activities are high priority (see Annex R):*

(1) further development of IWC catch databases including documentation of aggregated catch information;

(2) amend the National Progress Reporting systems as specified under Item 23.3.2;

(3) migration of the Southern Hemisphere Blue Whale Catalogue to an IWC-managed server; and

(4) development of the Entanglement Response database.

22.3.2 National progress report database

The number of countries completing National Progress Reports has dropped from around 20 in 2000 to around 15 in recent years with only 12 in 2017. The Committee reviewed the content and database for these reports and made several recommendations (see below).

Attention: SC, S, CG
The Committee ***recommends*** *that the Secretariat:*

(1) ***develops*** *a system to generate PDF files of each report that will include the names of national and regional coordinators for each country as authors to assist national and regional co-ordinators to provide feedback to contributors and to facilitate review of each country's national progress report;*
(2) ***develops*** *a system to aggregate data on specific issues such as bycatch and ship strikes - the Commission Bycatch Mitigation Initiative coordinator might also assist with promoting submission of information in National Progress reports;*
(3) ***implements*** *changes to the structure and content of National Progress Reports (see Annex R, table* 4*) to reduce the workload of data entry while still retaining all the data used by the Committee - the changes include removing the specific sections on sightings, photo-identification, tag deployment, tissue sampling and direct catches of large whales while adding two sections on cetacean databases/archives and systematic surveys; and*
(4) ***ensures*** *that the data are easily accessible by the Committee including by submitting a document at each meeting summarising catches for the previous year and appending a table of catches to the PDF files of national progress reports.*

22.4 Potential future IWC databases

22.4.1 Global database for disentanglement activities (with HIM)
A new *pro-forma* was developed for new database requests and major alterations to existing databases (Annex R, appendix 2). The *pro-forma* will be completed by the proponents and reviewed by the relevant sub-committee or working group, together with technical input from the Secretariat, similar to the procedures for funding proposals.

There are several databases which receive funding from IWC but are not hosted by the Secretariat (e.g. Pollution 2020). The new *pro-forma* is intended to adequately describe the form and function of these external databases and specify data availability arrangements with the Committee. This information will assist the assessment of any associated funding proposals.

Attention: SC, S, CG
The Committee ***recommends****:*

(1) adoption of the pro-forma developed for new database requests and major alterations to existing databases given in Annex R, appendix 2; and
(2) that the Secretariat develops formal data availability agreements for external databases that receive funding from the IWC.

22.4.2 Global bycatch database
The Committee has previously recommended the development of a database for the IWC's Global Whale Entanglement Response Network (GWERN). This was discussed as an example of a well-advanced proposal for a new database that could be used as a test of the new *pro-forma*. Mattila agreed to fill out the *pro-forma* using the specification for the GWERN database. If, as anticipated, this database is successful, then it could be expanded to include other related data. Hence the initial structure needs to be carefully designed to allow for future expansion.

22.4.3 Development of simple technical guidelines for new proposals
Another proposal, developed jointly by the Scientific and Conservation Committees, for a database of Scientific Committee recommendations will be prepared for the 2018 Joint CC/SC Working Group and will be available at the 2018 Scientific Committee meeting. This proposal will provide another opportunity to review the pro-forma and refine as needed.

23. IWC MULTINATIONAL RESEARCH PROGRAMMES AND NATIONAL RESEACH CRUISES THAT REQUIRE IWC ENDORSEMENT

23.1 IWC-POWER

SC/67a/ASI09 reported the results of the 7th annual IWC-POWER cruise, conducted between 2 July to 30 August 2016 in the central North Pacific (with the dedicated research area located between 20°N-30°N and between 135°W-160°W). The survey was conducted aboard the Japanese R/V *Yushin-Maru No.3*. Researchers from Japan, the US and Republic of Korea participated in the survey, which was implemented using methods based on the IWC SC guidelines. Further details on the cruise, including information on number of species seen, can be found in Annex Q, item 5.1.

The Committee thanked the Cruise Leader, researchers, Captain and crew, and the Steering Committee for completing the 6th cruise of the IWC-POWER programme. The Government of the USA had granted permission for the vessel to survey in their waters, without which this survey would not have been possible. The Government of Japan generously provided the vessel and crew. The Government of Republic Korea provided a researcher. Furthermore, the IWC Secretariat was thanked for providing support. The Committee recognises the value of the data contributed by this and the other POWER cruises, collected in accordance with survey methods agreed by the Committee, covering many regions not surveyed in recent decades, and addressing an important information gap for several large whale species.

SC/67a/Rep02 presented the report of the 2016 IWC-POWER cruise Planning Meeting held in Tokyo from 15-17 September 2016. The cruise will take place from 3 July-25 September 2017, including transit from and to Japan using the research vessel *Yushin-Maru* No. 2, which is kindly being provided by Japan. It had been confirmed, after the Planning meeting, that the ship will receive the necessary international clearance. Sailing with international status will provide considerable benefits with regard to permits and port entries for refuelling, and acoustic components such as deployment of sonobuoys. This will be the eighth cruise under the successful international IWC-POWER programme. Together, the cruises to be conducted in 2017, 2018 and 2019 will cover the Bering Sea. These plans were endorsed by the Committee in 2016. The 2017 cruise will cover the easternmost stratum in the Bering Sea, i.e. towards the US coast. This will give more time for obtaining the relevant permits for covering Russian waters in the westernmost stratum of the survey area. The cruise will make a valuable contribution to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific.

The Committee thanked Japan for hosting the IWC-POWER cruise meeting and the participants for their hard work.

Attention: SC, C-A, CG-R
The Committee ***reiterates*** *to the Commission the great value of the data contributed by the IWC-POWER cruises which cover many regions of the North Pacific Ocean not surveyed in recent years and so address an important information gap for several large whales. The Committee:*

(1) ***thanks*** *those governments, especially Japan who generously supplies the vessel and crew, for their continued support of this IWC programme;*
(2) ***agrees*** *that the 2016 cruise was duly conducted following the Requirements and Guidelines of the Committee (IWC, 2012b) and looks forward to receiving abundance estimates based on these data;*
(3) ***endorses*** *the plans for the 2017 POWER cruise, thanks the USA for providing acoustic equipment and* ***recommends*** *a detailed planning meeting for the 2018 cruise;*
(4) ***recommends*** *that the USA and Russia facilitate the proposed research by providing respective permits for their national waters; and*
(5) ***looks forward*** *to receiving a report from the 2017 survey at the 2018 Committee meeting.*

23.2 Southern Ocean Research Partnership (IWC-SORP)

The Southern Ocean Research Partnership (IWC-SORP) was established in March 2009 as a multi-lateral, non-lethal scientific research program with the aim of improving the coordinated and cooperative delivery of science to the IWC. The Partnership currently has 13 member countries: Argentina, Australia, Belgium, Brazil, Chile, France, Germany, Italy, New Zealand, Norway, South Africa, the United States of America, and Luxembourg was welcomed at this meeting. New members are warmly welcomed.

There are five ongoing IWC-SORP themes:

(1) 'The Antarctic Blue Whale Project';
(2) 'Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean';
(3) 'Foraging ecology and predatorprey interactions between baleen whales and krill';
(4) 'Distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica?' focused initially on east Australia and Oceania; and
(5) 'Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean'.

Bell presented the IWC-SORP Annual Report 2016/17 on the continued progress of research undertaken researchers involved in the five themes since last year (SC/67a/SH04rev). This progress includes the production of 27 peer-reviewed publications in beginning of 2016, bringing the total number of peer-reviewed publications related to IWC-SORP since the start of the initiative to 95. In addition, 103 IWC-SORP related papers have been submitted to the Scientific Committee, 16 of them this year.

Fieldtrips were undertaken to a variety of places during the past year, in particular, the western Antarctic Peninsula, sub-Antarctic Marion Island, and the Coral Sea. Thousands of images for photo-identification have been collected; a variety of satellite tag-types deployed on Antarctic minke whales, humpback whales and killer whales; hundreds of biopsy samples collected from these same species; unmanned aerial system (UAS) imagery recorded for photogrammetry purposes; and thousands of hours of acoustic recordings have been made. The support of tour companies in providing opportunistic research platforms to facilitate these activities and external data contributors were acknowledged by the Committee.

A brief report on the IWC-SORP Research Fund was also given (SC/67a/SH04rev and SC/67a/SCP02). In 2016, £144,058 GBP were allocated to 10 projects during an open, competitive grants round. £640,421 GBP remain unallocated and unspent in the fund. A new round is planned for 2017. The Committee acknowledged and thanked all contributors to the IWC-SORP Research Fund for their voluntary contributions. The Committee also noted that since SC/66b, substantial vessel time has also been secured by IWC-SORP researchers for the 2018 and 2019 austral field seasons.

Attention: SC, G
The Committee ***acknowledges*** *the great value of the IWC-SORP (Southern Ocean Research Partnership) programme to its work. The Committee:*

(1) ***encourages*** *the continuation of the Southern Ocean Research Partnership programme;*
(2) ***commends*** *the researchers involved who are key to the overall success of the Partnership in IWC-SORP for:*
  (a) the impressive quantity of work carried out across diverse member nations;
  (b) their contributions to the work of the Committee; and
(3) ***encourages****:*
  (a) the continued development, testing and implementation of leading edge technology; and
  (b) the continued development of collaborations between ships of opportunity and external bodies that can provide platforms for research and/or contribute data, inter alia*, photo-identification data, to IWC-SORP and the wider Committee.*

The Committee also endorses the revised process for reviewing SORP project proposals (see Appendix 1 to Annex V).

23.3 National Cruises that require IWC oversight

The Committee welcomed plans for national research cruises to be conducted in the intersessional period of 2017-18. The cruises will be conducted in coastal waters of western North Africa by COMHAFAT, in the Okhotsk Sea by Russia, in the North Pacific and the Antarctic by Japan, and in the Yellow Sea by Korea. Details on the cruise plans and scientists appointed by the Committee to provide IWC oversight to these cruises are presented in Annex Q, item 5.3.

The Committee also received cruise reports from surveys conducted in the Okhotsk Sea, the western North Pacific and the Antarctic, but these were not discussed because they did not provide estimates of abundance or they did not contain information that could contribute to improve the design of future surveys.

Table 29

Work plan for cruises under IWC funding or oversight.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
IWC-POWER	- 2017 IWC-POWER cruise in the Bering Sea. - Planning Meeting for the 2018 IWC-POWER cruise.	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.
Other national cruises with IWC oversight	Develop a process to review national cruise reports by an intersessional email correspondence group.	Review new plans if presented.

Attention: SC, C-A
The Committee ***endorses*** *the proposed sighting survey plans (see Annex Q, item 5.3) and* ***encourages*** *submission of abundance estimates from these studies in the future. The Committee also* ***agrees*** *to develop a process for the review of cruise reports at future meetings in the context of lessons that they may provide with respect to the design of future surveys or the analysis of the results of those surveys.*

23.4 Work plan
The work plan is shown in Table 29.

24. COMMITTEE PRIORITIES AND INITIAL AGENDA FOR THE 2018 MEETING
Work plans for the intersessional period and the next annual meeting are provided under the relevant agenda items and Annexes (D-T). The Committee will be developing a targeted 2-year workplan at next year's meeting for the consideration of the Commission with the objective of providing the Commission (and its sub-groups) with consolidated advice for its 2020 biennial meeting.

The computing tasks/needs for the 2017/18 period are given in Table 30.

25. SCIENTIFIC COMMITTEE BUDGET FOR THE BIENNUM 2017-18

25.1 Status of previously funded research, Workshop proposals, data processing and computing needs
25.1.1 Funded proposals for the current biennium 2017-18
Table 31 summarises the status of the work funded by the Commission last year. The great majority have been completed but several are ongoing. The projects all contributed substantially to the work of the Committee and its ability to provide advice to the Commission.

25.1.2 Funded proposals in previous years still ongoing
Several projects from previous years are still ongoing. These are all still of great value to the Committee and should be completed before the 2018 SC meeting. Details of all ongoing projects can be found in SC/67a/SCP02.

25.2 Consolidated budget for the next intersessional period (up to 2018)
Last year the Committee had submitted a two-year budget to the Commission (IWC, 2017b, p.96) that had been accepted by the Commission.

Suydam summarised the budget requests for 2018 and noted that there was sufficient money already allocated to cover these requests. The Committee therefore **recommends** the budget provided in Table 32.

SC01, SC INVITED PARTICIPANTS
Invited participants (IPs) are a vital component of the working of the IWC's Scientific Committee. IPs contribute in many ways including as sub-committees and Working Groups Convenors, co-Convenor and rapporteurs, subject area experts and Convenors of intersessional groups. All sub-committees and Working Groups benefit from this budget item. The funding requested this year is particularly high as the 2018 SC meeting is expected to take place in Kenya next year, which will mean high travel and subsistence costs. This year under this budget item 45 scientists from Argentina, Australia, Canada, Chile, France, Germany, India, Japan, Mexico, the Netherlands, Norway, Oman, Russian Federation, Slovenia, South Africa, Spain, USA and UK were supported.

25.2.1 Workshops
IA01(67A), WORKSHOP FOR AN IN-DEPTH ASSESSMENT OF NORTH PACIFIC HUMPBACK WHALES
This relates to the work of the In-depth Assessments (IA) sub-committee, and follows on from the first Workshop on the Comprehensive Assessment of North Pacific humpback whales that was held in Seattle in April 2017. The Workshop will continue the work with a view to completing or significantly advancing the assessment, including the relevant population modelling.

EM01, TWO JOINT IWC-SC AND SC-CCAMLR WORKSHOPS
A joint meeting of the scientific committees of CCAMLR and the IWC is proposed for 2018 to foster collaboration between the ecosystem modelling working groups of both Commissions responsible for managing whales and marine living resources in the Southern Ocean (see Item 16.1.3 for full details). The Workshops will establish plans for data collection and analysis towards the development of multi-species/ecosystem models of pertinence to the objectives of both Commissions.

AWMP01 AND 02, AWMP WORKSHOPS
The SWG on AWMP will hold two Workshops in the 2017/18 period to complete the development of *SLA*s for the Greenland hunts (common minke and fin whales) and work on the AWS.

CMP01(67A), FIFTH WORKSHOP ON THE RANGEWIDE REVIEW OF POPULATION STRUCTURE AND STATUS OF NORTH PACIFIC GRAY WHALES
This work is a continuation of the process set in place by the Committee in 2014. This technical Workshop will allow compilation and review of the results of the simulation trials previously agreed by the Committee. It is anticipated that this will be the final Workshop and will allow the Committee to conclude its review but, as with all simulation work, this will depend upon the results.

CMP02(67A), DRAFTING GROUP TO FINALISE THE SCIENTIFIC COMPONENTS OF THE UPDATED IUCN/IWC CMP FOR WESTERN GRAY WHALES
Finalise the scientific components of the updated IUCN/IWC CMP for western gray whales in time for the stakeholder Workshop planned to occur before the 2018 Commission meeting.

BRG04, WORKSHOP ON CETACEAN TAG DEVELOPMENT, TAG IMPACT ASSESSMENT AND TAGGING BEST PRACTICES
This project is a collaboration with the US Office of Naval Research and NOAA to co-organise and fund a workshop to evaluate and provide recommendations related to cetacean tag development, tag impacts and best practices. The Workshop will take place in September 2017.

WW01, INTERSESSIONAL WORKSHOP-DATA GAPS AND MODELLING REQUIREMENTS FOR ASSESSING THE IMPACTS OF WHALEWATCHING
The extent to which whalewatching impacts cetacean populations in the long-term remains uncertain. This Workshop will build a cohesive and coordinated approach for data collection and the development of models to assess the possible impacts of whalewatching by engaging experts from outside of the current membership of the WW sub-committee.

RMP01, INTERSESSIONAL WORKSHOPS - *IMPLEMENTATION REVIEW*, NORTH PACIFIC BRYDE'S WHALES
This Workshop is essential for the Committee to conduct a full *Implementation Review* of North Pacific Bryde's whales. Conducting *Implementation Reviews* are a required activity under the Committee's Requirements and Guidelines for the RMP.

Table 30

The computing tasks/needs for the 2017/18 period.

RMP
Modify the control programs used for *Implementation Simulation Trials* to report the three measures of status (see Item 5.4).
Revise the control program for the *Implementation Review* of Western North Pacific Bryde's whales to incorporate the new models; data preparation, conditioning and running of final trials (see Item 6.5).

AWMP
Amend the control program for the North Atlantic common minke whale RMP *Implementation Review* to allow: (a) density-dependence in the proportion of the West Greenland sub-stock that feeds off West Greenland; and (b) density-dependent dispersal between the sub-stocks feeding off West Greenland, as specified in Annex E, Appendix 3. Further revise the control program to implement any changes to the trial structure if specified by the intersessional Workshop in October 2017 (Item 7.1.2).

In-depth assessment
Prepare catch and marking data series for the In-depth Assessment of North Pacific sei whales using the revised boundaries agreed at this meeting (Item 9.1.2.2).

Cetacean abundance estimates and stock status
Incorporate the abundance estimates agreed at this meeting into the IWC abundance table and upload them to the IWC website. Continue to update the IWC abundance table intersessionally (see Item 12.4).
Provide information on status from recent Implementations or *Implementation Reviews* (Items 5.4 and 12.4).

IWC databases and catalogues
Catch summary database: develop system to allow online access.
Individual catch database: develop system to allow online access, document idiosyncrasies within data.
Create a database of catches for which there are no individual data, to conform with all available summary data on the area, sex and month of these catches, to enable easy creation of future catch series.

Bycatch
Assist with entry of data into the IWC ship dtrike database (Item 22.3.3).

Sightings data
Complete validation of the 2015 POWER cruise sightings data and validate data from the 2016 cruise.
Complete validation of the 1995-97 blue whale cruise data and incorporate into the DESS database (carried over).

Table 31

Progress on Workshop and Research Proposals agreed last year (IWC, 2017b, pp.83-86), see Table 26.

SC/66a RP	Title	Relevance
SC01	Invited Participants for SC/67a.	Completed
SH09	Workshop on integration of eastern south and central Pacific blue, humpback and fin whale photo-identification.	Completed (SC/67a/Rep03)
IA01	Pre-meeting for an in-depth assessment of North Pacific humpback whales.	Completed (SC/67a/Rep08)
EM01	Joint SC-CAMLR and IWC-SC Workshop.	Ongoing (Annex L)
AWMP/ RMP01	AWMP/RMP joint intersessional Workshop.	Completed (SC/67a/Rep05; SC/67a/Rep06)
BRG02	Fourth Workshop on the rangewide review of population structure and status of NP gray whales.	Completed (SC/67a/Rep04)
BRG04	Satellite tagging best practices Workshop.	Planning in progress (Annex O)
WW01	Intersessional Workshop on data gaps and modelling requirements for assessing the impacts of whalewatching.	Planning in progress (Annex N)
RMP01	Intersessional Workshop on *Implementation Review* of North Pacific Bryde's whales.	Completed (SC/67a/Rep07)
SP01	Review SP proposal for Japan's new whale research program in the Western North Pacific.	Completed (SC/67a/Rep01)
E03	HAB pre-meeting.	Completed (SC/67a/Rep09)
AWMP02	AWMP developers fund.	Ongoing (Annex E)
SH10	Modelling analyses for future assessments of Southern Hemisphere humpback populations.	Ongoing (Annex H)
IA02	Assessment modelling for an in-depth assessment of NP sei whales.	Ongoing (SC/67a/IA02)
RMP02	Essential computing support to the Secretariat for RMP.	Completed (SC/67a/Rep07; SC/67a/Rep06; Annex D, Annex E)
BRG05	Tracking southern right whales through the southwest Atlantic.	Ongoing (Annex O)
BRG03	Passive acoustic monitoring of the eastern South Pacific right whales: improving CMP outputs.	Completed (SC/67a/CMP13)
SH05	Acoustic monitoring of pygmy blue whales in the Mozambique Channel off the northwest coast of Madagascar.	Ongoing (SC/66b/CMP12)
IA03	IWC-POWER 2016 cruise.	Completed (SC/67a/Rep02; SC/67a/IA09; Annex F)
SH01	Antarctic Humpback Whale Photo Catalogue.	Completed (SC/67a/PH03)
SH02	Southern Hemisphere Blue Whale Catalogue.	Completed (SC/67a/PH04)
SH03b	Data archiving tool for northern Indian Ocean humpback whales.	Ongoing (Annex O)
HIM01	Ship strikes database coordinator.	Completed (SC/67a/HIM08)
HIM02	Design and construction of an initial global entanglement database.	Ongoing (Annex R; Annex J)
E01	Cetacean diseases of concern.	Ongoing (SC/67a/E06)
E04	SOCER (State of the Cetacean Environment Report).	Completed (SC/67a/E05)
SC02	Follow-up from previous recommendations.	Ongoing

Table 32

Summary of budget requests for 2018 based upon the budget agreed last year. For explanation and details of each project see text and IWC, 2017b, pp. 83-86). Items in bold type are new items this year funded using the money allocated last year for such projects. Items marked '*' are for items agreed last year but for which the estimate has been changed slightly in the light of new work. Items marked '**' are ongoing items agreed last year that require no additional money.

SC/66b RP no.	Title	Relevance	2018 (£)
Meeting/Workshop			
SC01	Invited Participants - SC/67b	SC	106,035*
IA01 (67a)	Workshop for an in-depth assessment of North Pacific humpback whales	IA	11,400
EM01	Two joint SC-CAMLR and IWC-SC Workshops	EM	16,000
AWMP01	AWMP first intersessional Workshop and genetic work	AWMP, RMP	0[1]
AWMP02	AWMP second intersessional Workshop	AWMP	10,000
CMP01 (67a)	5th Workshop on the rangewide review of population structure and status of North Pacific gray whales	AWMP, E, CMP	2,500[2]
CMP02 (67a)	Drafting group to finalise the scientific components of the updated IUCN/IWC CMP for western gray whales	CMP	0[3]
BRG04	Satellite tagging best practices Workshop	BRG, SH, E	0**
WW01	Intersessional Workshop: data gaps and modelling requirements for assessing the impacts of whalewatching	WW	11,500
RMP01	Intersessional Workshop: *Implementation Review* of North Pacific Bryde's whales	RMP	10,000
RMP01 (67a)	Intersessional Workshop: *Implementation Review* for Western North Pacific minke whales (joint with Bryde's)	RMP	5,000
WW01 (67a)	Review CC strategic plan on whalewatching pre-meeting on intersessional Workshop	WW	5,000
E05/E01 (67a)	Cumulative impacts - pre-meeting or intersessional meeting	E	10,000[4]
SM01	Intersessional Workshop: resolving *Tursiops* taxonomy	SM, SD	8,500
SM01 (67a)	Intersessional Workshop: boto mortality	SM	11,865
Modelling/computing			
SH07	Defining blue whale population boundaries and estimating associated historical catches, using catch data in the Southern Hemisphere and northern Indian Ocean	SH	9,500
AWMP02	AWMP developers fund	AWMP	2,000
IA02	Assessment modelling for an in-depth assessment of North Pacific sei whales	IA	2,500
RMP02	Essential computing support to the Secretariat for RMP	RMP	10,000
E02	Pollution 2020: contaminants, data integration and mapping	E, SM	0*
Research			
BRG01	Aerial photographic survey of southern right whales on the South Africa Cape nursery ground	SH	0[5]
BRG03	Passive acoustic monitoring of the eastern South Pacific southern right whales, improving CMP outputs	CMP	14,500
SH03a	Northern Indian Ocean humpback subspecies determination-genetics	SH	7,500
IA03	IWC-POWER cruise	ASI	21,000[6]
SH01 (67a)	Coding for Australian blue whale photo catalogue	SH	2,500
E02 (67a)	Mercury in cetaceans (requested by the Commission)	E	4,000
Databases/catalogues			
SH02	Southern Hemisphere Blue Whale Catalogue	SHPH	15,500
SH08	Development of a permanent blue whale song reference library	SH	4,000
HIM01	Ship strike database coordinator	HIM	10,000
E01	Cetacean diseases of concern	E	2,000
Report			
E03 (67a)	IWC strandings initiative	E	0[7]
E04	SOCER (State of the Cetacean Environment Report)	E	3,000*
Total request			**315,800**

Notes: [1]£8,000 was the expected financial need for 2018 but savings from 2017 allowed for the reduced budget of £0; [2]£9,500 was the expected financial need for 2018 but savings from 2017 allowed for the reduced budget of £2,500; [3]£3,000 was the expected financial need for 2018 but savings from 2017 allowed for the reduced budget of £0; [4]£14,000 was the expected financial need for 2018 but savings from 2016 allowed for the reduced budget of £10,000; [5]£20,000 was the expected financial need for 2018 but the 2017 allocation was not required and so will be used to fully fund this in 2018; [6]£36,000 was the expected financial need for 2018 but savings from previous years allowed for the reduced budget of £21,000. [7]£5,915 was the expected financial need for 2018 but savings from 2017 allowed for the reduced budget of £0.

RMP01(67A), INTERSESSIONAL WORKSHOP – *IMPLEMENTATION REVIEW* FOR WESTERN NORTH PACIFIC MINKE WHALES

This Workshop is essential in order for the Committee to conduct a full *Implementation Review* for the Western North Pacific common minke whales following the Committee's Requirements and Guidelines. Conducting *Implementation Reviews* are a required activity under the RMP.

WW01(67A), REVIEW CC STRATEGIC PLAN ON WHALE-WATCHING PRE-MEETING OR INTERSESSIONAL WORKSHOP

The Conservation Committee's Standing Working Group on Whalewatching requested the WW sub-committee to review and comment on the 2011-16 Strategic Plan (SC/67a/WW01). The WW sub-committee was invited to 'provide any advice regarding what should be included in the updated Strategic Plan for 2018-24, building on the 2011-16 Strategic Plan'. This meeting will discuss and draft the recommendations from the WW sub-committee for the next iteration of the Strategic Plan to the Standing Working Group (to be presented at SC/67b for review and approval) and will develop a clear draft ToR for the WW sub-committee, with the goal to distinguish, and maximise complementarity between them. These draft ToR will be presented to the WW sub-committee at SC/67b to be finalised in 2018.

E05-E01(67A), CUMULATIVE IMPACTS PRE-MEETING OR INTERSESSIONAL WORKSHOP

Cumulative impacts have been highlighted as an area for concern given the number of stressors identified through the environmental concerns SWG. To progress this topic within the SWG and to ensure the most up to date information is available from specialists with knowledge of this broad field a pre-meeting or workshop will be held. This topic has relevance to other sub-committees such as SM and HIM.

SM01, INTERSESSIONAL WORKSHOP, RESOLVING *TURSIOPS* TAXONOMY

Tursiops taxonomy is unresolved, and considered a sufficiently important issue to merit focused attention of the SM subcommittee at the 2015-17 meetings of the SC. Following this review, information will be synthesised to develop general interpretations and practical applications for taxonomic classification for this genus, evidence for taxonomic status in regional populations and identification of important areas for further research.

SM01(67A), INTERSESSIONAL WORKSHOP- BOTO MORTALITY

Recent studies have provided evidence that the abundance of the boto has declined in parts of the Brazilian Amazon. The specific causes of the decline are not clear, but the killing of botos for use as bait in the piracatinga fisheries is a cause for concern. The Workshop will assess the geographic extent of the piracatinga/boto issue. The outcomes of the Workshop shall include: (1) a comprehensive assessment of the status of piracatinga/boto issue; (2) evaluate the efficacy of Brazil's moratorium; (3) produce recommendations to potentially improve conservation actions across all countries; and (4) a consolidated report to be presented to the SC at next year's meeting for review.

25.2.2 Modelling/computing

SH07, DEFINING BLUE WHALE POPULATION BOUNDARIES AND ESTIMATING ASSOCIATED HISTORICAL CATCHES, USING CATCH DATA IN THE SOUTHERN HEMISPHERE AND NORTHERN INDIAN OCEAN

Data on blue whales taken during commercial whaling throughout the Southern Hemisphere and the northern Indian Ocean, contain valuable information on population structure. This proposal will analyse catches in all regions and land stations to delimit population structure using the 2016 IWC databases.

AWMP02, DEVELOPERS FUND

The developers fund has been invaluable in the work of *SLA* development and related essential tasks of the SWG. It has been agreed as a standing fund by the Commission. It has been proved to be of great value in ensuring progress throughout the *SLA* development period for the Alaskan and Chukotkan hunts as well as recent work on the PCFG and Greenlandic hunts, including the completion of the *Humpback SLA* in 2015. The primary development tasks now facing the Committee are for the remaining Greenlandic fisheries.

IA02, ASSESSMENT MODELING FOR AN IN-DEPTH ASSESSMENT-NORTH PACIFIC SEI WHALES

The project involves developing and utilising population dynamics models as required to progress the in-depth assessment for North Pacific sei whales.

RMP02, ESSENTIAL COMPUTING SUPPORT TO THE SECRETARIAT FOR RMP

Regular *Implementation Reviews* are required under the RMP. An *Implementation Review* is underway for the North Pacific Bryde's whales, and more will follow. The Committee has developed a complex trials structure for *Implementation Reviews*. A key task of this process is to develop and validate the code for simulation trials. Secretariat staff alone cannot handle this complete process themselves, so computing support is needed.

E02, POLLUTION 2020: CONTAMINANTS, DATA INTEGRATION AND MAPPING

Following the focus session on the global status and tends in persistent organic pollutants (POPs) in key cetacean species, it was recognised that a web application to enable researchers to visualise and interrogate datasets would be valuable. This tool would: display data on the rate of change in POP concentrations blubber in key cetacean species and identify regions where POPs remain of concern.

25.2.3 Research

BRG01, AERIAL PHOTOGRAPHIC SURVEY OF SOUTHERN RIGHT WHALES (*EUBALAENA AUSTRALIS*) ON THE SOUTHERN CAPE NURSERY GROUND IN SOUTH AFRICA, A PROPOSAL REQUEST FOR FUNDING OF THE 2017-18 SURVEY

The South African southern right whale population has been annually surveyed since 1979 resulting in a long-term index of population size. Continuing this long-term data series is vital. This proposal seeks funding to conduct the survey in 2017/18. It is not expected that the IWC will continue to provide funding for this monitoring, but it is recommended that the South African government ensure that funding is made available to support this important long-term programme.

BRG03, PASSIVE ACOUSTIC MONITORING OF THE EASTERN SOUTH PACIFIC SOUTHERN RIGHT WHALE, A KEY TO IMPROVE CONSERVATION MANAGEMENT PLAN OUTPUTS

In 2012, the IWC adopted a CMP for South Pacific southern right whales. Only few opportunistic sightings have been recorded but the location of the breeding ground is unknown. Passive acoustic monitoring is likely the most cost-effective way to investigate the seasonal distribution along the coasts of Chile and Peru. This information is crucial to facilitate the implementation of CMP long-term monitoring programme.

SH03A, CREATION OF A REGIONAL DATA ARCHIVAL AND ANALYSIS TOOL AND EXTENDED GENETIC ANALYSIS FOR CONSERVATION OF ARABIAN SEA WHALE POPULATIONS

This project will conduct an in-depth analysis of the genetics of 92 Arabian Sea humpback whales sampled off Oman between 2000 and 2015. Analysis will determine the population's taxonomic status, kinship, social structure and degree of inbreeding.

IA03, IWC-POWER CRUISE

The Committee has strongly advocated the development of an international medium- to long-term research programme involving sighting surveys to provide information for assessment, conservation and management of cetaceans in the North Pacific, including areas that have not been surveyed for decades. Objectives have been developed for the overall plan and requested funding will allow for the continuing work of the initial phase and progress on developing the medium-term phase. The amount of money is extremely small when seen in the context of Japan providing the vessel and associated costs for two years as it has in the past. The IWC contribution is for: (1) IWC researchers and equipment; (2) to allow the Committee's Technical Advisory Group to meet to review the multi-year results thus far and develop the plans for the next phase of POWER based on the results obtained from Phase I; and (3) to enable analyses to be completed prior to the 2018 Annual Meeting.

SH01(67A), CODING FOR AUSTRALIAN BLUE WHALE PHOTO CATALOGUE

This work is vital for the preparation of photo-identification data prior to their use in a capture-recapture estimate of abundance of Australian blue whales. The entire set of photographs (1,033 images) must be quality-coded by the same person (or team of persons trained together) so that there is no subjective bias in the coding of the photos. The expected outcome will provide a clean data set of photos for inter-matching that will in turn provide the data available to be used in an estimate of abundance.

Table 33

Workshop proposals agreed during this meeting (TBD: to be decided).

Title	Relevance	Date	Venue
Implementation Review of North Pacific Bryde's whales	RMP	February 2018	Tokyo
Implementation Review for Western North Pacific minke whales (joint with Bryde's)	RMP	February 2018	Tokyo
AWMP/RMP joint intersessional Workshop	AWMP, RMP	TBD	Copenhagen
Two AWMP intersessional Workshop on development of Greenland *SLA*s	AWMP	18-21 October 2017; 20-24 March 2018	Copenhagen
Rangewide review of population structure and status of North Pacific gray whales	CMP	29-31 March 2018	La Jolla
Finalise the scientific components of updated IUCN/IWC CMP for western gray whales	CMP	1-3 April 2018	La Jolla
Workshop for an in-depth assessment of North Pacific humpback whales	IA	TBD	Seattle
IWC-POWER planning meeting	ASI	October 2017	Tokyo
SOWER volume editorial meeting	ASI	October 2017	Tokyo
Joint SC-CAMLR and IWC-SC Workshop	EM	2018	
Satellite tagging best practices Workshop	SH, E, CMP	September 2017	Maryland
Cumulative impacts - pre-meeting or intersessional meeting	E	May 2018	Kenya
Workshop: data gaps and modelling requirements for assessing the impacts of whalewatching	WW	Late 2017/Early 2018	TBD
Review CC strategic plan on whalewatching pre-meeting on intersessional workshop	SC/WW	SC 2017	TBD
Intersessional Workshop: resolving *Tursiops* taxonomy	SM	February 2018	Louisiana
Intersessional Workshop: boto mortality	SM	December 2017	São Paulo

E02(67A), MERCURY IN CETACEANS

SC/67a/E04 provided a summary review of the significant amount of data on mercury in cetacean species that have been reported globally since the first reports in the 1970s. Mercury and selenium levels provided in the review and those solicited from additional technical experts will be added to the contaminant mapping tool. In addition, a more in-depth synthesis of available data will be undertaken.

25.2.4 Databases/catalogues

SH02, SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE

The Southern Hemisphere Blue Whale Catalogue is an international collaboration to facilitate cross-regional comparison of blue whale photo-identifications catalogues. To date the catalogue contains images of 1,520 individual blue whales. The request for funding will allow for comparisons of photos among different regions, which will improve the understanding of basic questions relating to blue whale population boundaries, migratory routes, visual health assessments and modelling abundance estimates. The results will contribute to the IWC Southern Hemisphere blue whale assessments.

SH08, DEVELOPMENT OF A PERMANENT BLUE WHALE SONG REFERENCE LIBRARY

Funding will be used to develop a permanent blue whale song reference library. The work will include development of a metadata standard for data submission and data use agreements. This library will facilitate research on blue whale acoustics, as well as have potential to provide information on geographic occurrence, habitat use, and baseline song types.

HIM01, SHIP STRIKE DATABASE COORDINATOR

The ongoing development of the IWC ship strike database requires data gathering, communication with potential data providers and data/database management. This project will provide support for expanding and maintaining the database.

E01, CETACEAN DISEASES OF CONCERN (CDOC)

This project will continue and expand a website to provide an information tool for cetacean diseases (infectious and non-infectious diseases as well as lesions or findings). Work will include the design, development, content management, implementation, and maintenance of the CDoC website.

25.2.5 Reports

E03(67A), IWC STRANDINGS INITIATIVE

This is an initiative that has been proposed by the Scientific Committee, supported by the Whale Killing Methods and Welfare Issues Working Group and is likely of interest to the Conservation Committee. It will provide expertise for coordination of emergency responses, expertise on strandings procedures, diagnostics and response and capacity building for stranding networks. It will positively impact member governments, as well as the Scientific Committee and Commission. It has relevance to the SM, HIM, and E-SWG, as well as other sub committees.

E04, STATE OF CETACEAN ENVIRONMENT REPORT (SOCER)

SOCER is a long-standing effort to provide information to Commissioners and Committee members on key current global developments that are affecting the cetacean environment. Focus will be on the Mediterranean Sea for 2018, including a section on issues of global concern. Funds are for salaries, library services, and printing.

26. WORKING METHODS OF THE COMMITTEE

26.1 Interactions between the Scientific Committee and the Conservation Committee

Commission Resolution 2014-4 called for the Scientific Committee to continue to improve its work towards conservation-related matters and the establishment of a joint working group between the Conservation Committee and the Scientific Committee to propose a procedure to facilitate the implementation and follow up of conservation recommendations. An *ad hoc* working group (SC/CC) discussed ways to improve communication with the CC/SC joint working group, noted above, and the Conservation Committee in general (see Annex T). After fruitful discussion, several recommendations were made.

Attention: SC, CC, C-R

With respect to improved and effective interactions between the Scientific Committee and the Conservation Committee, the Scientific Committee:

(1) ***recommends** that a group[25] is tasked to collate near the end of the Scientific Committee meeting, a draft summary of recommendations and issues related to the Conservation Committee's Strategic Plan, for presentation to the joint Conservation Committee and Scientific Committee Working Group (CC/SC WG) for discussion. This group would meet near the end of the annual Scientific Committee meeting;*

[25]Comprised of Convenors of Scientific Committee sub-groups dealing with Conservation Committee priority topics, and Scientific Committee members familiar with the relevant issues, with assistance from the Secretariat.

(2) ***agrees*** *that a better way is needed to communicate back to it the priorities, issues of concern and activities of the Conservation Committee (and potentially other Commission bodies) - a proposed communication framework is presented in Annex T, fig. 1;*
(3) ***requests*** *the joint Conservation Committee and Scientific Committee Working Group to consider meeting for a longer period to consider agenda items related to each priority topic area; and*
(4) ***recommends*** *that the membership of the CC/SC WG be expanded so that relevant Chairs of Scientific Committee sub-committees and/or key Scientific Committee members can attend meetings depending on agenda - this will allow Scientific Committee members to offer input and assist discussion under relevant priority items (e.g. whalewatching, bycatch, marine debris, ship strikes).*

It was suggested that a potentially productive way forward on priority conservation issues – where concentrated, expert scientific input could greatly improve conservation action – would be to review the scientific aspects of a priority conservation issue (e.g. bycatch, noise) at an intersessional meeting on a focussed topic, with both Scientific and Conservation Committee members present.

It was noted that the sub-committee on whalewatching had a fruitful discussion on how it can improve communication, prevent redundancy and develop joint activities with the CC Standing Working Group on Whalewatching (see Annex N, item 4.1.2).

Attention: C-A, CC
The Committee ***agrees*** *that the proposed joint intersessional meeting to discuss the CC's new Five Year Strategic Plan for Whalewatching (see Item 18.2.1.2) could be a good model to increase Scientific Committee and Conservation Committee collaboration and communication - similar meetings could consider other topics of mutual interest that are directly relevant to the Conservation Committee's Strategic Plan and priority items.*

With respect to improved communication of the Conservation Committee's Strategic Plan and priority items, the Committee ***recommends*** *that:*

(1) *Scientific Committee convenors highlight relevant Conservation Committee issues in their opening remarks;*
(2) *consideration is given to having an agenda item discussing Conservation Committee priorities and potential joint meetings or work in sub-committee agendas; and*
(3) *voluntary conservation reports provided by Contracting Governments are made available to the Scientific Committee.*

26.2 Rules of Procedure of the Scientific Committee

The Committee reviews its working methods at each meeting. In the past two years, the Committee has worked on several improvements of its working methods (known as the 'SC Handbook') and Rules of Procedure (RoP). These included refinements (or new procedures) to: (a) improving the Scientific Committee budget review process (in 2015); (b) funding mechanisms for the IWC-SORP were brought to the Committee's attention (in 2016); (c) Annex P (both in 2015 and 2016); (d) biennial reporting (in 2015); (e) Rules of procedures related to Invited Participants, observers and submission of documents (2015 and 2016); and (f) the structural set up of the Committee (2016).

The Committee Chair, Vice-Chair, Head of Science, Convenors and Co-Convenors presented a discussion document summarising several issues raised during the intersessional period. The objective of the document (summarised in Annex V) was to start discussions to facilitate agreement of a consolidated set of revisions by consensus at the 2018 meeting. These will be then forwarded to the Commission for its endorsement. The main issues that will be considered in this context relate to: (i) communication within the Committee; (ii) RoPs on invited participants, observers and local scientists; (iii) the role and genesis of the Convenors group; and (iv) RoPs and best practices on meeting papers.

Attention: SC
Based on the discussions at this meeting, the Committee ***agrees*** *that the Chair, Vice-Chair and Head of Science in consultation with the convenors should develop a consolidated draft version of proposed revised RoPs at least one month before the next SC meeting for the Committee's final consideration. It also* ***agrees*** *to update the Scientific Committee Handbook with the material redrafted in Annex V.*

26.3 Biennial reporting and related matters

This will be discussed at next year's meeting.

26.4 Additional proposals for revisions to 'Annex P'

As noted under Item 19, the Committee will present the Commission with proposed revisions to Annex P at next year's meeting, based upon discussions last year (IWC, 2017b, p.102) and Resolution 2016-2. An intersessional correspondence group (ICG-33, Annex W) will work to develop a draft for consideration at next year's meeting.

26.5 Other matters

26.5.1 Sustainability of the IWC-SC Implementation, Implementation Review and assessment processes

At this Scientific Committee meeting the RMP *Implementation Review* of North Atlantic common minke whales was completed, a process that started in 2014 with a joint AWMP/RMP intersessional meeting on stock structure (IWC, 2015b). Although the meeting concluded that panmixia could not be ruled out across the total North Atlantic, the Workshop agreed that four stock structure hypotheses should be considered. Although simpler than the previous (1992) situation, the process turned out to need two intersessional meetings, two pre-meetings (2015 and 2016), and several full sessions at four Annual Meetings.

For this *Implementation Review* (and indeed all of them) substantial intersessional work as well as work at Workshops and annual meetings was undertaken by Punt, Allison, Donovan, de Moor and Butterworth. The current process is critically dependent on these five experts, and particularly on Allison and Punt with respect to computing and the development of operating models. Without one of the latter two, the process would probably not be carried out, or it would at least be extremely slow. A similar situation occurs for the development of *Strike Limit Algorithms* (and subsequent *Implementation Reviews*) for the AWMP.

The Committee has frequently reiterated (IWC, 2017b, p.20) that the approaches used for the RMP and AWMP are not only of specific relevance to those topics, but are of broad relevance to the work of the Committee when examining status and the effects of human-related mortality. The modelling framework and approach to dealing with uncertainty is of wide application, for example, when assessing the effects of bycatch in fishing gear or ship strikes, the rangewide assessment of gray whales and in-depth or comprehensive assessments of populations/regions.

Concern was expressed that this major development in approach might not be possible within a few years given, for example, the possible retirement and/or change in professional priorities of some of the key personnel. A variety of potential ways forward were briefly considered as a prelude to a more detailed discussion next year. These ranged from the recruitment of one or more additional experts at the Secretariat through investigating ways to simplifying or automating some of the difficult steps of the analyses chain to using the process to train scientists from Contracting Governments.

Attention: SC, C-A

The Committee ***reiterates*** *the importance of the* Implementation Review *and assessment process to its ability to provide robust management advice with respect to the effects of human activities on cetaceans, especially but not limited to direct removals. It is* ***concerned*** *that efforts be made to ensure that such work can continue to be carried out in the future. The Committee:*

(1) ***agrees*** *to look at this issue in the context of medium-, long-term strategic planning on modelling capabilities and* Implementation Reviews *and assessments in more detail at next year's meeting; and*

(2) ***establishes*** *an Intersessional Correspondence Group under the Committee's chair (ICG-34, Annex W). to identify a way or ways to address this issue. Donovan will ensure that a subset of this group will meet on the margins of planned RMP and AWMP intersessional meetings to provide the ICG with potential solutions and ideas. The ICG will report back to the next annual meeting with the intention that the Committee will present an action plan to the next Commission meeting.*

26.5.2 Use of paper

Total paper use at Scientific Committee meetings has been significantly reduced after 2009, with a total copy count down to 20% of levels pre-2009. The quantity of required copies has levelled out over the last two years indicating that we are approaching the minimum level of printing necessary.

In the past few years, efforts were made to reduce the amount of use of non-recycled paper to a minimum by pre-ordering a stock of paper that was 50% recycled and 50% standard. However, the recycled paper caused paper jams in all supplied machines when creating large or double-sided documents, so was used for small-scale printing only. The same problem was encountered at the Red House with the switch to recycled paper in 2016, so a similar mixed-use system is in place there.

27. PUBLICATIONS

Donovan reported briefly on the status of the IWC Publications. In particular he **stressed** that for the *Journal* to be successful, members of the Committee needed to become more active in two ways: (1) volunteering to act as associate editors to take responsibility for papers from receipt to publication in co-operation with the Secretariat; and (2) volunteering to act as responsible reviewers in terms of commitment and turnaround times. The *Journal* will be contacting the Committee on how to take this further in the coming weeks. The Committee **reiterated** its support for the *Journal* and **recognised** the need to take responsibility in its running. It also thanked the Secretariat staff for their hard work during the year, noting that the present Supplement was the largest ever, totalling 671pp.

Bannister reported (by correspondence) that while progress was made at a two-day editorial Workshop following the POWER Cruise Planning meeting in Tokyo, September 2016, production of final manuscripts for the Volume remains slow, with many still in review. A further editorial Workshop over three days is planned for 8-10 October 2017, in Tokyo, following the 2018 POWER Cruise Planning meeting, where it is hoped to make considerable progress towards completion of the Volume. The Committee **thanked** Bannister for his extremely hard work on the volume and **looks forward** to seeing him at the Scientific Committee next year.

28. ELECTION OF OFFICERS

There was no need for an election this year and the Committee **thanked** the chair and Vice-Chair for their excellent work.

29. ADOPTION OF REPORT

The Chair concluded the Annual Meeting by reaffirming that the IWC Scientific Committee is a highly developed machine that produces an incredible amount of excellent science and scientific advice through important intersessional work and a well-designed final consolidation system, which is its annual meeting. She noted that nothing would be possible without the dedication of each and every member. The Chair sincerely thanked the Vice-Chair, the Head of Science, all Convenors and rapporteurs, all Committee's members and the Secretariat staff for their unremitting support and hard work. She would not survive without Greg's knowledgeable and wise advice or Robert's calm and reassuring backing. She thanked the Secretariat staff for being very patient and supportive with her. She thanked the Secretary, Simon Brockington, for welcoming her into the Red House in October 2015, to start a fulfilling adventure. Given his recent resignation, she thanked Simon for his hard work and willingness to engage in a constant and open exchange of views, which was not always easy. The Chair than gave the floor to the official Master of Ceremonies, Mark Simmonds, who thanked Simon for his great contributions to the IWC, including the disappearance of paper in the Committee. Finally, the Chair of the Commission, Joji Morishita, thanked the Secretary on behalf of the Commission for his almost seven years of service and wished him the best luck for his future career.

REFERENCES

Anderson, R.C. 2014. Cetaceans and tuna fisheries in the Western and Central Indian Ocean. 133pp. IPNLF Technical Report 2, International Pole and Line Foundation, London.

Archer, F.I., Martien, K.K., Taylor, B.L., LeDuc, R.G., Ripley, B.J., Givens, G.H. and George, J.C. 2010. A simulation-based approach to evaluating population structure in non-equilibrial populations. *J. Cetacean Res. Manage.*11(2): 101-14.

Archer, F.I., Morin, P.A., Hancock-Hanser, B.L., Robertson, K.M., Leslie, M.S., Bérubé, M., Panigada, S. and Taylor, B.L. 2013. Mitogenomic phylogenetics of fin whales (*Balaenoptera physalus* spp.): Genetic evidence for revision of subspecies. *PLoS One* 8(5): e63396.

Arctic Council. 2017. Fairbanks Declaration 2017, on the occassion of the Tenth Ministerial Meeting of the Arctic Council. 8pp. [Available at: *https://www.state.gov/e/oes/rls/other/2017/270802.htm*].

Baker, C.S., Steel, D., Hamner, R.M., Hickman, G., Boren, L., Alridge, W. and Constantine, R. 2012. Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2010-11, with retrospective matching to 2001-07. 48pp. Department of Conservation, Auckland.

Bettridge, S., Baker, C.S., Barlow, J., Clapham, P.J., Ford, M., Gouveia, D., Mattila, D.K., Pace, R.M., III, Rosel, P.E., Silber, G.K. and Wade, P.R. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the endangered species act. *NOAA Tech. Mem.* NOAA-TM-NMFS-SWFSC-540: 263pp.

Branch, T.A., Zerbini, A.N. and Findlay, K. 2007. Blue whale abundance in offshore Chilean waters from the 1997/98 SOWER survey. Paper SC/59/SH8 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 9pp. [Paper available from the Office of this Journal].

Bravington, M.V., Skaug, H.J. and Anderson, E.C. 2016. Close-Kin Mark-Recapture. *Stat. Sci.* 259-74.

Calambokidis, J., Laake, J. and Perez, A. 2017. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996-2015. Paper SC/A17/GW05 presented to the rangewide workshop on gray whales, April 2017 (unpublished). 69pp. [Paper available from the Office of this Journal].

Carretta, J.V., Danil, K., Chivers, S.J., Weller, D.W., Janiger, D.S., Berman-Kowalewski, M., Hernandez, K.M., Harvey, J.T., Dunkin, R.C., Casper, D.R., Stoudt, S., Flannery, M., Wilkinson, K., Huggins, J. and Lambourn, D.M. 2016. Recovery rates of bottlenose dolphins (*Tursiops truncatus*) carcasses estimated from stranding and survival rate data. *Mar. Mamm. Sci.* 32(1): 349-62.

Cerchio, S., Andrianantenaina, B., Lindsay, A., Rakdahl, M., Andrianarivelao, N. and Rasoloarijao, T. 2015. Omura's whale (*Balaenoptera omurai*) in the northwest of Madagascar: a first ecological description of the species. Paper SC/66a/SH29rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 21pp. [Paper available from the Office of this Journal].

Currie, J.J., Stack, S.H., Easterly, S.K., Kaufman, G.D. and Martinez, E. 2015. Modelling whale-vessel encounters: the role of speed in mitigating collisions with humpback whales (*Megaptera novaeangliae*). Paper SC/66a/HIM03 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

de la Mare, W.K. 2014. Estimating relative abundance of whales from historical Antarctic whaling records. *Can. J. Fish. Aquat. Sci.* 71: 106-19.

de Vos, A. 2017. First record of Omuras whale, *Balaenoptera omuri*, in Sri Lankan waters. *Mar. Biodiversity Rec.*10: 18. [M/S: MBIR-D-17-00022].

De Vos, A., Wu, T. and Brownell, R.L., Jr. 2013. Recent blue whale deaths due to ship strikes around Sri Lanka. Paper SC/65a/HIM03 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 8pp. [Paper available from the Office of this Journal].

Department of Conservation. 2005. Guidelines for minimising acoustic disturbance to marine mammals from seismic survey operations. Wellington, New Zealand: Department of Conservation, 2005.

Doniol-Valcroze, T., Gosselin, J.-F., Pike, D., Lawson, J., Asselin, N., Hedges, K. and Ferguson, S. 2015. Abundance estimate of the Eastern Canada-West Greenland bowhead whale population based on the 2013 High Arctic Cetacean Survey. Department of Fisheries and Oceans, *Can. Sci. Advis. Sec. Res. Doc.* 2015/058. v + 27pp.

duFresne, S., Hodgson, A., Smith, J., Bennett, L., Burns, D., MacKenzie, D. and Steptoe, V. 2014. Final report: Breeding stock 'D' humpback whale pilot surveys - methods and location. Prepared for AMMC. 67pp.

Durban, J.W., Weller, D.W. and Perryman, W.L. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Paper SC/A17/GW06 presented to the rangewide workshop on gray whales, April 2017 (unpublished). 5pp. [Paper available from the Office of this Journal].

Federhen, S. 2014. Type materials in the NCBI Taxonomy Database. *Nucleic Acids Res.*: GKU1127.

Findlay, K., Thornton, M., Shabangu, F., Venter, K., Thompson, I. and Fabriciussen, O. 2014. Report of the 2013/14 South African Antarctic blue whale survey, 000°-020°E. Paper SC/65b/SH01 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 33pp. [Paper available from the Office of this Journal].

Frasier, T.R., Petersen, S.D., Postma, L., Johnson, L., Heide-Jørgensen, M.P. and Ferguson, S.H. 2015. Abundance estimates of the Eastern Canada-West Greenland bowhead whale (*Balaena mysticetus*) population based on genetic capture-mark-recapture analyses. Department of Fisheries and Oceans, *Can. Sci. Advis. Sec. Res. Doc.*, 2015/008. iv + 21pp.

Fujino, K. 1960. Immunogenetic and marking approaches to identifying subpopulations of the North Pacific whales. *Sci. Rep. Whales Res. Inst., Tokyo* 15: 85-142.

Gagnon, C. 2016. Western gray whale activity in the East China Sea from acoustic data: memorandum for Dr Brandon Southall. Paper IWC/66/CC29 presented to the 66th Meeting of the International Whaling Commission, 24-28 October 2016, Portoroz, Slovenia (unpublished). 2pp. [Paper available from the Office of this Journal].

Gedamke, J. 2009. Geographic variation in Southern Ocean fin whale song. Paper SC/61/SH16 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 8pp. [Paper available from the Office of this Journal]

George, J.C., Sheffield, G., Reed, D.J., Tudor, B., Stimmelmayr, R., Person, B.T., Sformo, T. and Suydam, R. 2017. Frequency of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort seas bowhead whales. *Arctic* 70(1): 37-46.

Givens, G.H. 2016. On the simple carryover of strikes. Paper SC/D16/AWMP05 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 6pp. [Paper available from the Office of this Journal].

Gleason, C. 2016. The impacts of the International Whaling Commission's Whalewatching Sub-committee. Paper SC/66b/WW12 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Gleason, C. and Parsons, E.C.M. 2015. An initial review of whalewatching guidelines for endangered and critically endangered cetaceans. Paper SC/66a/WW09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 12pp. [Paper available from the Office of this Journal].

Government of Australia. 2016. Report on the Indian Ocean Rim Association (IORA) Sustainable Whale and Dolphin Watching Tourism Workshop, Colombo, Sri Lanka, 24-26 February 2016. Paper IWC/66/CC03 presented to the 66th Meeting of the International Whaling Commission, 24-28 October 2016, Portoroz, Slovenia (unpublished). 3pp. [Paper available from the Office of this Journal].

Government of Japan. 2015. Proposed research plan for new scientific whale research program in the Antarctic Ocean (NEWREP-A). Paper SC/F15/Document presented to the Newrep-A Special Permit Expert Panel Review Workshop, February 7-10 2015, Tokyo, Japan (unpublished). 101pp. [Paper available from the Office of this Journal].

Government of Japan. 2016a. Progress report of the work conducted by the proponents in response to IWC Scientific Committee's recommendations on NEWREP-A. Paper SC/66b/SP09 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Government of Japan. 2016b. Results of the analytical work on NEWREP-A recommendations on sample size and relevance of age information for the RMP. Paper SC/66b/SP10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 24pp. [Paper available from the Office of this Journal].

Hale, P.T., Barreto, A.S. and Ross, G.J.B. 2000. Comparative morphology and distribution of the *aduncus* and *truncatus* forms of bottlenose dolphin *Tursiops* in the Indian and Western Pacific Oceans. *Aquat. Mamm.* 26(2): 101-10.

Hamner, R.M., Constantine, R., Mattlinc, R., Waples, R. and Baker, C.S. In press. Genotype-based estimates of local abundance and effective population size for Hector's dolphins. *Biol. Cons.* [Available at: *http://dx.doi.org/10/1016/j.biocon.2017.02.044*].

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.S., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2016. Abundance of whales in east and west Greenland in 2015. Paper SC/D16/AWMP06rev1 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 38pp. [Paper available from the Office of this Journal].

Haug, T., Bogstad, B., Chierici, M., Gjter, H., Hallfredsson, E.H., Hoslashines, A.S., Haringkon Hoel, A., Ingvaldsen, R.B., Lindal Jorgensen, L., Knutsen, T., Loeng, H., Naustvoll, L.J., Rottingen, I. and Sunnanring, K. 2017. Future harvest of living resources in the Arctic Ocean north of the Nordic and Barents Seas: A review of possibilities and constraints. *Fish. Res.* 188: 38-57.

Hill, A.N., Karniski, C., Robbins, J., Pitchford, T., Todd, S. and Asmutis-Silva, R. 2017. Vessel collision injuries on live humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. *Mar. Mamm. Sci.*: 17pp.

Hoban, S., Bertorelle, B. and Gaggiotti, O.E. 2012. Computer simulations: tools for population and evolutionary genetics (L Orlando, Ed,). *Nature. Rev. Genet.* 13: 110-22.

Ichihara, T. 1957. An application of linear discriminant function to external measurements of fin whale. *Sci. Rep. Whales Res. Inst., Tokyo* 12: 127-89.

International Whaling Commission. 1995. Chairman's Report of the Forty-Sixth Annual Meeting, Appendix 4. IWC Resolution 1994-4. Resolution on a Review of Aboriginal Subsistence Management Procedures. *Rep. Int. Whal. Comm.* 45:42-43.

International Whaling Commission. 1996. Chairman's Report of the Forty-Seventh Annual Meeting. Appendix 11. IWC Resolution 1995-10. Resolution on the environment and whale stocks. *Rep. Int. Whal. Comm.* 46:47-48.

International Whaling Commission. 1997. Chairman's Report of the Forty-Eighth Annual Meeting, Appendix 8. IWC Resolution 1996-8. Resolution on environmental change and cetaceans. *Rep. Int. Whal. Comm.* 47:52.

International Whaling Commission. 1998. Chairman's Report of the Forty-Ninth Annual Meeting. Appendix 7. IWC Resolution 1997-7. Resolution on environmental change and cetaceans. *Rep. Int. Whal. Comm.* 48:48-49.

International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whal. Commn.* 1998:43-44.

International Whaling Commission. 2000. Chairman's Report of the Fifty-First Annual Meeting. Appendix 9. IWC Resolution 1999-8. Resolution on DNA testing. *Ann. Rep. Int. Whal. Commn.* 1999:55.

International Whaling Commission. 2001. Chairman's Report of the 52nd Annual Meeting. *Ann. Rep. Int. Whal. Commn.* 2000:11-63.

International Whaling Commission. 2003. Chair's Report of the Fifty-Fourth Annual Meeting. *Ann. Rep. Int. Whal. Commn.* 2002:1-53.

International Whaling Commission. 2004a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 6:1-60.

International Whaling Commission. 2004b. Report of the Scientific Committee. Annex T. Report of the data availability working group. *J. Cetacean Res. Manage. (Suppl.)* 6:406-08.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 7:327-32.

International Whaling Commission. 2006. Report of the IWC Scientific Committee Workshop on Habitat Degradation, 12-15 November 2004, Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 8:313-35.

International Whaling Commission. 2008a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1-74.

International Whaling Commission. 2008b. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 10:207-24.

International Whaling Commission. 2009. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2010a. Chairman's Report of the Sixty-First Annual Meeting, Annex F. IWC Resolution 2009-1. Consensus Resolution on Climate and Other Environmental Changes and Cetaceans. *Ann. Rep. Int. Whal. Commn.* 2009:95.

International Whaling Commission. 2010b. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.

International Whaling Commission. 2011a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 12:1-75.

International Whaling Commission. 2011b. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. *J. Cetacean Res. Manage. (Suppl.)* 12:399-411.

International Whaling Commission. 2012a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 13:1-74.

International Whaling Commission. 2012b. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2012c. Requirements and Guidelines for *Implementations* under the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 13:495-506.

International Whaling Commission. 2013a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.

International Whaling Commission. 2013b. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 14:118-36.

International Whaling Commission. 2013c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). Appendix 7. Draft guidelines for AWMP *Implementation Reviews*. *J. Cetacean Res. Manage. (Suppl.)* 14:170-71.

International Whaling Commission. 2014a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.

International Whaling Commission. 2014b. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 15:112-88.

International Whaling Commission. 2014c. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 15:87-111.

International Whaling Commission. 2014d. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 15:250-70.

International Whaling Commission. 2015a. Report of the AWMP Intersessional Workshop on Developing *SLA*s for the Greenland hunts, 8-11 January 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:433-58.

International Whaling Commission. 2015b. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

International Whaling Commission. 2015c. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 16:1-87.

International Whaling Commission. 2015d. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 16:196-221.

International Whaling Commission. 2015e. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 16:291-319.

International Whaling Commission. 2016a. Report of the 65th Meeting of the International Whaling Commission. Annex E. Resolutions Adopted at the 65th Meeting. Resolution 2014-1. Resolution on Aboriginal Subsistence Whaling (ASW). *Rep. 65th Meet. Int. Whal. Comm.* 2014:46.

International Whaling Commission. 2016b. Report of the Expert Panel to Review the Proposal by Japan for NEWREP-A, 7-10 February 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 17:507-54.

International Whaling Commission. 2016c. Report of the joint NMFS-IWC Preparatory Workshop Towards Ensemble Averaging of Cetacean Distribution Models, 21 May 2015, San Diego, CA, USA. *J. Cetacean Res. Manage. (Suppl.)* 17:599-610.

International Whaling Commission. 2016d. Report of the RMP Intersessional Workshop on the *Implementation Review* for North Atlantic Fin Whales, 16-20 February 2015, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 17:485-94.

International Whaling Commission. 2016e. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 17:1-92.

International Whaling Commission. 2016f. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 17:185-203.

International Whaling Commission. 2016g. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). Appendix 6. Trial structure for proposed testing of some AWS provisions for the *Bowhead SLA*. *J. Cetacean Res. Manage. (Suppl.)* 17:201-03.

International Whaling Commission. 2016h. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 17:250-82.

International Whaling Commission. 2016i. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 17:385-98.

International Whaling Commission. 2016j. Report of the Second Workshop on Mortality of Southern Right Whales (*Eubalaena australis*), 5-6 August 2014, Puerto Madryn, Chubut, Argentina. *J. Cetacean Res. Manage. (Suppl.)* 17:583-98.

International Whaling Commission. 2017a. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.

International Whaling Commission. 2017b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

International Whaling Commission. 2017c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 18:174-84.

International Whaling Commission. 2017d. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. Appendix 2. Some ideas on draft principles and scientific provisions of a potential Aboriginal Whaling Scheme (AWS). *J. Cetacean Res. Manage. (Suppl.)* 18:181-84.

International Whaling Commission. 2017e. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

International Whaling Commission. 2017f. Report of the Scientific Committee. Annex N. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 18:387-97.

International Whaling Commission. 2017g. Report of the Workshop on Acoustic Masking and Whale Population Dynamics, 4-5 June 2016, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 18:615-27.

International Whaling Commission and CCAMLR. 2010. Report of the Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models,11-15 August 2008, Hobart, Australia. *J. Cetacean Res. Manage. (Suppl.)* 11(2):541-86.

Jarman, S.N., Polanowski, A.M., Faux, C.E., Robbins, J., De Paoli-Iseppi, R., Bravington, M. and Deagle, B.E. 2015. Molecular biomarkers for chronological age in animal ecology. *Mol. Ecol.* 24: 4,826-47. [Available at: doi:10.1111/mec.13357].

Jedensjö, M., Kemper, C., Allen, S., Bejder, L., Parra, G.J., Cagnazzi, D., Palmer, C. and Krützen, M. 2013. Osteological and genetic variation question the occurrence of three species of bottlenose dolphins (*Tursiops* spp.) in Australia. Presented to the 20th Biennial Conference on the Biology of Marine Mammals, 9-13 December 2013, Dunedin, New Zealand.

Jepson, P.D., Deaville, R., Barber, J., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, B., Barnett, J., Berrow, S., Cunningham, A., Davison, N., Esteban, R., Ferreira, M., Foote, A., Genov, T., Gimenez, J., Loveridge, J., Llavona, A., Martin, V., Maxwell, D., Papachlimitzou, A., Penrose, R., Perkins, M., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A. and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.* 6: Article number: 18573. doi:10.1038/srep73.

Kanda, N., Bando, T., Matsuoka, K., Murase, H., Kishiro, T., Pastene, L.A. and Ohsumi, S. 2015. A review of the genetic and non-genetic information provides support for a hypothesis of a single stock of sei whales in the North Pacific. Paper SC/66a/IA09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

Kemper, C.M. 2004. Osteological variation and taxonomic affinities of bottlenose dolphins, *Tursiops* spp., from South Australia. *Aust. J. Zool.* 52: 29-48.

Kershaw, F., Carvalho, I., Loo, J., Pomilla, C., Best, P.B., FIndlay, K., Cerchio, S., Collins, T., Engel, M.H., Minton, G., Ersts, P., Barendse, J., Kotze, P.G.H., Razafindrakoto, Y., Ngouessono, S., Meÿer, M., Thorton, M. and Rosenbaum, H.C. 2017. Multiple processes drive genetic structure of humpback whale (*Megaptera novaeangliae*) populations across spatial scales. *Mol. Ecol.:* 0962-1083.

Knowlton, A.R., Robbins, J., Landry, S., McKenna, H.A., Kraus, S.D. and Werner, T.B. 2016. Effects of fishing rope strength on the severity of large whale entanglements. *Conserv. Biol.* 30(2): 318-28. [Available at: doi: 10.1111/cobi.12590].

Kraus, S., Kennedy, R., Mayo, C., McLellan, W.A., Moore, M.J. and Nowacek, D. 2016. Recent Scientific Publications Cast Doubt on North AtlanticRight Whales Future. *Front. Mar. Sci.* 3: pp137. [Available at: doi: 10.3389/fmars.2016.00137].

Laffoley, D. and Baxter, J.M. 2016. Explaining ocean warming: Causes, scale, effects and consequences. 456pp. Gland, Switzerland. IUCN [Available at: doi: 10.2305/IUCN.CH.2016.08.en].

Lah, L., Trense, D., Benke, H., Berggren, P., Gunnlaugsson, Þ. and Lockyer, C. 2016. Spatially Explicit Analysis of Genome-Wide SNPs Detects Subtle Population Structure in a Mobile Marine Mammal, the Harbor Porpoise. *PLoS ONE* 11(10): e0162792. [Available at: https://doi.org/10.1371/journal.pone.0162792].

Laist, D., Knowlton, A. and Pendleton, D. 2014. Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. *Endang. Spec. Res.* 23: 133-47.

Lang, A. and Martien, K. 2012. Using a simulation-based approach to evaluate plausible levels of recruitment into the Pacific Coast Feeding Group of gray whales: Progress report and preliminary results. Paper SC/M12/AWMP4 presented to the AWMP Gray Whale *Implementation Review* and Greenland Hunt *SLA* Development Workshop, 19-23 March 2012, La Jolla, USA (unpublished). [Paper available from the Office of this Journal].

LeDuc, R.G., Archer, E.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.R., van Waerebeek, K., Brownell Jr, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern Pacific: implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26: 740-51. [Available at: doi:10.1111/mec.13940].

Li, H. and Durbin, R. 2011. Inference of human population history from individual whole-genome sequences. *Nature* 475(7357): 493-6.

Malde, K., Seliussen, B.B., Quintela, M., Dahle, G., Besnier, F., Skaug, H.J., Oien, N., Solvang, H.K., Haug, T., Skern-Mauritzen, R., Kanda, N., Pastene, L.A., Jonassen, I. and Glover, K.A. 2017. Whole genome resequencing reveals diagnostic markers for investigating global migration and hybridization between minke whale species. *BMC Genomics* 18: 76pp.

Martien, K.K., Gregovich, D., Bravington, M.V., Punt, A.E., Strand, A.E., Tallmon, D.A. and Taylor, B.L. 2009. TOSSM: an R package for assessing performance of genetic analytical methods in a management context. *Mol. Ecol. Res.* 9(6): 1,456-59.

Matsuoka, K. and Hakamada, T. 2014. Estimates of abundance and abundance trend of the blue, fin and southern right whales in the Antarctic Areas IIIE-VIW, south of 60S, based on JARPA and JARPAII sighting data (1989/20-2008/09). Paper SC/F14/J05 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 27pp. [Paper available from the Office of this Journal]

Mizroch, S.A., Conn, P.B. and Rice, D.W. 2016. REVISE OF SC/66a/IA14: The mysterious sei whale: its distribution, movements and population decline in the North Pacific revealed by whaling data and recoveries of Discovery-type marks. Paper SC/66b/IA20 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 129pp. [Paper available from the Office of this Journal].

Mori, M. and Butterworth, D.S. 2006. Further progress on modeling the krill-predator dynamics of the Antarctic ecosystem. Paper SC/58/E14 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 14pp. [Paper available from the Office of this Journal].

Morishita, J., DeMaster, D.P., Ilyashenko, V., Zharikov, K. and IWC Secretariat. 2016. Report of the Small Group to develop an approach to address the question of 'stinky' whales in the Chukotka hunt. Paper IWC/66/21 presented to the 66th Meeting of the International Whaling Commission, 24-28 October 2016, Portoroz, Slovenia (unpublished). 1pp. [Paper available from the Office of this Journal].

National Academies of Sciences Engineering and Medicine. 2016. Approaches to understanding the cumulative effects of stressors on marine mammals. 4pp.

Pace, R.M., Cole, T.V.N. and Henry, A.G. 2014. Incremental fishing gear modifications fail to significantly reduce large whale serious injury rates. *Endang. Spec. Res.* 26(115-126).

Pagel, C.D., Scheer, M. and Lück, M. 2016. Swim encounters with killer whales (Orcinus orca) off Northern Norway: interactive behaviours directed towards human divers and snorkellers obtained from opportunistic underwater video recordings. *J. Ecotour.* [Available at: DOI: 10.1080/14724049.2016.1273939].

Parsons, E.C.M., Classen, J.M. and Bauer, A. 2004. Recent advances in whale-watching research. Paper SC/56/WW6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 13pp. [Paper available from the Office of this Journal].

Pastene, L.A., Acevedo, J., Siciliano, S., Sholl, T.G.C., de Moura, J.F., Ott, P.H. and Aguayo-Lobo, A. 2015. Population genetic structure of the South American Bryde's whale. *Revista de Biologia Marina y Oceanografia* 50(3): 453-64.

Pastene, L.A., Goto, M., Taguchi, M. and Kitakado, T. 2016a. Temporal and spatial distribution of the 'J' and 'O' stocks of common minke whale in waters around Japan based on microsatellie DNA. Paper SC/F16/JR38 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 15pp. [Paper available from the Office of this Journal].

Pastene, L.A., Goto, M., Taguchi, M. and Kitakado, T. 2016b. Updated genetic analyses based on mtDNA and microsatellite DNA suggest possible stock differentiation of Bryde's whales between management sub-areas 1 and 2 in the North Pacific. Paper SC/F16/JR44 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].

Pastene, L.A. and Yoshida, H. 2015. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. Appendix 4. Additional genetic analyses on stock structure in the North Pacific sei whale. *J. Cetacean Res. Manage. (Suppl.)* 16: 193.

Peltier, H., Authier, M., Deaville, R., Dabin, W., Jepson, P.D., Van Canneyt, O., Daniel, P. and Ridoux, V. 2016. Small cetacean bycatch as estimated from stranding schemes: the common dolphin case in the northeast Atlantic. *Environ. Sci. Pol.* 63(2016): 7-18.

Perrin, W.F. and Myrick, A.C. 1980. Age determination of toothed whales and sirenians. *Rep. Int. Whal. Commn.*: 229pp.

Polanowski, A.M., Robbins, J., Chandler, D. and Jarman, S.N. 2014. Epigenetic estimation of age in humpback whales. *Mol. Ecol. Resour.* 14(5): 976-87.

Priyadarshana, T., Randage, S.M., Alling, A., Calderan, S., Gordon, J., Leaper, R. and Porter, L. 2016. Distribution patterns of blue whale (*Balaenoptera musculus*) and shipping off southern Sri Lanka. *Regional Studies in Marine Science* 3: 181-88.

Redfern, J.V., Moore, T.J., Fiedler, P.C., De Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23: 394-408. [available at: wileyonlinelibrary.com].

Reeves, R.R., Lund, J.N., Smith, T.D. and Josephson, E. 2011. Insights from whaling logbooks on whales, dolphins and whaling in the Gulf of Mexico. *Gulf Mex. Sci.* 29: 41-67.

Reyes Reyes, M.V., Iniguez Bessega, M.A. and Dolman, S.J. 2016. Review of legislation applied to seismic surveys to mitigate effects on marine mammals in Latin America. *Proceedings of Meetings on Accoustics*. 27(032002)..

Robbins, J., Knowleton, A.K. and Landry, S. 2015. Apparent survival of North Atlantic right whales after entanglement in fishing gear. *Biol. Conserv.* 191: 421-7.

Robbins, J., Landry, S. and Mattila, D.K. 2009. Estimating entanglement mortality from scar-based studies. Paper SC/61/BC3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 4pp. [Paper available from the Office of this Journal].

Rone, B., Zerbini, A., Douglas, A., Weller, D.W. and Clapham, P. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. *Mar. Biol.* 164: 1-23.

Rosel, P.E., Corkeron, P., Engleby, L., Epperson, D., Mullin, K., Soldevilla, M.S. and L., T.B. 2016. Status review of Bryde's whales (*Balaenoptera edeni*) in the Gulf of Mexico under the Endangered Species Act. *NOAA Tech. Memo.* NMFS-SEFSC-692.

Ross, P.S., Dungan, S.Z., Hung, S.K., Jefferson, T.A., MacFarquhar, C., Perrin, W.F., Riehl, K., Slooten, E., Wang, J.Y., White, B.N., Würsig, B., Yang, S.C. and Reeves, R.R. 2010. Averting the Baiji syndrome: characterising habitat for critically endangered dolphins in eastern Taiwan Strait. *Aquatic Conservation: Mar. Freshw. Ecosyst.* 20: 685-94.

Schwacke, L.H., Zolman, E.S., Balmer, B.C., De Guise, S., George, R.C., Hoguet, J., Hohn, A.A., Kucklick, J.R., Lamb, S., Levin, M., Litz, J.A., McFee, W.E., Place, N.J., Townsend, F.I., Wells, R.S. and Rowles, T.K. 2012. Anaemia, hypothyroidism and immune suppression associated with polychlorinated biphenyl exposure in bottlenose dolphins (*Tursiops truncatus*). *Proc. Roy. B.* 279: 48-57.

Shabangu, F.W., Yemane, D., Stafford, K.M., Ensor, P. and Findlay, K.P. 2017. Modelling the effects of environmental conditions on the acoustic occurrence and behaviour of Antarctic blue whales. *PLoS One* 12(2): e0172705.

Simmonds, M.P. 2016. Impacts and effects of ocean warming on marine mammals. pp.303-20. *In*: Laffoley, D. and Baxter, J.M. (eds). *Explaining ocean warming: Causes, scale, effects and consequences. Full report*. IUCN, Gland, Switzerland. Available here: https://portals.iucn.org/library/node/46254.

Slooten, E., Wang, J., Dungan, S., Forney, K., Hung, S.K., Jefferson, T., Riehl, K., Rojas-Bracho, L., Ross, P., Wee, A., Winkler, R., Yang, S. and Chen, C. 2013. Impacts of fisheries on the Critically Endagered humpback dolphin *Sousa Chinesis* population in the eastern Taiwan Strait. *Endang. Spec. Res.* 22: 99-114.

Thomisch, K., Boebel, O., Clark, C.W., Hagen, W., Spiesecke, S., Zitterbart, D.P. and Van Opzeeland, I. 2016. Spatio-temporal patterns in acoustic presence and distribution of Antarctic blue whales *Balaenoptera musculus intermedia* in the Weddell Sea. *Endang. Spec. Res.* 30: 239-53.

Torres, L., Rayment, W.J., Olavarría, C., Thompson, D., Graham, B., Baker, C.S., Patenaude, N., Bury, S.J., Boren, L., Parker, G. and Carroll, E.L. 2016. Demography and ecology of southern right whales *Eubalaena australis* wintering at sub-Antarctic Campbell Island, New Zealand. *Polar Biol.* 40(1): 95-106.

Vacquié-Garcia, J., Lydersen, C., Marques, T.A., Aars, J., Ahonen, H., Skern-Mauritzen, M., Øien, N. and Kovacs, K.M. 2017. Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endang. Spec. Res.* 32: 59-70. [Available at: DOI: 10.3354/esr00791].

Vail, C.S. 2016. An overview of increasing incidents of bottlenose dolphin harassment in the gulf of Mexico and possible solutons. *Front. Mar. Sci.* 3(110). [Available at: doi: 10.3389/fmars.2016.00110].

van der Hoop, J.M., Corkeron, P., Henry, A.G., Knowlton, A.R. and Moore, M.J. 2016. Predicting lethal entanglements as a consequence of drag from fishing gear. *Mar. Poll. Bull.*: 14pp.

Wada, S., Oishi, M. and Yamada, T.K. 2003. A newly discovered species of living baleen whale. *Nature* 426: 278-81.

Wade, P.R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. *Mar. Mamm. Sci.*14(1): 1-37.

Wade, P.R. and Baker, C.S. 2012. High plausibility of Hypothesis III for stock structure of the western North Pacific minke. Paper SC/64/NPM11 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 7pp. [Paper available from the Office of this Journal].

Wang, J.Y., Riehl, K.N., Klein, M.N., Javdan, S., Hoffman, J.M., Dungan, S.Z., Dares, L.E. and Araujo-Wang, C. 2016. Biology and Conservation of the Taiwanese humpback dolphin. *Adv. Mar. Biol.* 73: 28pp.

Weinstein, B.G., Double, M., Gales, N., Johnston, D.W. and Friedlaender, A.S. 2017. Identifying overlap between humpback whale foraging grounds and the Antarctic krill fishery. *Biol. Cons.* 210: 184-91.

Williams, R., Burgess, M.G., Ashe, E., Gaines, S.D. and Reeves, R.R. 2016. U.S. seafood import restriction presents opportunity and risk. *Science* 354(6318): 1,372-5.

WWF and FiA. 2017. Report of the International Workshop on the Conservation of Irrawaddy Dolphins in the Mekong River.

Yasunaga, G., Mogoe, T., Tamura, T., Yoshida, H., Bando, T. and Kato, H. 2017. Results of the feasibility study on non-lethal techniques to address the key research objective of JARPNII, based on data and samples obtained in the period 2014-2016. Paper SC/J17/JR03 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 39pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

(I)=Interpreter, (H)=Head of Delegation, (AH)=Alternate Head of Delegation)

ANTIGUA AND BARBUDA
Tricia Lovell (H)

ARGENTINA
Miguel Iñíguez (H)

AUSTRALIA
William de la Mare (H)
Michael Double (AH)
Elanor Bell
John McKinlay
Deb Callister

AUSTRIA
Michael Stachowitsch (H)

BELGIUM
Fabian Ritter (H)
Stephanie Langerock (AH)
Els Vermeulen

BRAZIL
Rodrigo de Almeida (H)
Alexandre Zerbini
Pedro Fruet

COLOMBIA
Ana Maria Gonzalez (H)

COSTA RICA
Eugenia Arguedas (H)
Javier Rodríguez-Fonseca

CÔTE D'IVOIRE
Nda Konan (H)

CROATIA
Ana Štrbenac (H)
Katja Jelić

DENMARK
Lars Witting (H)

FRANCE
Vincent Ridoux (H)

GERMANY
Nicole Hielscher (H)
Elke Burkhardt

GUINEA, REP. OF
Samba Diallo (H)

ICELAND
Gisli Víkingsson (H)
Thorvaldur Gunnlaugsson
Christophe Pampoulie

ITALY
Giancarlo Lauriano (H)
Simone Panigada
Caterina Fortuna
Sandro Mazzariol

JAPAN
Toshihide Kitakado (H)
Joji Morishita (AH)
Luis Pastene (AH)
Hideyoshi Yoshida (AH)
Yoshihiro Fujise
Tsutomu Tamura
Mutsuo Goto
Takashi Hakamada
Genta Yasunaga
Kenji Konishi
Tatsuya Isoda
Mioko Taguchi
Dan Goodman
Tomio Miyashita
Hikari Maeda
Gen Nakamura
Hideki Moronuki
Yuki Morita
Hiroyuki Morita
Haruya Kumakiri
Kazunari Tanaka
Yukiya Tsuno
Ryo Futagoishi
Yoshihiro Takagi (I)
Saemi Baba (I)
Hiroko Yasokawa (I)

KENYA
Jane Kinya (H)
Susan Imende

KOREA, REP. OF
Jung Youn Park (H)
Hyun Woo Kim (AH)
Kyum Joon Park
Kyunglee Lee
Hyun Young Kim

LUXEMBOURG
Pierre Gallego (H)
Melania Andrea Cosentino

NETHERLANDS
Meike Scheidat (H)
Anja Pel-Roest

NEW ZEALAND
David Lundquist (H)
Julia Reynolds

NORWAY
Tore Haug (H)
Arne Bjørge
Nils Øien
Katherine Ryeng
Hans-Julius Skaug
Hiroko Solvang

PORTUGAL
Marina Sequeira (H)
Luis Antonio de Andrade Freitas (AH)

RUSSIAN FEDERATION
Kirill Zharikov (H)
Pavel Gushcherov
Natalia Slugina
Ayvana Enmikau

SAINT LUCIA
Horace Walters (H)
Thomas Nelson

SLOVENIA
Andrej Bibič (H)

SPAIN
Begoña Santos (H)
Raquel García Vernet
Graham Pierce

SWITZERLAND
Patricia Holm (H)

UK
Stuart Reeves (H)
Sarah Baulch
Catherine Bell
Ailsa Hall
Russell Leaper
Jamie Rendell
Mark Simmonds

USA
Debbie Palka (H)
Amy Baird
Scott Baker
John Bickham
Robert Brownell
Danielle Cholewiak
Phil Clapham
Carolyn Doherty
John Craig George
Geof Givens
Denise Greig
Yulia Ivashchenko
Aimee Lang
Kristen Long
Sarah Mallette
Sue Moore
Patricia Rosel
Howard Rosenbaum
Teri Rowles
Jonathan Scordino
Claire Simone
Raphaela Stimmelmayr
Robert Suydam
Peter Thomas
Vera Trainer
Paul Wade
David Weller
Gina Ylitalo

INVITED PARTICIPANTS
Alex Aguilar
Aida al-Jabri
Rob Baldwin
Mark Belchier
Alessandro Bocconcelli
Anabela Brandão
Mark Bravington
Doug Butterworth
Ana Cañadas
Cristina Castro
Frank Cipriano
Tim Collins
Enrique Crespo
Hannah Cubaynes
Céline Cunen
Rohan Currey
Carryn De Moor
Andrew DeWoody
Wang Ding
Giuseppe Notarbartolo di Sciara
Simon Elwen
Olga Filatova
Ken Findlay
Peter Fretwell
Silvia Frey
Ari Friedlaender
Naoko Funahashi
Barbara Galletti
Tilen Genov
Patricia Glibert
Frances Gulland
Helena Herr
Jefferson Hinke
Nils Lid Hjort
Rus Hoelzel
Jennifer Jackson
Kelli Johnson
Hidehiro Kato
Greg Kaufman
Nachiket Kelkar
Barbara Kilpatrick
Aimee Leslie
Matt Leslie
Dennis Litovka
Bruce Mate
Koji Matsuoka
Brian Miller
David Miller
Gianna Minton
Sally Mizroch
Hiroto Murase
Ada Natoli
Leslie New
Simon Northridge
Paula Olson
Hans Paerl
Guido Parra
Chris Parsons
Shambhu Paudel
Somany Phay
Lindsay Porter
André Punt
Jessica Redfern
Randall Reeves
Vanesa Reyes
Jooke Robbins
Tracey Rogers
Lorenzo Rojas-Bracho
Naomi Rose
Flore Samaran
Lori Schwaeke
Ana Širović
Liz Slooten
Dipani Sutaria
Ralph Tiedemann
Juan Pablo Torres-Florez
Jorge Urbán-Ramirez
Fran Van Dolah
Andrew Von Duyke
Koen Van Waerebeek
Lars Walløe
Mason Weinrich
Andrew Willson
Maria Zicos

CONVENORS
Elanor Bell
Robert Brownell, Jr.
Doug Butterworth
Tim Currey
Greg Donovan
Mike Double
Ailsa Hall
Helena Herr
Jen Jackson
Toshihide Kitakado
Aimee Lang
Russell Leaper
Brendan Miller
Paula Olson
Debi Palka
Chris Parsons
Lindsay Porter
Jooke Robbins
Lorenzo Rojas-Bracho
Teri Rowles
Meike Scheidat
Robert Suydam
Ralph Tiedemann
Jorge Urban-Ramirez
Lars Walløe
Alex Zerbini

INTERGOVERNMENTAL ORGANISATIONS

ACCOBAMS
Simone Panigada

PICES
Tsutomu Tamura

INTERNATIONAL ORGANISATIONS

IUCN
Justin Cooke

OBSERVERS

Centro de Conservacion Cetacea
Elsa Cabrera

EIA
Danie Hubbell

IWC SECRETARIAT
Cherry Allison
Simon Brockington
Andrea Cooke
Julie Creek
Greg Donovan
Stella Duff
Sarah Ferriss
Marion Hughes
Jemma Jones
David Mattila
Brendan Miller
David Peers
Jess Peers
Katie Penfold
Sarah Smith
Mark Tandy
Kate Wilson

Annex B

Agenda

1. Introductory items
    - 1.1 Chair's welcome and opening remarks
    - 1.2 Appointment of rapporteurs
    - 1.3 Meeting procedures and time schedule
    - 1.4 Establishment of sub-committees and working groups
    - 1.5 Computing arrangements

2. Adoption of Agenda

3. Review of available data, documents and reports
    - 3.1 Documents submitted
    - 3.2 National Progress Reports on research
    - 3.3 Data collection, storage and manipulation
        - 3.3.1 Catch data and other statistical material
        - 3.3.2 Progress of data coding projects
        - 3.3.3 Progress on programme verification projects

4. Cooperation with other organisations
    - 4.1 African States Bordering the Atlantic Ocean (ATLAFCO)
    - 4.2 Arctic Council
        - 4.2.1 PAME (Protection of the Arctic Marine Environment)
    - 4.3 Convention on Biological Diversity (CBD)
    - 4.4 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
    - 4.5 Convention on the Conservation of Migratory Species (CMS)
        - 4.5.1 Scientific Council
        - 4.5.2 Conference of Parties (COP)
        - 4.5.3 Agreement on Small Cetaceans of the Baltic and North Seas (ASCOBANS)
        - 4.5.4 Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)
        - 4.5.5 Other
    - 4.6 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
    - 4.7 Food and Agriculture Organisation of the United Nations (FAO)
    - 4.8 Inter-American Tropical Tuna Commission (IATTC)
        - 4.8.1 Agreement on the International Dolphin Conservation Program (AIDCP)
    - 4.9 International Committee on Marine Protected Areas (ICMMPA)
    - 4.10 International Council for the Exploration of the Sea (ICES)
    - 4.11 International Maritime Organization (IMO)
    - 4.12 International Union for the Conservation of Nature (IUCN)
    - 4.13 North Atlantic Marine Mammal Commission (NAMMCO)
    - 4.14 North Pacific Marine Science Organisation (PICES)
    - 4.15 Protocol on Specially Protected Areas and Wildlife of the Cartagena Convention for the Wider Caribbean (SPAW)
    - 4.16 Pacific Region Environment Programme (SPREP)
    - 4.17 Other

5. General assessment issues with a focus on those related to the Revised Management Procedure (RMP)
    - 5.1 Evaluate the energetics based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
        - 5.1.1 Review intersessional progress, continue evaluation and consider nature of sensitivity tests
    - 5.2 Implications of *IST*s for consideration of 'status' (with ASI and AWMP)
        - 5.2.1 Review and agree approach or develop work plan to agree approach
    - 5.3 General consideration of how to evaluate the effect of special permit catches on stocks
        - 5.3.1 Develop guidelines or an approach to develop guidelines
    - 5.4 Work plan

6. RMP – *Implementation*-related matters
    - 6.1 North Atlantic common minke whales
        - 6.1.1 Report of intersessional Workshop
        - 6.1.2 Completion of *Implementation Review*
        - 6.1.3 Conclusions and recommendations
    - 6.2 Western North Pacific common minke whales
        - 6.2.1 Preparation for next *Implementation Review*
        - 6.2.2 Conclusions and recommendations
    - 6.3 Western North Pacific Bryde's whales
        - 6.3.1 Review of the 'First' intersessional Workshop on the *Implementation Review*
        - 6.3.2 Conclusions and recommendations
    - 6.4 Other
    - 6.5 Review RMP *Implementation Review* schedule for next six years
    - 6.6 Work plan

7. Aboriginal Subsistence Whaling Management Procedure
    - 7.1 *SLA* development for the Greenlandic hunts
        - 7.1.1 Fin whales
        - 7.1.2 Common minke whales
        - 7.1.3 Bowhead whales update
    - 7.2 Aboriginal whaling management scheme
        - 7.2.1 Review results of intersessional Workshop and finalise work plan to complete in 2018
    - 7.3 Review *Implementation Review* schedule for next six years
    - 7.4 Work plan

8. Stocks subject to aboriginal subsistence whaling including management advice
    - 8.1 Eastern Canada and West Greenland bowhead whales

13.4 Estimation of rates of bycatch, risks of, and mortality for small cetaceans
13.5 Scientific aspects of mitigation measures for small cetaceans
13.5.1 Consider scientific aspects of bycatch mitigation measures and prevention
13.6 Work plan

14. Ship strikes
14.1 Mitigation of ship strikes in high risk areas
14.1.1 Review progress towards assessing and mitigating ship strikes in previously identified high risk areas
14.1.2 Consideration of methods to identify 'high risk' areas
14.2 Co-operation with IMO Secretariat and relevant IMO committees
14.2.1 Review co-operation

15. Environmental concerns
15.1 Pollution 2020
15.1.1 Review on intersessional progress
15.1.2 Receive review on mercury in cetaceans
15.2 Oil spill impacts
15.2.1 Development of information resource and communication strategy
15.2.2 Progress on oil spill science, planning and preparedness
15.3 Cumulative impacts
15.3.1 Brief update on intersessional progress and plans for 2018
15.4 Harmful algal blooms
15.4.1 Focus session (or pre-meeting): synthesis of current state of science and impacts to cetaceans
15.5 Marine debris
15.5.1 Brief update on intersessional progress and plans for 2018
15.6 Diseases of concern
15.6.1 Progress on website and communications (including quarterly CDoC updates) and plans for 2018
15.7 Strandings and mortality events
15.7.1 Short review on intersessional progress and plans for 2018
15.8 Noise
15.8.1 Update on national and international ocean noise strategies
15.8.1.1 Update on intersessional co-operation with the IUCN WGWAP Noise Task Force
15.8.1.2 New international and national guidelines and advice (e.g. IUCN, NOAA)
15.9 Climate change
15.9.1 Brief update on intersessional progress
15.9.2 Reconsiderations of this agenda item in light of other items (e.g. Arctic issues, river dolphins)
15.10 Arctic issues
15.10.1 Progress on priority topics including co-operation with other bodies
15.11 Other
15.11.1 SOCER
15.12 Work plan

16. Ecosystem modelling
16.1 Co-operation with CCAMLR on multispecies modelling
16.1.1 Review plans for a joint workshop in 2018
16.2 Applications of species distribution models (SDMS) and ensemble averaging
16.2.1 Review progress and develop a work plan
16.3 Effects of long-term environmental variability on whale populations
16.3.1 Review progress and develop a work plan
16.4 Further investigation of individual-based energetics models
16.4.1 Review progress on recommendations from SC/66b and develop a work plan
16.4.2 Review 'regime shift' component of NEWREP-NP
16.5 Modelling of competition among whales
16.5.1 Review requested analyses from SC/66b and develop a work plan
16.6 Update of information on krill distribution and abundance by NEWREP-A
16.6.1 Review results of survey and analysis
16.7 Other
16.7.1 Spatial modelling using environmental covariates
16.7.2 Review of ecosystem modelling developments outside the IWC
16.8 Work plan
17. Small cetaceans
17.1 Global *Tursiops* taxonomy review
17.1.1 Review intersessional progress
17.1.2 Work plan to complete review
17.2 A review of small cetaceans in rivers, estuaries and restricted coastal habitats in Asia
17.3 Poorly documented takes food, bait or cash
17.3.1 Review report from workshop in Thailand
17.3.2 Future plans
17.4 Small cetacean task team
17.5 Progress on previous recommendations
17.6 Review takes of small cetaceans
17.6.1 Directed catches
17.6.2 Live captures
17.7 Status of the voluntary fund for small cetacean conservation research
17.7.1 Status of funds and review progress of funded projects
17.8 Work plan

18. Whalewatching
18.1 Assess impact of whalewatching
18.1.1 Review work plan on Modelling and Assessment of Whalewatching Impact (MAWI)
18.1.2 Review specific papers addressing impacts
18.1.3 Consider documented emerging concerns and how to assess them
18.2 5-year strategic plan and joint work with Conservation Committee
18.2.1 Develop plan to provide scientific advice requested in the plan (including the online handbook) and to minimise dual consideration of issues amongst the two Committees

18.3 Platform of opportunity data
 18.3.1 Provide advice and recommended practice
18.4 Progress on scientific recommendations
18.5 Work plan

19. Special permits
 19.1 NEWREP-A
  19.1.1 Progress with previous recommendations
  19.1.2 Committee conclusions and recommendations
 19.2 JARPN II
  19.2.1 Progress with previous recommendations
  19.2.2 Committee conclusions and recommendations
 19.3 NEWREP-NP
  19.3.1 Expert Panel Review Report and progress with recommendations
  19.3.2 Committee conclusions and recommendations
 19.3 Work plan

20. Whale sanctuaries

21. IWC List of Recognised Species

22. IWC databases and catalogues
 22.1 Guidelines for IWC catalogues and photo-ID databases
 22.2 Progress with existing or proposed new catalogues
  22.2.1 IWC-POWER catalogues
  22.2.2 Integration of eastern South and Central Pacific blue, humpback, and fin whale photo-catalogues
  22.2.3 Southern Hemisphere and Indian Ocean humpback whales: catalogues
  22.2.4 Southern Hemisphere Antarctic and pygmy blue whales: catalogues and databases
  22.2.5 Integrating existing western gray whale catalogues and databases
 22.3 Progress with existing IWC databases
  22.3.1 IWC catch database
  22.3.2 National Progress Report database
  22.3.3 Global ship strike database
  22.3.4 Photographic archive database
  22.3.5 Updated IWC sightings database to link to multiple data types
  22.3.6 SORP databases
 22.4 Potential future IWC databases
  22.4.1 Global database for disentanglement activities
  22.4.2 Global bycatch database
  22.4.3 Development of simple technical guidelines for new proposals

23. IWC multinational research programmes
 23.1 POWER
 23.2 SORP
 23.3 Work plan

24. Committee priorities and initial Agendas for the 2018 meeting

25. Scientific Committee budget for the biennum 2017-18
 25.1 Status of previously funded research, workshop proposals, data processing and computing needs
  25.1.1 Funded proposals for the current biennium 2017-18
  25.1.2 Funded proposals in previous years still ongoing
 25.2 Consolidated budget for the next intersessional period (up to 2018)

26. Working methods of the Committee
 26.1 Interactions between the Scientific Committee and the Conservation Committee
  26.1.1 Review progress of the Joint Intersessional CC/SC Working Group
  26.1.2 Procedures to interact with the Conservation Committee and other Commission bodies
   26.1.2.1 Membership
   26.1.2.2 Consideration of intersessional focus meetings
   26.1.2.3 Handling overlapping topics (e.g. WW, bycatch, ship strikes, CMPs)
   26.1.2.4 Proposals and work plan
 26.2 Rules of Procedure of the Scientific Committee
 26.3 Biennial reporting and related matters
 26.4 Additional proposals for revisions to ‘Annex P’
 26.5 Other matters

27. Publications

28. Election of Officers

29. Other business

30. Adoption of Report

Annex C

List of Documents

SC/67a/ASI

01. Diallo, S.T. Research plan for a COMHAFAT cetacean sighting survey in coastal waters of western North Africa in winter 2018. 7pp.
02. Gushcherov, P.S., Tiupeleev, P.A., Samanov, V.I. and Miyashita, T. Research plan for the cetacean sighting survey in the eastern Sea of Okhotsk in 2017. 6pp.
03. Gushcherov, P.S., Tiupeleev, P.A., Blokhin, S.A., Shkarupa, M.A., Samanov, V.I. and Miyashita, T. Cruise report of the cetacean sighting survey in the northern part of the Sea of Okhotsk in 2016. 26pp.
04. Hakamada, T., Matsuoka, K. and Pastene, L.A. Research plan for the NEWREP-A dedicated sighting survey in the Antarctic in 2017/18. 12pp.
05. Matsuoka, K., Hakamada, T., Moriyama, R., Mure, H., Abe, N., Ohkoshi, C. and Miyashita, T. Result of the Japanese dedicated cetacean sighting survey in the western North Pacific in 2016. 12pp.
06. Hakamada, T., Matsuoka, K., Miyashita, T. and Pastene, L.A. Research plan for a cetacean sighting survey in the western North Pacific in 2018 under proposed NEWREP-NP. 9pp.
07. Isoda, T., Konishi, K., Yamaguchi, F., Kawabe, S., Moriyama, R., Kasai, H., Igarashi, Y., Mogoe, T. and Matsuoka, K. Results of the NEWREP-A dedicated sighting survey during the 2016/17 austral summer season. 28pp.
08. Hakamada, T., Matsuoka, K. and Miyashita, T. Research plan for a sighting survey in the western North Pacific in 2017. 7pp.
09. Matsuoka, K., Gilpatrick, J.W., Jr., Kim, J.H. and Yoshimura, I. Cruise report of the 2016 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). 29pp.
10. Park, K.J., Kim, H.W., Lee, K.L., Sohn, H., Choi, Y.M. Plan for the Korean sighting survey in the Yellow Sea. 6pp.

SC/67a/AWMP

01. Punt, A.E. and Brandão, A. Results of trials to evaluate the interim allowance strategy for West Greenland humpback whales. 23pp.
02. Suydam, R., George, J.C., Person, B., Ramey, D., Stimmelmayr, R., Sformo, T., Pierce, L. and Sheffield, G. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2016. 9pp.

02rev1. Suydam, R., George, J.C., Person, B., Ramey, D., Stimmelmayr, R., Sformo, T., Pierce, L. and Sheffield, G. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2016. 9pp.

03. Ilyashenko, V. and Zharikov, K. Aboriginal subsistence whaling in the Russian Federation in 2016. 3pp.
04. Brandão, A. Precision of 5th percentiles of West Greenland bowhead whales. 13pp.
05. Witting, L. A source-sink migration model for minke whales in West Greenland. 15pp.

05rev1. Witting, L. A source-sink migration model for minke whales in West Greenland. 15pp.

06. Witting, L. A candidate *SLA* for fin whales in West Greenland. 10pp.
07. Suydam, R. and George, C. Update on plans for a population survey of Bering-Chukchi-Beaufort bowhead whales. 3pp.
08. Ferguson, M.C., Givens, G.H., Clarke, J.T., Willoughby, A., Brower, A. and George, J.C. A minimum abundance estimate of BCB bowhead whales in the western Beaufort Sea in late August, 2016. 18pp.
09. Givens, G.H., Mocklin, J.A., Brattström, L.V., Tudor, B.J., Koski, W.R., George, J.C., Zeh, J.E. and Suydam, R.S. Survival rate and 2011 abundance of Bering-Chukchi-Beaufort Seas bowhead whales from photo-identification data over three decades. 24pp.
10. George, J.C., Stimmelmayr, R., Brower, A., Clarke, J., Ferguson, M., Von Duyke, A., Sheffield, G., Stafford, K., Sformo, T., Person, B., Sousa, L., Tudor, B. and Suydam, R. 2016 health report for the Bering-Chukchi-Beaufort Seas bowhead whales - preliminary findings. 21pp.
11. Blokhin, S.A., Litovka, D.I. and Shkarupa, M.A. Results of gray whale *Eschrichtius robustus* monitoring research off Chukotka, Russian Federation, 2012-2016. 4pp.
12. Brandão, A. Potential *SLA*s for West Greenland fin whales testing against the agreed evaluation trials. 7pp.
13. Allison, C. Information received from Canada re the bowhead catch in 2016. 2pp.

SC/67a/CMP

01. Crespo, E.A., Coscarella, M.A., Pedraza, S.N., Dans, S.L., Svendsen, G.M. and Degrati, M. Southern right whales *Eubalaena australis* still growing but at a decelerated speed. 15pp.
02. Nakamura, G., Yoshida, H., Morita, H., Ito, K., Bando, T., Mogoe, T., Miyashita, T. and Kato, H. Status report of conservation and researches on the western North Pacific gray whales in Japan, May 2016 - April 2017. 8pp.
03. Sutaria, D., Sule, M., Jog, K., Bopardikar, I., Jamalabad, A. and Panicker, D. Baleen whale records from India. 16p.

03rev1. Sutaria, D., Sule, M., Jog, K., Bopardikar, I., Jamalabad, A. and Panicker, D. Baleen whale records from India. 16p.

04. Sueyro, N., Crespo, E., Arias, M. and Coscarella, M. Density thresholds triggers a response in the distribution of southern right whales (*Eubalaena australis*) in Peninsula Valdés. 11p.
05. Moazzam, M. and Nawaz, R. Arabian humpback and baleen whale sightings along the Pakistan coast: information generated through WWF Pakistan's fishing crew observer programme. 14pp.

05rev1. Moazzam, M. and Nawaz, R. Arabian humpback and baleen whale sightings along the Pakistan coast: information generated through WWF Pakistan's fishing crew observer programme. 14pp.

06. ARIAS, M., COSCARELLA, M., SVENDSEN, G., ROMERO, M.A., CURCIO, N., SUEYRO, N., CRESPO, E. AND GONZALEZ, R. Changes in the distribution and abundance of southern right whale *Eubalaena australis* in San Matias Gulf (Patagonia, Argentina). 14pp.
07. MINTON, G. AND ANTONOPOULOU, M. The Arabian Sea Whale Network: a brief progress report. 6pp.
07rev1. MINTON, G. AND ANTONOPOULOU, M. The Arabian Sea Whale Network: a brief progress report. 6pp.
08. REYES REYES, M.V., HEVIA, M., MARINO, A. AND IÑÍGUEZ BESSEGA, M.A. Presence of Southern right whales on the Patagonian Shelf off Argentina during summer from opportunistic sightings. 8pp.
08rev1. REYES REYES, M.V., HEVIA, M., MARINO, A. AND IÑÍGUEZ BESSEGA, M.A. Presence of Southern right whales on the Patagonian Shelf off Argentina during summer from opportunistic sightings. 7pp.
09. GOVERNMENT OF CHILE AND GOVERNMENT OF PERU. Report of the first international coordination meeting to implement the Eastern South Pacific Southern Right Whale population Conservation Management Plan of the International Whaling Commission, Santiago, Chile, March 7th-8th 2017. 18pp.
10. HAYDEN, M., BHAWAL, R., ESCOBEDO, J., HARMON, C., KLEIN, D., SAN-FRANCISCO, S., ZABET-MOGHADDAM, M., T., O.H., BICKHAM, J. AND GODARD-CODDING, C.A.J. Steroid hormone analyses in western and eastern gray whale blubber by ELISA and nanoLC/MS/MS methodologies. 20pp.
11. URBAN R., J., SWARTZ, S.L., GOMEZ-GALLARDO, A., MARTINEZ, S. AND ROSALES-NANDUCA, H. 2017 gray whale research in Laguna San Ignacio and Bahia Magdalena, Mexico. 17pp.
12. WILLSON, A., CERCHIO, S., COLLINS, T., GRAY, H., KENNEDY, A.S., LOOKER, E., MINTON, G., SARROUF-WILLSON, M., ZERBINI, A.N. AND BALDWIN, R. Research update on Arabian Sea humpback whales in the Sultanate of Oman. 10pp.
12rev1. WILLSON, A., CERCHIO, S., COLLINS, T., GRAY, H., KENNEDY, A.S., LOOKER, E., MINTON, G., SARROUF-WILLSON, M., ZERBINI, A.N. AND BALDWIN, R. Research update on Arabian Sea humpback whales in the Sultanate of Oman. 10pp.
13. GALLETTI VERNAZZANI, B., BUCHAN, S., BROWNELL, R.L., JR., GOYA, E. AND MOORE, S.E. Progress report on passive acoustic monitoring of the Eastern South Pacific Southern Right Whale, a key to improving Conservation Management Plan outputs: December 2016-April 2017. 7pp.
14. DAKHTEH, S.M.H., RANJBAR, S., MOAZENI, M., MOHSENIAN, N., DELSHAB, H., MOSHIRI, H. AND VAN WAEREBEEK, K. On the presence of humpback whales in the Persian Gulf: rare or rarely documented? 8pp.
15. WILLSON, A., BALDWIN, R., COLLINS, T., GODLEY, B., MINTON, G., AL-HARTHI, S., PIKESLEY, S. AND WITT, M. Preliminary ensemble ecological niche modelling of Arabian Sea humpback whale vessel sightings and satellite telemetry data. 17pp.

SC/67a/E

01. SHPAK, O.V. AND STIMMELMAYR, R. Preliminary image analysis of acute and chronic injuries, parasites, and skin conditions in the Okhotsk bowhead whale (*Balaena mysticetus*) stock in the western Okhotsk Sea. 16pp.
02. HALL, A., KRISTEN-JENSEN, S., CUMMINGS, C., TEN DOESCHATE, M., DAVISON, N. AND BROWNLOW, A. Domoic acid exposure in stranded cetaceans in Scotland. 11pp.
03. HUBBELL, D. Developments in mitigating the impact of vessel based heavy fuel oil use on Arctic cetaceans. 6pp.
04. MARSILI, L., CAPANNI, F., CASINI, S. AND LEONZIO, C. Mercury levels in several species of cetaceans in the world: a review. 9pp.
05. STACHOWITSCH, M., ROSE, N.A. AND PARSONS, E.C.M. State of the Cetacean Environment Report (SOCER) 2016. 16pp.
05rev1. STACHOWITSCH, M., ROSE, N.A. AND PARSONS, E.C. M. State of the Cetacean Environment Report (SOCER) 2017. 16pp.
06. SIMEONE, C.A. Progress report on IWC Initiative on Strandings - May 2017. 142pp.
06rev1. SIMEONE, C.A. Progress report on IWC Initiative on on Strandings - May 2017. 11pp [does not include appendices].
07. SIMEONE, C.A. Progress report on IWC intersessional Working Group on Cetacean Diseases of Concern (CDoC) - May 2017. 3pp.
08. KOVEKOVDOVA, L.T., SIMOKON, M.V., BLOKHIN, S.A. AND LITOVKA, D.I. Toxic and active elements (Fe, Zn, Cu, Hg, As, Cd, Pb, Se, Mn) in tissues and organs of gray whales and Pacific walrus harvested in the Mechigmensky Bay (western Bering Sea, Russia), 2008-2016. 4pp.
09. GENOV, T., JEPSON, P.D., BARBER, J.L., HACE, A., GASPARI, S., CENTRIH, T. AND KOTNJEK, P. Polychlorinated biphenyls (PCBs) in free-ranging common bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Trieste (northern Adriatic Sea), in relation to demographic parameters. 11pp.
09rev1. GENOV, T., JEPSON, P.D., BARBER, J.L., HACE, A., GASPARI, S., CENTRIH, T. AND KOTNJEK, P. Polychlorinated biphenyls (PCBs) in free-ranging common bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Trieste (northern Adriatic Sea), in relation to demographic parameters. 11pp.

SC/67a/EM

01. DE LA MARE, W.K., MCKINLAY, J.P. AND WELSH, A.H. Analyses of the JARPA Antarctic minke whale fat weight data set. 57pp.
02. MCKINLAY, J.P., DE LA MARE, W.K. AND WELSH, A.H. A re-examination of minke whale body condition as reflected in the data collected under JARPA. 108pp.
03. DE LA MARE, W.K., MCKINLAY, J.P. AND WELSH, A.H. Comments, notes and supplementary analyses following the exchange of primary drafts on the analyses of Antarctic minke whale body condition data. 11pp.
04. CUNEN, C., WALLØE, L. AND HJORT, N.L. Decline in energy storage in Antarctic minke whales during the JARPA period: assessment via the Focused Information Criterion (FIC). 56pp.
05. ARREGUI, M., BORRELL, A., VÍKINGSSON, G., ÓLAFSDÓTTIR, D. AND AGUILAR, A. Stable isotope analysis of fecal material provides insight into the diet of baleen whales. 10pp.
06. GARCÍA-VERNET, R., SANT, P., VÍKINGSSON, G., BORRELL, A. AND AGUILAR, A. Are stable isotope values and oscillations consistent in all baleen plates along the filtering apparatus? Validation of an increasingly-used methodology. 12pp.
07. CUNEN, C. No paradox: explaining how we can observe a decrease in fat weight, while the total weight appears to remain unchanged. 8pp.
08. CUNEN, C. Analysis of fat weight: three new wide models. 9pp.

09. Wada, A., Konishi, K., Banjo, S., Kasai, H., Igarashi, Y. and Tamura, T. Results of the krill and oceanographic survey under the NEWREP-A in the Antarctic in 2016/17. 10p.
10. Friedlaender, A.S., Heaslip, S.G., Johnston, D.W., Read, A.J., Nowacek, D.P., Durban, J.W., Goldbogen, J.A. and Gales, N. Differential foraging strategies by sympatric krill predators in a rapidly changing polar environment. 50p.
11. Weinstein, B.G. and Friedlaender, A.S. Dynamic foraging of a top predator in a seasonal polar marine environment. 22p.
12. Tulloch, V.J.D., Plagányi, E.E., Matear, R., Brown, C. and Richardson, A.J. Ecosystem modelling of baleen whale predators and their prey: consequences of historic whaling in the Southern Hemisphere. 25pp.
13. James, V.C., Ritter, F., Reyes, V., Iñíguez, M., Asmutis-Silvia, R., Simmonds, M. and Fuchs, A. Whales as ecosystem engineers: a bibliography drawing the big(ger) picture. 7pp.
14. Moosa, N. and Butterworth, D.S. Summary of an update of the Mori-Butterworth (2006) model of the krill-predator dynamics of the Antarctic ecosystem. 31p.
15. Murase, H., Friedlaender, A., Kelly, N., Kitakado, T., McKinlay, J., Palacios, D.M. and Palka, D. An update of review of species distribution models (SDMs) applied to baleen whales and a guideline on the techniques and underlying assumptions of the models. 29p.
16. Konishi, K. Response to SC/67a/EM01, EM02 and EM03 by de la Mare, McKinley and Welsh. 7pp.

SC/67a/GDR

[No primary papers received]

SC/67a/HIM

01. Leaper, R. and Calderan, S. Review of methods used to reduce risks of cetacean bycatch and entanglement. 30pp.
02. Fretwell, P.T., Jackson, J.A. and Ulloa-Encina, M. Using remote sensing to detect whale strandings in remote areas - Patagonia sei whales. 16pp.
03. De Vos, A. and Emmert, S. Potential application of Automatic Identification System (AIS) data extracted from a public platform to monitor ship-strike of whales. 6pp.
04. George, J.C., Tudor, B., Givens, G.H., Mocklin, J. and Brattström, L.V. Initial investigations of bowhead whale entanglement scar frequency and acquisition rates via aerial photography. 15pp.
05. Cotton Rockwood, R., Calambokidis, J. and Jahncke, J. High mortality of blue, humpback and fin whales from vessel collisions on the US west coast suggests population impacts and insufficient protection. 32pp.
06. Scordino, J., Carretta, J., Cottrell, P., Greenman, J., Savage, K., Scordino, J. and Wilkinson, K. Ship strikes and entanglements of gray whales in the North Pacific Ocean, 1924-2015. 92pp.
07. Slooten, E. and Dawson, S.M. Bycatch and PBRs for Maui and Hector's dolphin. 16pp.
07rev1. Slooten, E. and Dawson, S.M. Bycatch and PBRs for Maui and Hector's dolphin. 16pp.
08. Ritter, F. and Panigada, S. 5th progress report on IWC Ship Strike Data Coordination - May 2017. 8pp.
09. Hubbell, D. and Portley, N. The Polar Code and marine mammal avoidance planning in the International Maritime Organization. 9pp.
10. How, J.R., Coughran, D., Double, M.C. and De Lestang, S. Gear modifications reduced whale entanglements in a commercial rock lobster fishery. 34pp.
11. Brownell, R.L., Jr., De Vos, A. and Ilangakoon, A.D. Large whale strandings from Sri Lanka between 1889 and 2014. 14pp.
12. Leathers, A. and Leslie, A. Gear switching to remove threats to Māui dolphin and address the socio-economic barriers to effective conservation. 17pp.
13. NO PAPER.
14. Galletti Vernazzani, B., Chirife, A., Cabrera, E., Sironi, M. and Brownell, R.L., Jr. Entanglement and death of a Critically Endangered eastern South Pacific southern right whale (*Eubalaena australis*) in Chile. 10pp.
15. First IMMA Regional Workshop for the Mediterranean Chania, Greece, 24-28 October 2016: Report of the Workshop. 27pp.
16. Cooke, J.G. Dynamics of whale/ship collisions: an exploratory analysis. 14pp.
17. Burkanov, V.N., Lowry, L.F., Weller, D.W. and Reeves, R.R. Entanglement risk to western gray whales in Russian far east fisheries. 32pp.

SC/67a/IA

01. Clapham, P.J. and Ivashchenko, Y.V. Length data for Japanese fin whale catch statistics in the Southern Hemisphere are probably largely reliable. 7pp.
02. Punt, A.E. Progress report: a multi-stock model for North Pacific sei whales. 8pp.

SC/67a/NH

01. McDonald, M., Širović, A., Sugioka, H., Kato, H., Yoshida, R. and Kyo, N. Preliminary analysis of blue and fin whale acoustic presence off Hokkaido, Japan. 5pp.
02. Širović, A., Oleson, E.M., Stafford, K.M. and McDonald, M.A. Blue whale song occurrence in the North Pacific. 6pp.
03. Burdin, A.M., Sychencko, O., Volkov, A. and Mamaev, M. Status of western North Pacific gray whales off northeastern Sakhalin Island and eastern Kamchatka, Russia in 2016. 9pp.
04. Ovsyanikova, E.N., Fedutin, I.D., Burdin, A.M., Burkanov, V.N., Filatova, O.A., Fomin, S.V., Hoyt, E., Mamaev, E.G., Sekiguchi, K. and Shpak, O.V. Records of North Pacific right whales in Russian coastal waters between 2003-2016 and catalogue of individually identified whales. 6pp.
05. Pike, D.G., Gunnlaugsson, T. and Víkingsson, G. Icelandic aerial survey 2016: survey report and an abundance for common minke whales. 29pp.
06. Filatova, O.A., Fedutin, I.D., Titova, O.V., Shpak, O.V., Burdin, A.M. and Hoyt, E. Cetacean surveys in the coastal waters of the Russian Pacific in 2014-2016. 5pp.
07. Matsuoka, K., Zharikov, K.A., Hakamada, T. and Miyashita, T. Sightings of the North Pacific right whales (*Eubalaena japonica*) in the western North Pacific (1982 to 2016). 11pp.
07rev1. Matsuoka, K., Zharikov, K.A., Hakamada, T. and Miyashita, T. Sightings of the North Pacific right whales (*Eubalaena japonica*) in the western North Pacific (1982 to 2016). 11pp.

08. Wright, D.L. and Clapham, P.J. Passive acoustic monitoring of North Pacific right whales (*Eubalaena japonica*). 9pp.
09. Cubaynes, H.C., Fretwell, P.T. and Jackson, J.A. Whales from space: spectral and visual description of four mysticete species using VHR satellite imagery. 22pp.
10. Cooke, J.G., Shpak, O.V., Meschersky, I.G., Burdin, A.M., MacLean, S.A. and Chichkina, A.N. Updated estimates of population and trend for Okhotsk Sea bowhead whales. 8pp.
11. Cooke, J.G., Weller, D.W., Bradford, A.L., Sychencko, A.O., Burdin, A.M., Lang, A.R. and Brownell, R.L., Jr. Population assessment update for Sakhalin gray whales, with reference to stock identity. 9pp.
12. Cerchio, S., Yamada, T.K. and Brownell, R.L., Jr. Known global distribution of Omura's whale (*Balaenoptera omurai*) and assessment of range-wide threats. 15pp.

SC/67a/PH

01. Olson, P.A., Findlay, K., Venter, K., Ensor, P., Double, M.C., Matsuoka, K. and Pastene, L.A. Photo-identification of Antarctic blue whales: new data from 1980-2014. 8pp.
02. Cheeseman, T., Johnson, T., Southerland, K. and Muldavin, N. Happywhale: Globalizing marine mammal photo identification via a citizen science web platform. 7pp.
03. Stevick, P.T., Carlson, C., Crowe, L., Kellett, M., Fernald, T. and Allen, J.M. Interim report: IWC Research Contract 16, Antarctic Humpback Whale Catalogue. 8pp.
04. Galletti Vernazzani, B., Olson, P. and Salgado-Kent, C. Progress report on Southern Hemisphere Blue Whale Catalogue: period June 2016-May 2017. 8pp.
05. Olson, P., Jackson, J. and Donovan, G. IWC photo-identification catalogues: draft guidelines. 6pp.

SC/67a/RMP

01. Øien, N. Report of the Norwegian 2016 survey for minke whales in the *Small Management Area* CM - the Jan Mayen area. 10pp.
02. De La Mare, W. Further developments of the individual based energetics model and progress on the development of an emulation model. 26pp.
03. Solvang, H.K., Skaug, H.J. and Øien, N. Preliminary abundance estimates of common minke whales in Svalbard 2014, the Norwegian Sea 2015, and Jan Mayen 2016 – the first three years of the survey cycle 2014-2019 of the Northeast Atlantic. 12pp.
04. Hakamada, T., Takahashi, M., Matsuoka, K. and Miyashita, T. Abundance estimate for western North Pacific Bryde's whale by sub-areas based on IWC-POWER and JARPNII sighting surveys. 19pp.

SC/67a/SCP

01. Scientific Committee Chair, Scientific Committee Vice-Chair, Head of Science and SC Convenors. Important information on the Scientific Committee Agenda and the biennial work plan 2017-2018. 22pp.
02. Penfold, K. Report to the IWC Scientific Committee on Financial Position to 31st March 2017. 8pp.

SC/67a/SCSP

01. Government of Japan. Proponents' preliminary response to the Report of the Expert Panel to review the proposal for NEWREP-NP. 28pp.
02. Punt, A.E. and Donovan, G.P. An approach to quantifying potential improvements in management performance from scientific research programmes. 9pp.
03. Yasunaga, G., Ito, N., Isoda, T., Nakamura, G., Hirose, A., Hayashi, R., Yoshii, K., Kim, Y., Akagi, M., Nakajo, K., Nishimura, F., Asano, Y., Ozaki, R., Katsumata, T., Yamada, R., Koizumi, C., Kumagai, S., Sato, H., Sakaguchi, M., Kanbayashi, J. and Kato, H. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2016 - (Part II) - Coastal component off Sanriku. 24pp.
04. Bando, T., Konishi, K., Nakai, K., Sato, K., Yamagata, Y., Tsunekawa, M., Ueda, Y., Moriyama, R., Mure, H. and Ogawa, T. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2016 - (Part I) - Offshore component. 16pp.
05. Mogoe, T., Isoda, T., Yoshida, T., Nakai, K., Kanbayashi, J., Ono, K., Yoshimura, I., Ueda, Y., Mure, H., Ueta, E., Wada, A., Eguchi, H. and Tamura, T. Results of the second biological field survey of NEWREP-A during the 2016/17 austral season. 22pp.
06. NO PAPER.
07. Yoshida, H., Shimetani, K., Maeda, H., Nakamura, G., Nakai, K., Inoue, S., Hirose, A., Hayashi, R., Akagi, M., Nakajyo, K., Nishimura, F., Asano, H., Fukami, A., Kumagai, S., Kanbayashi, J., Kuwagaki, A., Miyashita, T., Minamikawa, S., Kanaji, Y., Sasaki, H., Yamada, R., Kakinuma, A. and Kato, H. Cruise Report of the Second Phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2016 - (Part III) - Coastal component off Kushiro. 15pp.
08. De La Mare, W.K. Properties of estimates of M and MSYR using statistical catch at age models conditioned on the NEWREP-NP proposed catches of sei whales. 27pp.
09. Tamura, T., Kitakado, T. and Pastene, L.A. Progress report of the work conducted in response to JARPNII research recommendations by the IWC Scientific Committee. 7pp.
10. Government of Japan. Revised proposed research plan for New Scientific Whale Research Program in the western North Pacific (NEWREP-NP). 148pp.
11. Yasunaga, G., Inoue, S., Yoshida, H. and Kitakado, T. Update of analyses on efficiency of biopsy sampling for sei, Bryde's and common minke whales, based on data and samples obtained during the 2014-2016 JARPNII surveys. 10pp.
12. Pastene, L.A., Kitakado, T. and Tamura, T. Progress report of the work conducted in response to NEWREP-A research recommendations by the IWC Scientific Committee. 8pp.
13. Kitakado, T. and Pastene, L.A. Addendum of the NEWREP-NP proposed revised research plan. 57pp.

SC/67a/SDDNA

01. Tiedemann, R., Tiedemann, M.R., Goto, M., Taguchi, M. and Pastene, L.A. Finding parent-offspring pairs among western North Pacific common minke whales. 18pp.
02. Dewoody, J.A., Fernandez, N.B., Bruniche-Olsen, A., Antonides, J.D., Doyle, J.M., San Miguel, P., Westerman, R., Vertyankin, V.V., Godard-Codding, C. and Bickham, J.W. Characterization of the gray whale (*Eschrichtius robustus*) genome and a genotyping array based on single nucleotide polymorphisms in candidate genes: update of SC/66b/DNA04. 3pp.

03. Baird, A.B., Georges, M., Harper, H., Holbert, A., George, J.C., Suydam, R.S. and Bickham, J.W. Progress report about mtDNA and SNP databases for Bering-Chukchi-Beaufort Seas bowhead whales. 12pp.
04. Bruniche-Olsen, A., Westerman, R., Kazmierczyk, Z., Vertyankin, V.V., Godard-Codding, C., Bickham, J.W. and Dewoody, J.A. The inference of gray whale (*Eschrichtius robustus*) population attributes from whole-genome sequences. 29pp.
05. Taguchi, M., Goto, M. and Pastene, L.A. A synthesis of the work conducted on stock structure of western North Pacific common minke whale in response to recommendations from the IWC Scientific Committee. 6pp.
05rev1. Taguchi, M., Goto, M. and Pastene, L.A. A synthesis of the work conducted on stock structure of western North Pacific common minke whale in response to recommendations from the IWC Scientific Committee. 6pp.

SC/67a/SH
01. NO PAPER.
02. Torres, L.G., Barlow, D.R., Hodge, K., Klinck, H., Steel, D., Baker, C.S., Chandler, T., Gill, P., Ogle, M., Lilley, C., Bury, S., Graham, B., Sutton, P., Burnett, J., Double, M., Olson, P., Bott, N. and Constantine, R. New Zealand blue whales: recent findings and research progress. 23pp.
02rev1. Torres, L.G., Barlow, D.R., Hodge, K., Klinck, H., Steel, D., Baker, C.S., Chandler, T., Gill, P., Ogle, M., Lilley, C., Bury, S., Graham, B., Sutton, P., Burnett, J., Double, M., Olson, P., Bott, N. and Constantine, R. New Zealand blue whales: recent findings and research progress. 23pp.
03. Miller, B.S., Miller, E., Calderan, S., Leaper, R., Stafford, K., Širović, A., Rankin, S., Findlay, K., Samaran, F., Van Opzeeland, I., McCauley, R., Gavrilov, A., Harris, D., Gedamke, J., Bell, E., Andrews-Goff, V. and Double, M. Circumpolar acoustic mapping of endangered Southern Ocean whales: voyage report and preliminary results for the 2016/17 Antarctic Circumnavigation Expedition. 18pp.
03rev1. Miller, B.S., Miller, E., Calderan, S., Leaper, R., Stafford, K., Širović, A., Rankin, S., Findlay, K., Samaran, F., Van Opzeeland, I., McCauley, R., Gavrilov, A., Harris, D., Gedamke, J., Bell, E., Andrews-Goff, V. and Double, M. Circumpolar acoustic mapping of endangered Southern Ocean whales: voyage report and preliminary results for the 2016/17 Antarctic Circumnavigation Expedition. 18pp.
04. Bell, E.M. Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2016/17. 73pp.
04rev1. Bell, E.M. Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2016/17. 74pp.
05. Findlay, K., Thornton, M., Wilkinson, C., Vermeulen, E. and Hoerbst, S. Report on the 2016 Mammal Research Institute Whale Unit Southern Right Whale Survey, Nature's Valley to Lambert's Bay, South Africa. 13pp.
05rev1. Findlay, K., Thornton, M., Wilkinson, C., Vermeulen, E. and Hoerbst, S. Report on the 2016 Mammal Research Institute Whale Unit Southern Right Whale Survey, Nature's Valley to Lambert's Bay, South Africa. 13pp.
06. Meister, M., Burkhardt, E., Spiesecke, S., Thomisch, K., Van Opzeeland, I. and Boebel, O. Intra-annual and diel patterns in the acoustic presence of fin whales (*Balaenoptera physalus*) off Elephant Island. 7pp.
07. Herr, H., Bell, E., Burkhardt, E., Butterworth, D., Dalla Rosa, L., Donovan, G., Double, M., Findlay, K., Friedlaender, A., Hevia, M., Iñíguez, M., Jackson, J., Kelly, N., Miller, B., Olson, P., Panigada, S., Pérez-Alvarez, M.J., Reyes Reyes, M.V., Rodriguez-Fonesca, J., Samaran, F., Sepúlveda, M., Širović, A., Williams, R. and Zerbini, A. Southern Hemisphere fin whales: development of a study proposal for the West Antarctic Peninsula. 8pp.
08. Davidson, A.R., Rayment, W. and Slooten, E. Population dynamics of New Zealand southern right whales (*Eubalaena australis*). 21pp.
09. Herr, H., Bell, E., Burkhardt, E., Butterworth, D., Dalla Rosa, L., Donovan, G., Double, M., Findlay, K., Friedlaender, A., Hevia, M., Iñíguez, M., Jackson, J., Kelly, N., Miller, B., Olson, P., Panigada, S., Pérez-Alvarez, M.J., Reyes Reyes, M.V., Rodriguez-Fonesca, J., Samaran, F., Sepúlveda, M., Širović, A., Williams, R. and Zerbini, A. Southern Hemisphere fin whales: review of available data. 20pp.
10. Samaran, F., Berne, A., Leroy, E.C., Marcia, M., Royer, J.Y. and Stafford, K. Antarctic blue whales (*Balaenoptera musculus intermedia*) recorded north of the equator in the Atlantic Ocean. 8pp.
11. Sremba, A.L., Pitman, R., Wilson, P., Martin, A.R., Jackson, J.A. and Baker, C.S. Species identification of whale bones from former whaling stations of South Georgia and the Antarctic Peninsula by mtDNA barcoding. 7pp.
12. Melcón, M.L., Reyes Reyes, M.V., Marino, A., Jones, J., Baumann-Pickering, S., Hildebrand, J.A. and Iñíguez, M.A. Visual and acoustic records of sperm whales during the Argentine SORP cruises from 2014-2017 through the Western Antarctic Peninsula. 5pp.
13. Gray, H., Willson, A., Baldwin, R., Minton, G., Natoli, A., Looker, E., Ponnampalam, L. and Collins, T. A note on sperm whale (*Physeter macrocephalus*) records from the Sultanate of Oman and United Arab Emirates. 25pp.
13rev1. Gray, H., Willson, A., Baldwin, R., Minton, G., Natoli, A., Looker, E., Ponnampalam, L. and Collins, T. A note on sperm whale (*Physeter macrocephalus*) records from the Sultanate of Oman and United Arab Emirates. 25pp.
14. Murase, H., Kato, H., Kitakado, T., Matsuoka, K., Palka, D., Pastene, L.A. and Punt, A.E. In-depth assessment of an eastern Indian and a western South Pacific stock of Antarctic minke whale from 2001 to 2014: a synthesis and summary (draft). 46pp.
15. Castro, C.A., Rasmussen, K., Aldo, P., Cardenas, D., Carnero-Huaman, R., Galo, E. and Kaufman, G. Bryde's whale *Balaenoptera edeni* occurrence and movements in coastal areas off Ecuador, Peru and Panama. A preliminary report. 10pp.

SC/67a/SM
01. Rojas-Bracho, L., Barlow, J., Bjørge, A., Brownell, R.L., Jr., Donovan, G.P., Jaramillo-Legorreta, A., Ramirez Flores, O.M., Read, A., Reeves, R., Taylor, B. and Thomas, P.O. Report of the Fifth Meeting of the Comite Internacional para la Recuperacion de la Vaquita (CIRVA-5). 166pp.
02. Félix, F., Van Waerebeek, K., Sanino, G.P., Castro, C., Van Bressem, M.F. and Santillán, L. Morphological variation in dorsal fins among common bottlenose dolphin populations in the Southeast Pacific Ocean 11pp.

03. NO PAPER.
04. Marcondes, M.C.C., Angeli, M., Fontes, F. and Palazzo, J.T., Jr. Preliminary report on franciscana fisheries interaction in FMA Ia, Brazil. 16pp.
05. NO PAPER.
06. Funahashi, N. and Kasuya, T. Bottlenose dolphins and southern form of short-finned pilot whales around Japan: their stock structure and catch trends. 15pp.
06rev1. Funahashi, N. and Kasuya, T. Bottlenose dolphins and southern form of short-finned pilot whales around Japan: their stock structure and catch trends. 15pp.
07. Chen, I., Nishida, S., Yang, W.C., Isobe, T., Tajima, Y. and Hoelzel, A.R. Genetic diversity of bottlenose dolphins (*Tursiops* sp.) populations in the western North Pacific and the conservation implications. 40pp.
08. Sutaria, D., Bopardikar, I. and Mihir, S. Irrawaddy dolphins, *Orcella brevirostris* from India. 10pp.
08rev1. Sutaria, D., Bopardikar, I. and Mihir, S. Irrawaddy dolphins, *Orcella brevirostris* from India. 10pp.
09. Mihir, S., Bopardikar, I., Jog, K., Jamalabad, A., Panicker, D., Tregenza, N. and Sutaria, D. A review of finless porpoise, *Neophocaena phocaenoides* records from India with a special focus on the population in Sindhudurg, Maharashtra. 18pp.
10. Van Waerebeek, K., Reyes, J.C., Sanino, G.P., Félix, F., Van Bressem, M.F., Avila, I.C., Santillán, L., Montes, D., García-Godos, I., Echegaray, M. and Abad, A.V. Common bottlenose dolphins *Tursiops truncatus* of Pacific South America, a synoptic review of population identification data. 13pp.
11. Rojas-Bracho, L. Eighth Meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA-8), Southwest Fisheries Science Center, November 29-30th, 2016, La Jolla, CA. 70pp.
12. Iñíguez Bessega, M. Report of the Conservation Management Plan for franciscana (*Pontoporia blainvillei*). 3pp.
13. Da Silva, V.M.F. and Martin, A.R. A note on the continuing hunt for botos (*Inia geoffrensis*) in the Brazilian Amazon and the continuing rapid decline of this dolphin. 5pp.
14. Rojas-Bracho, L. Ninth meeting of the Comite Internacional para la recuperacion de la Vaquita, Southwest Fisheries Science Center, La Jolla, CA, April 25-26 2017, Executive Summary. 3pp.
14rev1. Rojas-Bracho, L. Ninth meeting of the Comite Internacional para la recuperacion de la Vaquita, Southwest Fisheries Science Center, La Jolla, CA, April 25-26 2017. Note: revised version contains full report. 38pp.
15. Ministry for Primary Industries and Department of Conservation. Māui dolphin: 2017 update on New Zealand's research and management approach. 7pp.
16. Kelkar, N., Dey, S., Dey, M. and Raza, R. Responses of South Asian river dolphins to waterways development and habitat modification: preliminary analyses and an update on stakeholder responses. 9pp.
17. Wang, D., Wang, K., Hao, Y., Zheng, J. and Mei, Z. Progress on the conservation of the Yangtze finless porpoise (YFP) 2015-2017. 6pp.
17rev1. Wang, D., Wang, K., Hao, Y., Zheng, J. and Mei, Z. Progress on the conservation of the Yangtze finless porpoise (YFP) 2015-2017. 6pp.
18. NO PAPER.
19. Paudel, S. and Koprowski, J.L. The endangered Ganges river dolphins in Nepal: a small and declining population. 8pp.
20. Brownell, R.L., Jr., Vidal, O. and Hohn, A.A. Vaquita bycatch rates by age and type of fishing gear. 4pp.
21. Parra, G.J. and Cagnazzi, D. Australian snubfin dolphins *Orcaella heinsohni*: a review of current knowledge and conservation status. 15pp.
22. Hamera, A., Braulik, G., Khan, U. and Nawaz, R. Indus River dolphin (*Platanista genetica minor*) - an update on the current population assessment and conservation challenges. 11pp.
22rev1. Hamera, A., Braulik, G., Khan, U., Leslie, A. and Nawaz, R. Indus River dolphin (*Platanista genetica minor*) - an update on the current population assessment and conservation challenges. 11pp.
23. Beasley, I., Jedensjo, M. and Anamiato, J. Confirmed occurrence of the Australian snubfin dolphin, *Orcaella heinsohni*, in Papua New Guinea. 13pp.
24. Filatova, O.A. and Shpak, O.V. Update on the killer whale live captures in Okhotsk Sea. 3pp.

SC/67a/WW

01. Wulff, R. and IWC Secretariat. Update on the IWC Whale Watching Handbook and Strategic Plan. 3pp.
02. Sepúlveda, M., Pérez-Álvarez, M.J., Santos-Carvallo, M., Pavez, G., Olavarría, C., Moraga, R. and Zerbini, A.N. From whaling to whale-watching: identifying fin whale critical foraging habitats off the Chilean coast. 18pp.
03. Baldwin, R., Willson, A., al Baluchi, A. and al-Jabri, A. Planning for responsible humpback whale watching in Oman. 14pp.
04. McCordic, J.A., Currie, J.J., Stack, S.H., Kaplun, S.M. and Kaufman, G.D. Land-based surveys to determine effects of vessel presence on humpback whale behaviour in Maui, Hawaii, USA. 16pp.
05. Parsons, E.C.M. and Brown, D.M. Recent advances in whalewatching research: 2016-2017. 22pp.
06. PAPER WITHDRAWN.
07. Currie, J.J., McCordic, J.A., Kaplun, S.M., Stack, S.H. and Kaufman, G.D. An update on 'Whale and Dolphin Tracker': an application for cetacean data collection and long-term monitoring. 8pp.
08. New, L. Update on the Modelling and Assessment of Whalewatching Impacts (MAWI) Steering Group. 3pp.

PLENARY PAPERS

SC/67a/Plenary

01. Gales, N. Introduction to the Standing Working Group on Special Permit Programmes. 10pp.
02. International Whaling Commission. Cooperation with other organisations. 17pp.
02rev1. International Whaling Commission. Cooperation with other organisations. 19pp.

REPORTS FROM INTERSESSIONAL WORKSHOPS

SC/67a/Rep

01. Report of the Expert Panel Workshop on the Proposed Research Plan for New Scientific Whale Research Programme in the Western North Pacific (NEWREP-NP), 30 January-3 February 2017, Tokyo, Japan. 81pp.
02. Report of the Planning Meeting for the 2017 IWC-POWER Cruise in the North Pacific with initial discussion for the 2018 and 2019 cruises, 15-17 September 2016, Tokyo, Japan. 24pp.

03. Report of the Workshop on Southern Hemisphere Blue, Fin and Humpback Whale Photo-identification Catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula, 2 December 2016, Valparaiso, Chile. 20pp.

03rev1. Report of the Workshop on Southern Hemisphere Blue, Fin and Humpback Whale Photo-identification Catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula, 2 December 2016, Valparaiso, Chile. 20pp.

04. Draft Report of the Fourth Rangewide Workshop on the status of North Pacific Gray Whales, 27-29 April 2017, La Jolla, CA, USA. 26pp.

05. Report of the Third RMP Intersessional Workshop on the *Implementation Review* for North Atlantic common minke whales, 16-18 December 2016, Copenhagen, Denmark. 11pp.

06. Report of the 2016 AWMP Intersessional Workshop on developing *SLAs* for the Greenland hunts and the AWS, 17-22 December 2016, Copenhagen, Denmark. 30pp.

07. Report of the Workshop on the *Implementation Review* of western North Pacific Bryde's whales, 21-24 March, Tokyo, Japan. 38pp.

08. Chair's summary of the First IWC Workshop on the Comprehensive Assessment of North Pacific Humpback Whales, 19-21 April 2017, Seattle, USA. 8pp.

09. Report of the Workshop on Harmful Algal Blooms (HABs) and Associated Toxins, 7-8 May 2017, Bled, Slovenia. 21pp.

Annex D

Report of the Sub-Committee on the Revised Management Procedure

Members: Robbins (Convenor), Al Jabri, Allison, Baba, Baker, Bell, Bjørge, Brandão, Brownell, Butterworth, Cipriano, Cooke, de la Mare, de Moor, Diallo, Doherty, Donovan, Double, Enmynkau, Fortuna, Frey, Fruet, Fujise, Funahashi, Gonzalez, Goodman, Goto, Gunnlaugsson, Hakamada, Haug, Hoelzel, Hubbell, Iñíguez, Isoda, Johnson, Kim, Kitakado, Konan, Lang, Lundquist, Maeda, Mallette, Matsuoka, McKinley, Miyashita, Morishita, Morita, H., Morita, Y., Moronuki, Murase, Nakamura, Nelson, Øien, Palka, Pampoulie, Panigada, Park, Pastene, Phay, Punt, Redfern, Reeves, Santos, Simmonds, Skaug, Slugina, Solvang, Taguchi, Tamura, Tiedemann, Víkingsson, Wade, Walløe, Walters, Witting, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
In the absence of Robbins, Donovan welcomed the participants.

1.2 Election of Chair and appointment of rapporteurs
Robbins was elected Chair. Punt acted as the rapporteur.

1.3 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

On behalf of Japan, Moronuki stated that:

> 'Japan understands that one of the objectives of agenda items '2.3 General consideration of how to evaluate the effect of special permit catches on stocks' and '2.4 Improvements in SCAA or RMP performance by improved precision in biological parameters' is consideration of relevant guidelines proposed for incorporation into Annex P responding to the recommendations from the Expert Panel of NEWREP-NP (SC/67a/Rep01).
>
> 'As Japan expressed in its response paper to the Panel (SC/67a/SCSP01), many of the requirements proposed by the Panel, including additional requirements of quantifications of the effect on stock and improvement in RMP performance impose unreasonably heavy burdens upon proponents. These are mainly unnecessary and reflect a misunderstanding of the review process which has the effect of making any implementation of Special Permit programs unreasonably difficult particularly for those Contracting Governments whose resources and capacities are limited. For this reason, Japan will oppose the proposed amendments of Annex P that reflect the noted recommendations of the Expert Panel.
>
> 'However, Japanese scientists may participate in discussions as far as it concerns purely scientific and technical perspectives associated with RMP.'

St. Lucia associated itself with the view expressed by Japan.

1.4 Available documents
The documents considered by the sub-committee were SC/67a/RMP01-04, SC/67a/NH05, SC/67a/Rep01, SC/67a/Rep05, SC/67a/Rep07, SC/67a/SCSP01-02, SC/67a/SCSP08 and SC/67a/SCSP13.

2. GENERAL ASSESSMENT ISSUES WITH A FOCUS ON THOSE RELATED TO THE REVISED MANAGEMENT PROCEDURE

2.1 Relationship between $MSYR_{mat}$ and $MSYR_{1+}$: evaluate energetics-based model
SC/67a/RMP02 illustrated some improvements in the parameterisation of the individual based energetics model (IBEM) for humpback whales. Some examples were given of the density-dependent relationships for a range of demographic parameters and how these are affected by variability in food supply. The results showed that the variability and correlation between demographic parameters is linked to variable food supply. A stage-based model was developed to use these parameter characteristics to emulate the results given by the full IBEM. Some illustrations showed that certain features of the IBEM are emulated by the stage-based model, but some differences in dynamics are also evident. Further work is needed to develop and apply diagnostics to compare the properties of the IBEM model and its emulator in order to make improvements to the latter.

The sub-committee thanked de la Mare for continuing to develop the IBEM and to initiate development of an emulator model. An emulator model could form the basis for future *Implementation Simulation Trials* once it is fully developed. The sub-committee noted that this work was initiated to examine more fully the relationship between $MSYR_{1+}$ and $MSYR_{mat}$, but that a stochastic model could replace the current deterministic model as the basis for the operating models used in *Implementation Simulation Trials*.

The sub-committee identified priorities for the next steps for this work:

(1) continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model;
(2) compare the yield curves from the IEBM with those from the emulator model; and
(3) develop guidelines for how to use an emulator model as the basis for a multi-stock, multi-area population dynamics model and how such a model could be conditioned given available data.

The sub-committee noted that it would not be easy to use age data during conditioning if the operating model were based on a stage-structured population dynamics model, and suggested that de la Mare consider developing an emulator model based on an age-structured model. In addition, it recognised the importance of applying the IEBM and any emulator model to minke whales, given that minke whales are the primary focus of the sub-committee.

2.2 Implications of *IST*s for consideration of 'status'

RMP and AWMP *Implementation Simulation Trials* are designed to provide robust management advice, but not 'status' in the traditional sense expected by the Commission (i.e. what is the present 'stock' level compared to the unexploited level and what are the likely future trends). Rather, they provide considerable output for a wide range of plausible scenarios that would need to be integrated and summarised to provide measures of status. The results of a set of *Implementation Simulation Trials* should be summarised by the following three statistics to provide information on status:

- current depletion (number of animals aged 1+ and older relative to 1+ carrying capacity);
- current 1+ abundance; and
- 1+ abundance in 2050 if all future RMP and AWMP catches (but not projected bycatches) are assumed to be zero.

Results should be provided for two values for the MSY rate (1% in terms of harvesting of the total (1+) component of the population and 4% in terms of harvesting of the mature component) unless the base-case trials are based on a higher value for the lowest plausible value for MSY rate or if MSY rate has been estimated and there is an agreed value. In addition, results should be summarised across simulations and trials (medians over simulations and averages across base-case trials).

Each base-case trial may have a different number of breeding stocks. Results should be reported by area, specifically for the Ocean Basin (i.e. 'Region'), and by 'Medium Area', rather than by the sub-areas on which the population model underlying the trials are based to avoid having a very large number of summary statistics. However, there needs to be flexibility in reporting. For example, the Committee may also wish to present results for individual biological stocks that it believes the Commission needs to be informed about, and hence that the default of reporting results by area would provide a misleading impression. For future assessments, the choice of the stocks for which results are reported needs to be decided during *Implementations* and *Implementation Reviews*. The sub-committee **recommends** that the Guidelines for Conducting *Implementations* and *Implementation Reviews* be updated to reflect that the choice of the stocks for which results are be reported needs to be decided during *Implementations* and *Implementation Reviews*, and that the control programs used for *Implementation Simulation Trials* be modified to report the three measures of status. In addition, the results for all stocks should be calculated and made available to the Commission, but not included in the primary presentation.

2.3 General consideration of how to evaluate the effect of special permit catches on stocks

Evaluation of the effects of catches on stocks should be based on the best available information regarding the status and productivity of the stock or stocks in the area in which scientific permit catches are to occur. Conducting projections to evaluate the effects of catches will rely on a well-specified sampling plan that includes details on where within the study area and when catches are expected to occur (should this information be uncertain, it will be necessary to consider sensitivity to alternative plausible outcomes of the sampling plan).

Where possible, evaluation of scientific permit catches should be based on existing models and methods developed by the Scientific Committee. The draft guidelines consider the following scenarios:

(1) where either an AWMP or RMP *Implementation* has been completed for the species/region concerned;
(2) where an in-depth assessment has been completed; and
(3) other cases (i.e. where neither (1) nor (2) apply).

In all cases, projections should consider a set of scenarios that aim to cover the core uncertainties for the region and species (although, not at the level of detail one would expect for an RMP/AWMP *Implementation*). In some cases, the amount of modelling work could be minimal if it is clear that the effects of the catches will be minimal. Appendix 2 outlines a set of guidelines for the calculations to evaluate the effects of special permit catches on stocks.

2.4 Improvements in management performance (in relation to RMP and SCAA) by improved precision in biological parameters

SC/67a/SCSP02 outlined a potential approach for using the RMP *Implementation Simulation Trial* framework to inform quantification of the management-related benefits of research programs. The approach involves:

(1) defining a metric to quantify the benefits of scientific research (such as the improvement in catches given a fixed level of risk);
(2) identifying a set of uncertainties that, if addressed, may improve management performance as indicated by that metric;
(3) calculating the extent to which alternative research programmes will reduce those uncertainties; and
(4) using simulations to relate the improved management performance to sample size.

A simple example was provided for a case in which a lethal research programme occurs in coastal areas and there is uncertainty about productivity (as quantified using MSYR) and stock structure (one or two stocks).

General issues

Discussion focussed on general issues related to evaluating management-related benefits of scientific research programmes and special permit programmes, in particular. The sub-committee noted that the present situation has been frustrating to both proponents and reviewers as witnessed by comments in Panel reports and in responses to those reports by proponents. It was agreed that, in principle, it would be useful to both proponents and reviewers if there were general guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits. Whilst the sub-committee agreed that it is not reasonable to 'accept' either a general assertion that there will be benefits or to 'require' a formal demonstration with 100% certainty that there will be an improvement, it was recognised from the discussions of the papers at this meeting that developing consensus on what constitutes 'sufficient' information will be a difficult task. It was therefore:

(1) agreed that the topic should be given priority at next year's sub-committee meeting; and
(2) strongly encouraged that members develop discussion documents (and where possible potential guidelines) to address this issue well in advance of next year's meeting.

While it was not considered appropriate to form an intersessional correspondence group, it encouraged collaboration and sharing of ideas amongst interested scientists.

The sub-committee noted that Panel Reports have included many 'recommendations', some of which are actually suggestions for further analyses to help the proponents as they conduct future work, but do not reflect fundamental flaws with the programme. It **recommends** that future Panel Reports separate out more clearly types of 'recommendations' (either: (a) tasks that the Panel considers need to be completed (and reviewed where necessary) before the lethal component of a programme is initiated; or (b) tasks required for non-lethal components of the programme to be better achieved) and 'suggestions' (tasks that are desirable to enhance the value of the research, but are not considered essential for the programme).

Specific issues

SC/67a/SCSP13 (see Appendix 3 for a summary) contains information about: (i) the basis and analytical methods related to the selection of the sample size for common minke whales (Annex 11 and section 3.1.3 of the revised NEWREP-NP research plan); (ii) the basis and analytical methods related to the selection of the sample size for sei whales (Annex 16 and section 3.2.3 of the revised NEWREP-NP research plan); and (iii) assessments of the potential effect of catches on the stocks of minke and sei whales (sections 4.1 and 4.2 of the revised NEWREP-NP research plan).

Some members of the sub-committee asserted that there was not a link between the collection of age data and improvement in management performance in the proposal nor in SC/67a/SCSP13, such as increased catches given pre-specified levels of risk. Other members responded that this level of analysis was not required for evaluation of a Scientific Permit proposal and that analyses presented to the 2016 meeting of the Scientific Committee (Government of Japan, 2016) had provided initial indications that a revision to the *CLA* that uses age data will lead to improved management performance. They also noted that age data can be used to improve estimates of natural mortality (*M*) for North Pacific sei whales, which is related to the size of expected catches.

SC/67a/SCSP08 reported simulation analyses addressing a part of the report of the Expert Panel review of NEWREP-NP. The Panel provided some conclusions on the potential reliability of estimates of *M* using statistical catch at age (SCAA) models and the likely utility of such estimates in providing information relevant to trials for the RMP. However, the Panel also considered that verification of those conclusions would be advisable. Simulations tests of SCAA analyses verified that the Panel's conclusions are correct. The simulations also showed that the proposed sample size in NEWREP-NP is too small to lead to narrowing the plausible ranges of the parameters used in RMP simulation trials. Sample sizes sufficiently large to lead to reliable estimates entail a substantial risk of further declines in population abundance.

The sub-committee noted that MSYR and *M* were estimated with bias in SC/67a/SCSP08 even with large sample sizes. De la Mare stated that larger catches led to less bias, but the exact reasons for the bias were unclear, although were perhaps related to lack of contrast.

Appendix 4 provides a response to SC/67a/SCSP08 by providing an example for North Pacific sei whales showing that the level of transient catch depends on *M*, for a fixed value for MSYR. Appendix 5 gives a counter example to Appendix 4 based on conclusions that might be drawn about the conservation performance of management using different values of *M*, with and without increasing natural mortality for older animals.

The sub-committee was unable to address all the implications raised in SC/67a/SCSP08, SC/67a/SCSP13 and Appendices 4 and 5. There were widely different opinions on the issues, which meant that achieving consensus within the sub-committee would be impossible at this meeting.

2.5 Work plan

Item	During the intersessional period	During SC/67b
Item 2.1: Conduct work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat.}$	(a) Parameterise the individual-based model for 'minke-like' whales (de la Mare); (b) further develop emulator models (de la Mare); and (c) conduct simulations of the *CLA* for the energetics-based model (de la Mare).	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat.}$
Item 2.2: Implications of *IST*s, for consideration of status.	(a) Update the Guidelines for *Implementations* and *Implementation Reviews* to reflect decisions on evaluation status of stocks (Donovan); and (b) modify the control programs used for *Implementation Simulation Trials* to report the three measures of status (Allison).	-
Item 2.4: Improvements in management performance (in relation to RMP and SCAA) by improved precision in biological parameters.	Develop documents on guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits.	Review any proposals on guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits.

3. RMP – *IMPLEMENTATION*-RELATED MATTERS

3.1 North Atlantic common minke whales

3.1.1 Report of the intersessional Workshop

Donovan summarised the report of the Third RMP Intersessional Workshop on the *Implementation Review* for North Atlantic common minke whales (SC/67a/Rep05, this volume). The Workshop was held at the kind invitation of the Greenland Representation, Copenhagen, from 16-18 December 2016 with the objective of facilitating the completion of the *Implementation Review* at the 2017 Annual Meeting of the Scientific Committee.

Fig. 1 shows a map of the 11 sub-areas referred to in the text whilst Fig. 2 shows the stock structure hypotheses considered.

The Workshop focused on finalising the trial specifications to account for issues raised at the 2016 Annual Meeting and intersessionally. Changes were made to the specifications of the trials to account for the following issues:

(a) taking account of process error in the CVs for the abundance estimates for the E sub-areas;
(b) modifying the mixing matrices to remove the possibility of unrealistically low values for the size of the W-2 stock prior to exploitation; and
(c) placing a maximum on the exploitation rates in the WG sub-area to avoid implausibly high values, especially when animals of only one stock (usually the W-2 stock) are in the WG sub-area.

The full set of trials are given in Table 1 and the Workshop confirmed the plausibility ratings agreed at the 2016 Annual Meeting and agreed those trials that needed reconditioning. Not all of those could be reconditioned at the Workshop and so it focussed on two of the more complex trials, NM01-1 and NM01-4. It agreed that these had been conditioned satisfactorily and that the rest of the trials should be conditioned prior to the 2017 Annual Meeting. The Workshop also updated the trial specifications to include

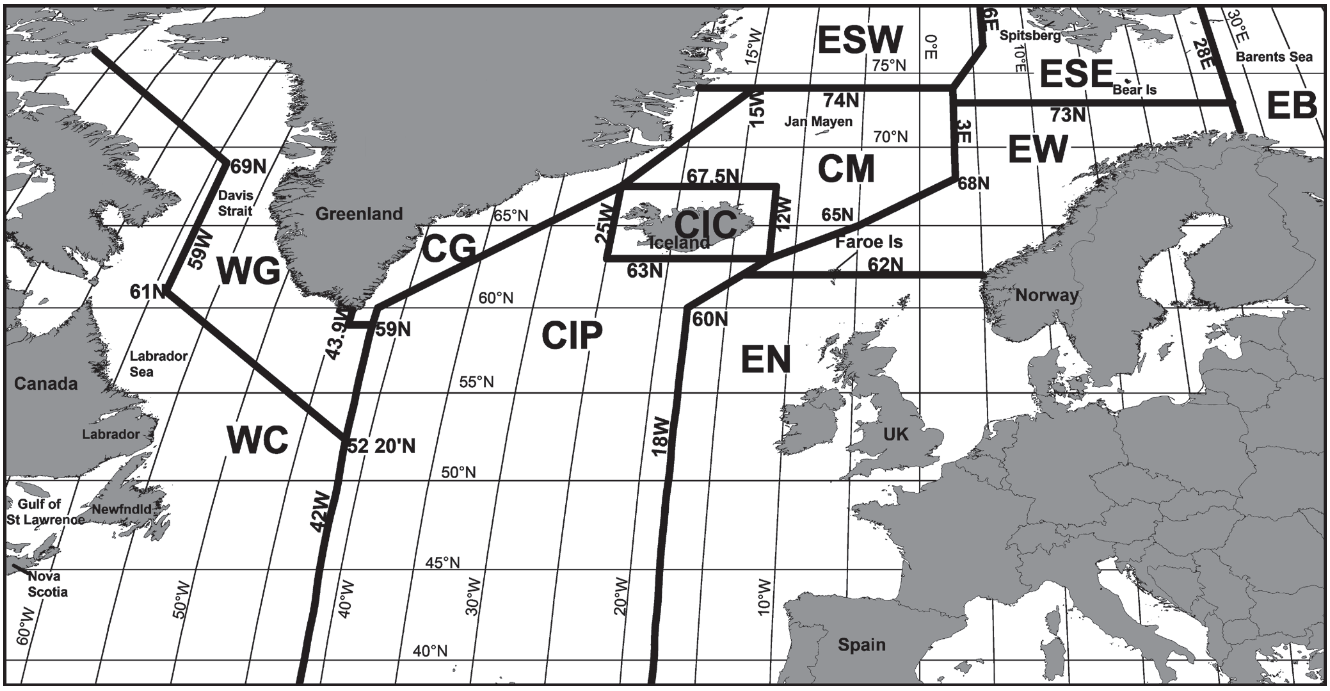


Fig. 1. Sub-areas used in the *Implementation Review* for the North Atlantic common minke whales.

Table 1

The *Implementation Simulation Trials* for North Atlantic minke whales. The trials in strikeout were eliminated during this meeting.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Trial weight	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	M	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	H	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	M	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	H	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	M	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	M	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	M	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	M	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
~~NM09-1~~	~~I~~	~~1%~~	~~3~~	~~Baseline~~	~~2008-13~~	~~M~~	~~E-2 stock in EN 10%~~
~~NM09-4~~	~~I~~	~~4%~~	~~3~~	~~Baseline~~	~~2008-13~~	~~M~~	~~E-2 stock in EN 10%~~
NM10-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM10-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM12-1	I	1%[1]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM12-4	I	4%[2]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM13-1	II	1%[1]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM13-4	II	4%[2]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM01-1v	I	1%[1]	3	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM01-4v	I	4%[2]	3	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM02-1v	II	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM02-4v	II	4%[2]	2	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM03-1v	III	1%[1]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM03-4v	III	4%[2]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-1v	IV	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-4v	IV	4%[2]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value

[1] 1+; [2] mature.

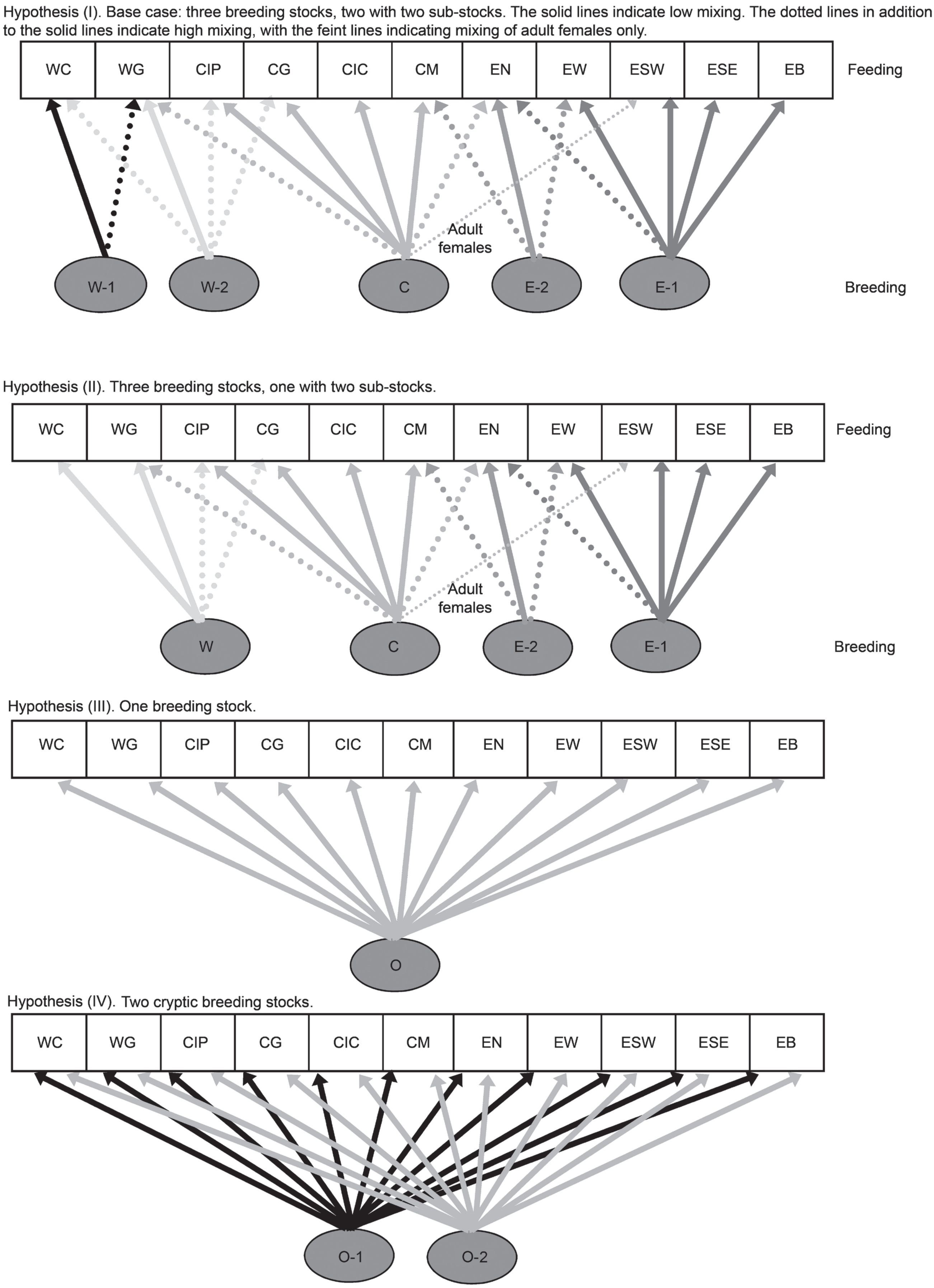


Fig. 2. Stock hypotheses considered in the *Implementation Review* for the North Atlantic common minke whales. Hypotheses I and II are considered high priority whilst Hypotheses III and IV are considered medium priority.

the most recent catches and agreed abundance estimates. The Workshop agreed that the projections would be based on the removals from the WG sub-area set to the minimum of need and the output from the interim *SLA* (IWC, 2009), rather than assuming the catch equals the need. A work plan was developed to enable the *Implementation Review* to be completed at the 2017 Annual Meeting.

In conclusion, Donovan thanked the participants for their dedicated work on such complex issues, particularly Punt and Allison.

The sub-committee thanked Donovan for chairing the meeting, which put the sub-committee in a position to complete the *Implementation Review* this year.

3.1.2 Completion of Implementation Review

3.1.2.1 CONDITIONING OF TRIALS

3.1.2.1.1 TRIALS NM09-1 AND NM09-2

Stock structure hypotheses I and II include two 'sub-stocks[1]' of the E stock. The E-2 sub-stock is found in sub-areas CM, EN and EW. Unlike the C stock and the E-1 sub-stock, there is no sub-area in which only the E-2 sub-stock is found. Thus, there are no data that directly inform on the minimum value for the unexploited abundance of the E-2 sub-stock. To address this, the trials based on stock hypotheses I and II arbitrarily specify that 50% of the whales in the EN sub-area at pristine equilibrium are from the E-2 sub-stock, with the entries in the mixing matrices for females in the E-2 sub-stock being pre-specified (80% of female E-2 animals are found in the EN sub-area). The unexploited and current abundances of the E-2 sub-stock are, in effect determined by the arbitrarily specified proportion of the number of animals in the EN sub-area that are from the E-2 sub-stock.

The results of the conditioning show that the size of the E-2 sub-stock ranges between ~3,000 mature females (trials NM10-1 and NM10-4) and 400 mature females (trials NM09-1 and NM09-4); the base-case trials (trials NM01-1, NM01-4, NM02-1, and NM02-4) are intermediate between these. For the base case trials, this leads to a current abundance for the E-2 stock of 1,500-2,000 mature females. In contrast, the current abundance of the E-1 sub-stock is approximately ten times higher at 20,000 mature females. All trials suggest that the *current* abundance of the E-2 stock is increasing and well above MSYL. In addition, all of the trials mimic the abundance and sex-ratio data adequately.

There is no stochastic mixing prior to the start of the projection period. However, the results of projections of the size of the E-2 sub-stock will be impacted by stochastic mixing. For years in which few C and E-1 whales are in sub-area EN, the exploitation rate on the E-2 sub-stock will be high. This effect is exacerbated for trial NM09-1; there can be as many as ~12,000 whales in the EN sub-area in some years, but in years where there are few C and E-1 whales present, abundance could be as low as 1,500. The operating model assumes that the allocated catch limits are taken exactly, irrespective of how few whales there are in the EN sub-area. This is unreasonable.

The sub-committee noted that evidence for sub-stocks within the E stock was weak and that the support for retaining the EN sub-stock as a possibility was because of some differences in chemical concentrations in blubber (IWC, 2015). Given the unexpected results in terms of unexploited size of the EN sub-stock and the weak evidence for existence of this sub-stock, the sub-committee **agrees** trials NM09-1 and NM09-4 are low plausibility.

[1]Sub-stocks are modelled as stocks. The joint AWMP/RMP Workshop on stock structure (IWC, 2015, p.552) had agreed that that there is a single E stock and the previous sub-stocks need not to be maintained. Nonetheless, because there was some discontinuity in pollutant profiles, it had also agreed that the separate sub-stocks may be maintained in the trials.

3.1.2.1.2 MODIFICATIONS TO TRIALS

Allison reported that the changes to the trials since the 2016 Scientific Committee were as follows.

(1) The 2015 abundance estimates and catches (as agreed at the December 2016 Workshop) are now included in the operating model. The first assessment is now in 2016 and it uses the new estimates. Any remaining abundance estimates for 2014-15 that are not yet available (for sub-areas ESW, ESE, EW and CM) are assumed to have occurred in 2016.

(2) The exploitation rate (catch as a proportion of the number of 1+ animals) in the WG sub-area is very high in a few years in the future when the catch for the WG sub-area is set to 164 whales, in particular when mixing is such that only animals of one stock (usually the W-2 stock) are in the WG sub-area. Given the nature of the hunt, it is implausible that aboriginal whalers could catch most of the whales in the WG sub-area in any one year. Therefore, a maximum annual exploitation rate was set for the WG sub-area. This maximum rate must be realistic given past exploitation rates achieved by aboriginal whalers, but not so low that the conservation performance of a candidate *SLA* would be impacted substantially. The maximum exploitation rate is set at twice the maximum historical exploitation rate achieved by aboriginal hunters; this level is sufficiently precautionary (exploitation rates can still be high enough that stocks can be depleted) and also more realistic given past exploitation rates.

(3) A minimum value for the mixing matrix parameter γ_{10} of 0.1 was imposed to eliminate the possibility of unrealistically low values for the size of the W-2 stock prior to exploitation, as agreed at the December 2016 Workshop.

(4) The new abundance estimates for the WG sub-area (in 2007 and 2015, see Table 2) led to implausibly low estimates of the pristine size of the W-2 sub-stock, so the following additional restraints were imposed:
   (a) the ratio of the pristine sizes of sub-stocks W-2 and W-1>0.10; and
   (b) the pristine size of sub-stock W-2 >2,000.

(5) The calculation of the final UAB statistics were revised so that they are based on comparison with projections with aboriginal catches in the WG and CG sub-areas set by the 'Interim *SLA*' (IWC, 2009), but no commercial catches.

(6) The CVs used by Norway when applying the RMP to the E *Medium Area* during the *catch cascading* process account for process error. However, the trials considered at the 2016 Scientific Committee ignored process error,

Table 2

New and revised abundance estimates for the North Atlantic common minke whales.

Year	Sub-area	Abundance	CV
2007	WG	9,853$	0.430
2015	WG	5,241	0.490
2015	CIP	6,306	0.345
2015	CG	5,408*	0.344
2015	CIC	12,710	0.530

$this replaces an earlier estimate of 16,609 (CV 0.428) as it takes into account improved information on availability bias (see SC/67a/Rep02). *CG sub-area estimate based on adding the estimates of abundance from TNASS-2015 (2,727; CV 0.52) and the East Greenland aerial survey (2,681; CV 0.45).

Table 3

Summary of the diagnostic plots and statistics used to evaluate conditioning.

Plot/statistic	Description	Factors in the evaluation
Fit of the operating model by sub-area to the estimates of abundance	The plot for each subarea shows the abundance estimates and their 90% confidence intervals, the fit of the model to the actual data ('deterministic'; solid red lines), and the median and 90% intervals from the 100 replicates (solid black and dashed lines respectively).	Adequate performance for these plots is that: (i) the 'deterministic' trajectory passes through the centroid of the data points; (ii) the 'deterministic' and median trajectories are not markedly different; (iii) the 90% interval for the 1+ abundance in a year with data matches the sampling distribution for the data when there is only one data point; and (iv) the 90% intervals for 1+ abundance for years with data are narrower than the sampling distributions when there are multiple abundance estimates for a sub-area.
Fit of the operating model to the sex ratio types ('original' and 'fishery').	The plots for each sex ratio type show the data points by sub-area and their assumed (normal) sampling distributions, along with the model-predictions from the fit to actual data, and the median and the 90% intervals for the model predictions.	For these plots, the 'deterministic' estimates should match the data almost exactly, and the 95% intervals from the stochastic replicates should closely match the sampling distributions. The model should mimic the original sex ratios fairly closely, but should not match them as well as the fishery sex ratios because the model imposes relationships among the abundances by sub-area, in particular that the overall sex ratio is 1:1 across the spatial domain of the model.
Individual trajectories of mature female numbers by sub-area	This plot shows 10 time-trajectories of mature female numbers by sub-area and the abundance estimates and their 90% confidence intervals	This plot is examined qualitatively to ensure that there are no 'unexpected' trajectories that would be missed by simply looking at overall 90% limits only.
Annual numbers of mature females.	This plot shows the median and 90% intervals for the annual numbers of mature females.	This plot is examined qualitatively to check that the model has not converged to an 'unrealistic' situation (e.g. that one of the stocks never existed).

which led to larger catch limits than would be expected in reality. The trials were therefore modified to multiply the observed CVs of abundance estimates for the E *Medium Area* by the slope of a regression of the CVs for the E *Medium Area* which took process error into account against the CVs for this Area when process error is ignored (1.43).

The sub-committee **endorses** these changes to the specifications. The final trial specifications are given as Appendix 6.

3.1.2.1.3 CONDITIONING

Table 3 provides a summary of the diagnostic statistics used to evaluate whether conditioning has been achieved satisfactorily and Fig. 3 shows some example diagnostic plots – the full set of diagnostics will be available at the Secretariat. The sub-committee considered that conditioning had been achieved satisfactorily for all trials in Table 1.

3.1.2.2 EVALUATION OF RMP VARIANTS: OVERVIEW OF PROCEDURE TO FOLLOW

The procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance agreed by the Committee (IWC, 2007) involves conducting the following steps for each stock (or sub-stock) in an *Implementation Simulation Trial*.

(1) Construct a single stock trial, which is 'equivalent' to the stock. For example, if a particular stock in the *Implementation Simulation Trial* involved carrying capacity halving over the 100-year projection period, the 'equivalent single stock trial' will also involve carrying capacity halving over the next 100 years.

(2) Conduct two sets of 100 simulations based on this single stock trial in which future catch limits are set by the *CLA*. The two sets of simulations correspond to the 0.60 and 0.72 tunings of the *CLA*. Rather than basing these calculations on a single initial depletion, the simulations for each stock shall be conducted for the distribution of initial depletions for the stock concerned in the *Implementation Simulation Trial* under consideration.

(3) The cumulative distributions for the final depletion and for the minimum depletion ratio (the minimum over each of the 100-year projections of a trial of the ratio of the population size to that when there are only incidental catches) shall be constructed for each of these two tunings of the *CLA*.

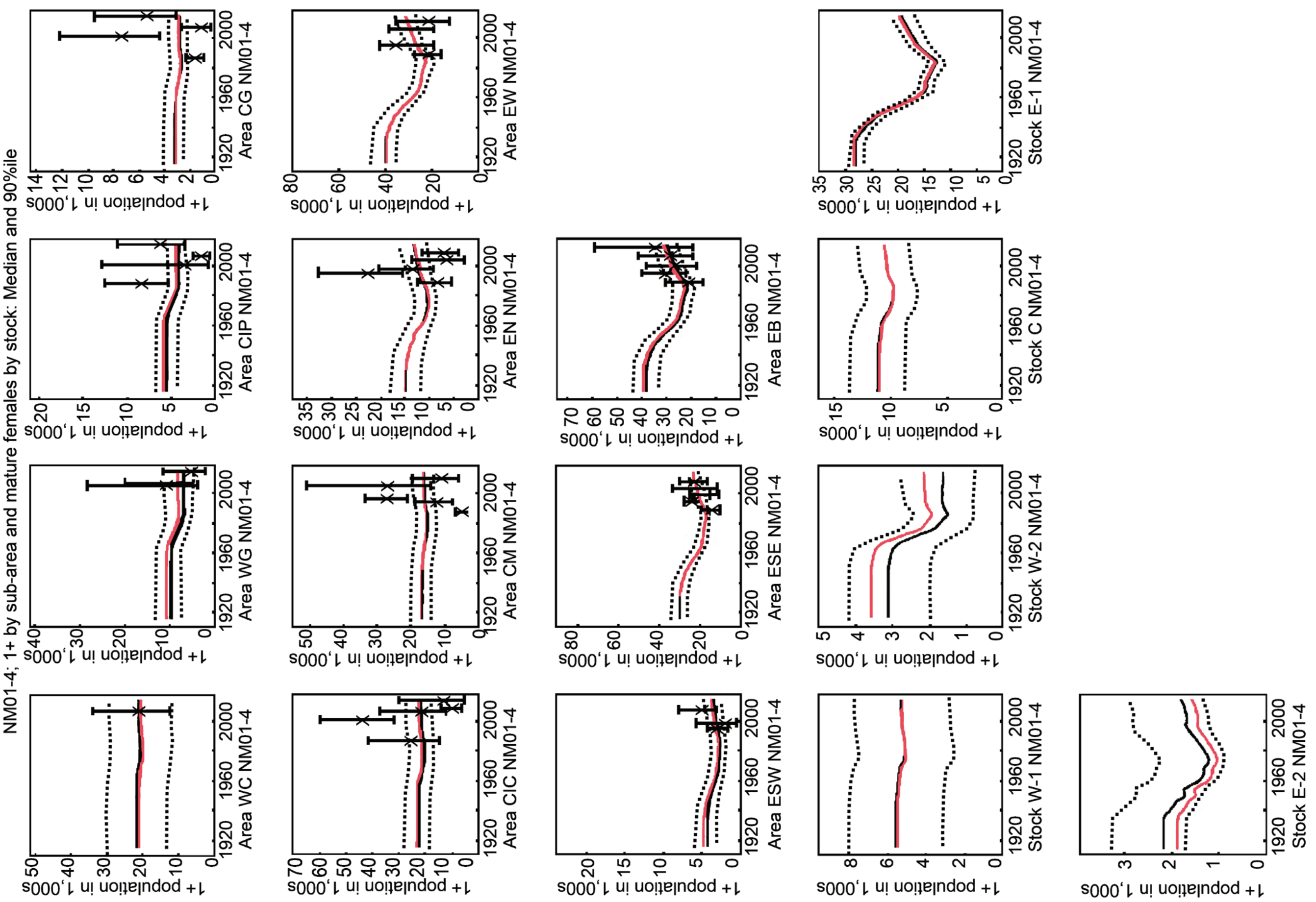
(4) The lower 5%-ile of these distributions shall form the basis for determining whether the performance of the RMP (i.e., the RMP variant under consideration) for the *Implementation Simulation Trial* is 'acceptable' - A, 'borderline' - B or 'unacceptable' - U, as follows:

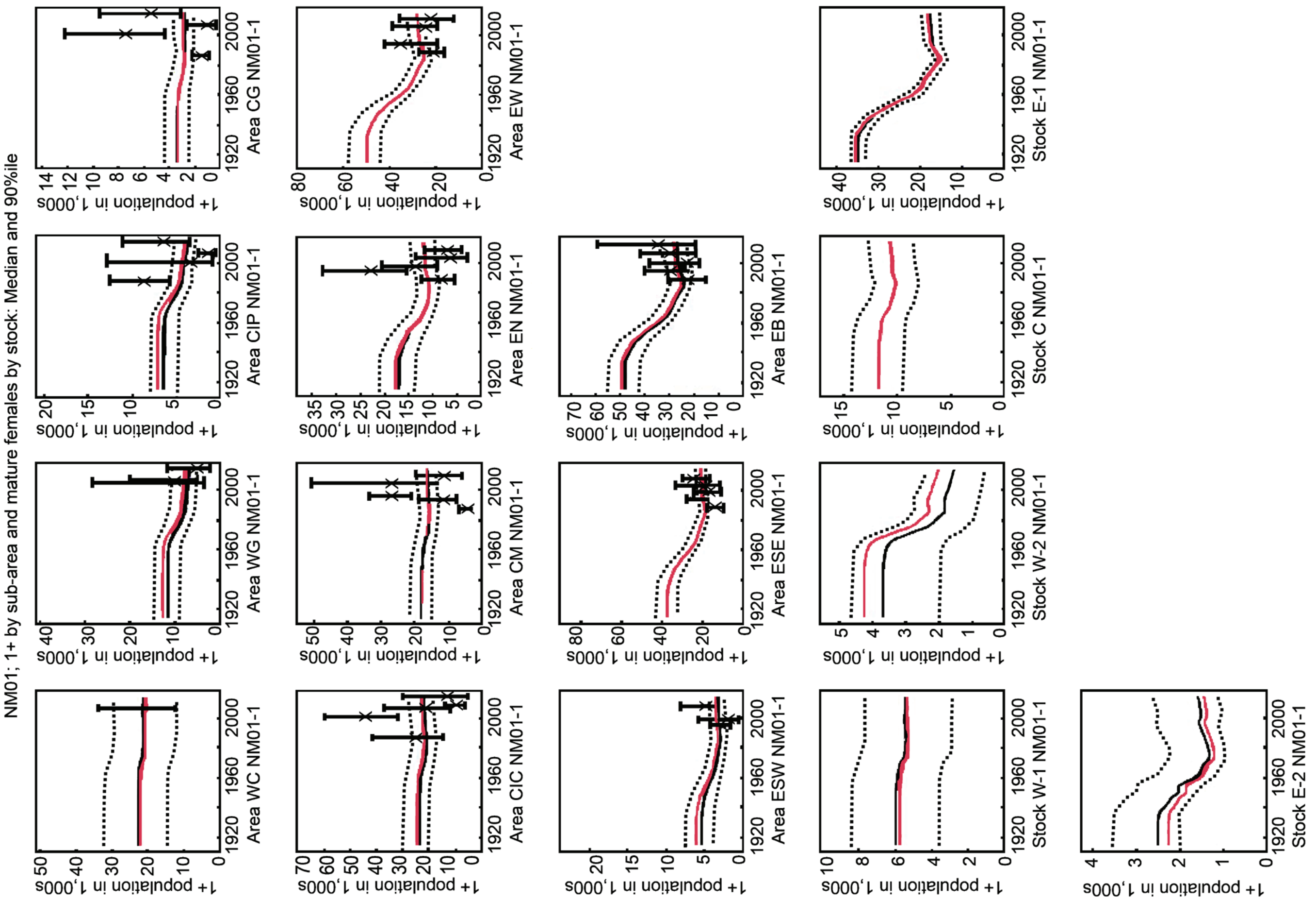
  (a) if the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than for the equivalent single stock trial with the 0.72 tuning of the *CLA* (or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than 0.999), the performance of the RMP variant shall be classified as 'acceptable';

  (b) if performance is not 'acceptable' and either the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than for the equivalent single stock trial with 0.60 tuning of the *CLA*, the performance of the RMP variant shall be classified as 'borderline'; and

  (c) if performance is neither 'acceptable' nor 'borderline' and if the 5%-ile of the final depletion and the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* are less than those for the equivalent single stock trial with 0.60 tuning of the *CLA*, then performance of the RMP variant shall be classified as 'unacceptable'.

If the performance for a small number of medium weight trials is 'borderline' but close to 'acceptable', then performance of the variant can be considered 'acceptable without research'. A flow chart summarising the decision process that should be followed is given as Fig. 4. The sub-committee reviewed the results of the *Implementation Simulation Trials* based on the experience gained during recent *Implementations* and *Implementation Reviews*. The purposes of the following tables range from providing a


NM01-4; 1+ by sub-area and mature females by stock: Median and 90%ile
1+ population in 1,000s
Area WC NM01-4
Area WG NM01-4
Area CIP NM01-4
Area CG NM01-4
Area CIC NM01-4
Area CM NM01-4
Area EN NM01-4
Area EW NM01-4
Area ESW NM01-4
Area ESE NM01-4
Area EB NM01-4
Stock W-1 NM01-4
Stock W-2 NM01-4
Stock C NM01-4
Stock E-1 NM01-4
Stock E-2 NM01-4


NM01; 1+ by sub-area and mature females by stock: Median and 90%ile
1+ population in 1,000s
Area WC NM01-1
Area WG NM01-1
Area CIP NM01-1
Area CG NM01-1
Area CIC NM01-1
Area CM NM01-1
Area EN NM01-1
Area EW NM01-1
Area ESW NM01-1
Area ESE NM01-1
Area EB NM01-1
Stock W-1 NM01-1
Stock W-2 NM01-1
Stock C NM01-1
Stock E-1 NM01-1
Stock E-2 NM01-1

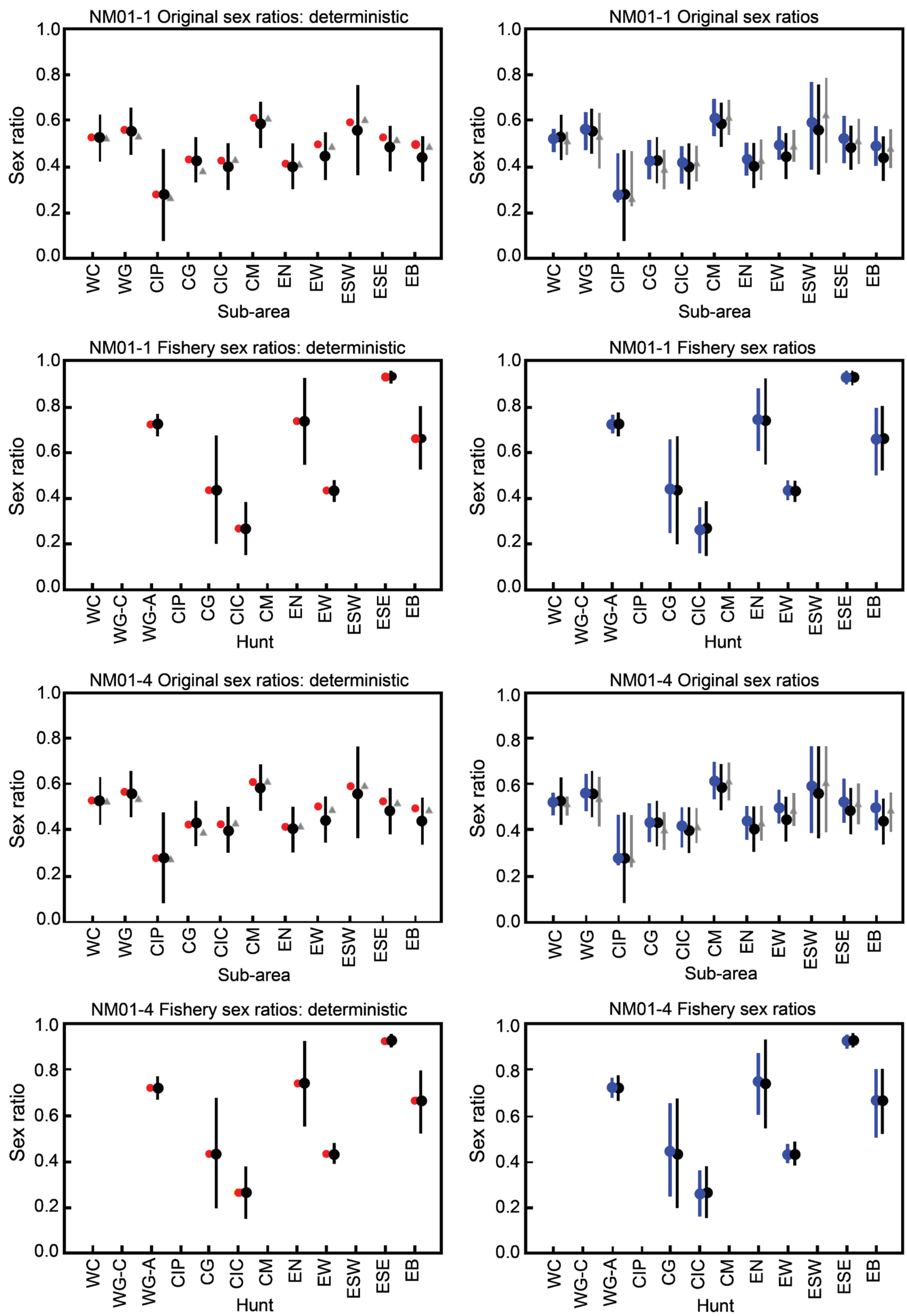


Fig 3. Examples of the plots used to evaluate conditioning for the NM01-1 and NM01-4 trials. The upper 11 plots on p.122 show the fit of the model to the actual data ('deterministic'; solid red lines), and the median and 90% intervals from the 100 replicates (solid black and dashed lines respectively) together with the abundance estimates and their 90% confidence intervals for each sub-area. The following 5 plots show the numbers of mature females by stock, again the median and 90% intervals from the 100 replicates and the 'deterministic' trajectory. Plots on the left of the page are for $MSYR_{1+}$=1% and on the right for $MSYR_{mat}$=4%. The plots on this page show the proportions of females by subarea in the pristine population (the 'original' sex ratios) and the fishery proportions. The plots on the left show the model-predictions from the fit to actual data by sub-area (red dots) together with the data points (black dots) and their assumed (normal) sampling distributions. The plots on the right show the median model predictions (blue dots) and the 90% intervals for each sex ratio type together with the data points and their assumed sampling distributions. The grey triangles show the sex ratio in the 2016 population for comparison with the pristine values.

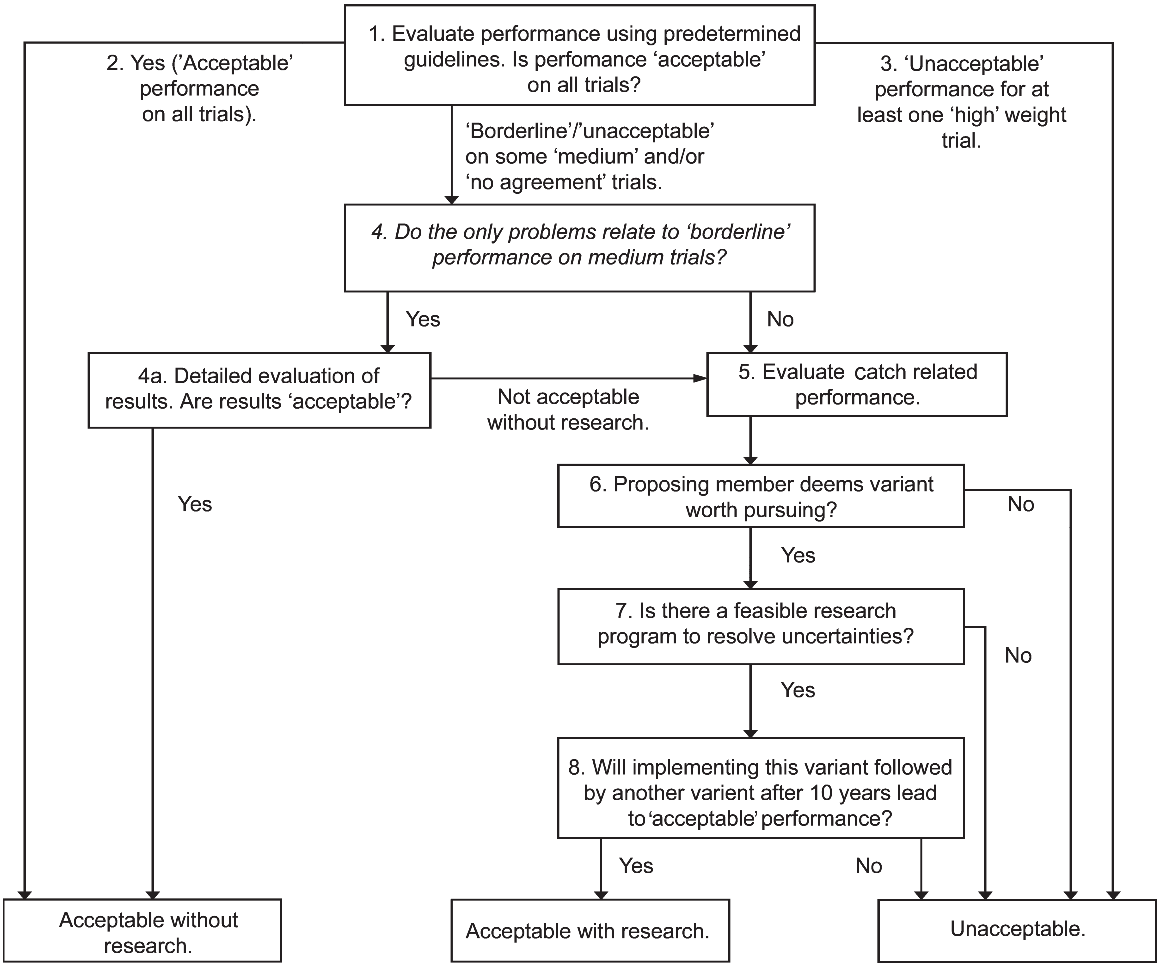


Fig. 4 Flowchart summarising the procedure for review of ISTs (IWC, 2005).

quick summary of conservation performance to listing many of performance statistics for each trial and RMP variant. The master set of plots and tables is archived by the Secretariat and available to members of the Scientific Committee on request.

(1) A table showing for each RMP variant: the average over the trials of the lower 5%-ile, median and upper 95%-ile of catch in the C and E *Medium Areas* for the first 10 years of the projection period and over the entire projection period and a summary of the application of the procedure for defining 'acceptable' - A, 'borderline' - B and 'unacceptable' - U performance. Results are shown separately for the 'high' and 'medium' plausibility trials (Table 4).
(2) A table showing the detailed results for each trial and RMP variant. The following information is included in this table:
   (a) median catch over the entire projection period and median, lower 5%-ile and upper 5%-ile over the first 10 years;
   (b) lower 5%-ile and median of the final depletion distribution (by stock);
   (c) lower 5%-ile and median of the minimum depletion ratio distribution (by stock); and
   (d) lower 5%-ile and median of the initial depletion distribution (by stock).

This table also includes the values for the thresholds for each performance statistic and stock for the trials and the outcomes of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance.

3.1.2.3 EVALUATION OF RMP VARIANTS: REVIEW TRIAL RESULTS

The five management variants to be considered were as follows:

(1) Sub-areas CIC, CM, CG, CIP, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the ESW+ESE *Small Area* is all taken in sub-area ESE. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);
(2) Sub-areas CIC, CM, CG, CIP, EN and EB+ESW+ESE+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ ESW+ESE +EW *Small Area* is all taken in sub-area EW. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);
(3) Sub-areas CIC, CM, CG, CIP, EN, ESW+ESE, and EB+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ EW *Small Area* is all taken in sub-area EW and the catch from the ESW+ESE *Small Area* is taken in the ESE sub-area. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);
(4) As for variant 1, except that sub-areas CIC+CIP+CM are a single *Small Area* and all of the catches from this

Small Area are taken in sub-area CIC. The catch limits set for the CG *Small Area* are not taken (except that the Aboriginal catch is taken); and

(5) Sub-areas CIP+CIC+CG+CM, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for the E *Small Areas* based on catch cascading from the E *Combination Area*. All the catches from CIP+CIC+CG+CM *Small* Area are taken in sub-area CIC (after taking the Aboriginal catch from CG) and those for the ESW+ESE *Small Area* are taken in sub-area ESE.

There are a number of possible scenarios to consider when evaluating the trials, and it is at this stage that a degree of judgement is required, including consideration of the overall balance of the trials and the characteristics of the specific trials for which performance is questionable. Table 5 summarises the application of the rules for evaluating conservation performance:

(1) There is no RMP variant for which performance is 'acceptable' for all trials (step 1). However, none of the RMP variants performed 'unacceptably' on a 'high' weight trial so step 4 of the flowchart is applied.
(2) All of the RMP variants had 'borderline' performance for the same trials (NM01-1, NM02-1, NM05-1, NM06-1, NM12-1, NM13-1, and NM01-1v) and sub-stock (E-2). The sub-committee therefore considered the conservation performance for each RMP variant for these trials in detail (step 4a):
    (a) Variant 1. The performance statistics for this variant are just below the 'acceptable' threshold for trials NM06-1 and NM13-1 and closer to the 'acceptable' rather than the 'unacceptable' threshold for all but trial NM01-1v.
    (b) Variant 2. The conservation performance of the variant is poorer than for variant 1, with values for the performance statistics closer to the 'unacceptable' threshold, and close to the 'unacceptable' threshold for trial NM12-1.
    (c) Variant 3. The conservation performance for this variant is intermediate between those for variants 1 and 2.
    (d) Variant 4. This variant achieved performance statistics for trials NM02-1, NM06-1 and NM13-1 that were marginally different from 'acceptable', and achieved performance statistics that were closer to the 'acceptable' rather than the 'unacceptable' threshold for all other trials for which performance was 'borderline'.
    (e) Variant 5. The performance of this variant was essentially identical to that for variant 4.

Overall, and taking into account that less than acceptable performance occurred only for one sub-stock when $MSYR_{1+}$ was 1%, that the evidence for sub-stock E-2 is very weak, and that the performance statistics for variants 1, 3, 4 and 5 were closer to 'acceptable' than 'unacceptable' even for this stock, the sub-committee **recommends** these variants to be considered be 'acceptable without research'. In terms of catch performance, all of the RMP variants achieve very similar catches (particularly when average catch over 100 years is considered) for the E *Medium Area* (Table 5). In contrast, RMP variants 4 and 5 lead to higher catches for the C *Medium Area*, with variant 5 leading to catches that are higher than those for variant 4. Given that variant 2 performs close to 'unacceptably' on several trials and does not outperform the other variants in terms of catch statistics, the sub-committee **concludes** that this variant is 'unacceptable'.

3.1.3 New information

SC/67a/NH05 reported estimates of abundance for the CIC area based on an aerial survey conducted during July 2016. The estimates were reviewed by the ASI Working Group (see Item 3 of Annex Q), which focused on the incomplete coverage of several of the survey blocks and how to perhaps obtain a minimum estimate of abundance for future use in an *Implementation Review*. The ASI Working Group also reviewed the report of the 2016 survey in Management sub-area CM (SC/67a/RMP01) and the progress towards the next estimate of abundance for the E *Medium Area* (SC/67a/RMP03).

3.1.4 Conclusions and recommendations

Based on the results of the *Implementation Simulation Trials*, variants 1, 3, 4 and 5 are acceptable in terms of conservation performance. Of these variants, variant 5 achieves the best performance in terms of catch.

The sub-committee noted the considerable work that has been undertaken to complete the *Implementation Review*, which involved revising the stock structure hypotheses and hence the *Implementation Simulation Trials*. The sub-committee particularly acknowledged the work of Allison and de Moor who coded and ran the trials and Donovan who led this *Implementation Review*.

This completes the *Implementation Review*.

3.2 North Pacific common minke whales

3.2.1 Review of new information

Allison and de Moor informed the sub-committee that a minor error had been detected in the code implementing the *Implementation Simulation Trials* for the western North Pacific minke whales. The error has been corrected, with no substantial changes to the conclusions from the *Implementation Review* that was completed in 2013.

The sub-committee noted that discussions in the Working Group on Stock Definition and DNA related to stock structure for the western North Pacific minke whales (Item 2.2 of Annex I). The SDDNA WG agreed that the results of the kinship analysis are inconsistent with the mixing matrices associated with stock structure hypothesis C as currently implemented in the *Implementation Simulation Trials* among sub-areas 7CS, 7CN, 8 and 9. The implications of these discussions will need to be accounted for during the upcoming *Implementation Review*.

3.2.2 Prepare for the next Implementation Review

The sub-committee noted that considerable amounts of new information, in particular genetics data, has been collected since the last *Implementation Review* in 2013. In particular, that *Implementation Review* had been based on genetics data to 2006 and many samples had been collected and analysed since then.

The sub-committee recognised that the most difficult aspect of the last *Implementation Review* had been selecting, modelling and assigning plausibility to stock structure hypotheses. Although considerable new data and analyses had been become available since 2013, it was likely that resolving how to handle stock structure uncertainty in the next *Implementation Review* will again be challenging. Much progress on complex topics such as addressing stock structure uncertainty can be accomplished during focused Workshops. The sub-committee therefore **recommends** that a preparatory meeting be held prior to SC/67b on stock structure for western North Pacific minke whales. This meeting can be held immediately before or after the second Intersessional Workshop for the western North Pacific Bryde's whales.

Table 4

Table of summary statistics for the *Implementation Simulation Trials* for the North Atlantic common minke whales.

Trial	Var	C Area Average Catch			C Area 1st 10 years			E Area Average Catch			E Area 1st 10 years			P final					P min					Combined					Overall
		Med	5%	95%	Med	5%	95%	Med	5%	95%	Med	5%	95%	V1	2	3	4	5	V1	2	3	4	5	V1	2	3	4	5	
NM01-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM01-1	V1	130	86	190	154	145	164	371	252	522	410	359	473	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1	V2	130	86	190	154	145	164	411	290	547	410	364	465	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1	V3	130	86	190	154	145	164	388	261	529	411	362	472	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1	V4	264	213	326	358	352	380	369	250	519	410	359	473	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1	V5	275	223	342	389	384	409	368	250	518	410	359	473	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM01-4	V1	129	87	184	154	145	164	506	383	672	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4	V2	129	87	184	154	145	164	517	395	669	425	382	493	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4	V3	129	87	184	154	145	164	512	389	672	426	379	497	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4	V4	277	221	341	359	352	380	505	382	671	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4	V5	288	233	351	390	384	409	505	382	671	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM02-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM02-1	V1	138	91	202	154	144	165	368	253	511	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-1	V2	138	91	201	154	144	165	417	283	551	408	362	478		A	A	A	B		A	A	A	B		A	A	A	B	B
NM02-1	V3	138	91	202	154	144	165	385	263	530	410	361	483		A	A	A	B		A	A	A	B		A	A	A	B	B
NM02-1	V4	285	225	347	358	351	386	366	250	509	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-1	V5	293	236	365	389	384	414	366	249	508	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM02-4	V1	135	92	200	154	143	165	507	376	674	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4	V2	135	92	200	154	143	165	523	400	663	423	379	488		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4	V3	135	92	200	154	143	165	517	381	672	424	377	499		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4	V4	282	229	350	358	351	387	506	375	671	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4	V5	294	242	363	390	384	416	506	375	671	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM03-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM03-1	V1	133	99	195	155	149	166	506	369	653	427	381	500			A					A					A			A
NM03-1	V2	135	102	200	155	149	166	531	405	656	426	396	483			A					A					A			A
NM03-1	V3	134	100	197	155	149	166	513	380	650	428	389	493			A					A					A			A
NM03-1	V4	237	188	314	357	351	371	487	352	633	427	381	500			A					A					A			A
NM03-1	V5	235	186	318	389	383	401	486	351	632	427	381	500			A					A					A			A
NM03-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM03-4	V1	130	96	191	154	149	166	507	367	660	433	385	509			A					A					A			A
NM03-4	V2	130	97	193	154	149	166	515	369	640	431	403	492			A					A					A			A
NM03-4	V3	130	97	192	154	149	166	510	372	655	434	392	503			A					A					A			A
NM03-4	V4	234	186	303	358	351	371	497	359	648	433	385	509			A					A					A			A
NM03-4	V5	232	184	305	389	383	401	497	359	648	433	385	509			A					A					A			A
NM04-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM04-1	V1	119	87	170	156	149	167	571	438	722	434	387	511			A	A				A	A				A	A		A
NM04-1	V2	121	88	175	156	149	167	600	483	713	434	404	493			A	A				A	A				A	A		A
NM04-1	V3	120	87	173	156	149	167	578	452	719	435	397	501			A	A				A	A				A	A		A
NM04-1	V4	196	154	275	355	351	369	555	420	706	434	387	511			A	A				A	A				A	A		A
NM04-1	V5	195	149	274	387	383	399	554	420	705	434	387	511			A	A				A	A				A	A		A
NM04-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM04-4	V1	117	85	168	156	149	167	576	434	737	440	391	520			A	A				A	A				A	A		A
NM04-4	V2	117	85	169	156	149	167	589	454	702	438	410	500			A	A				A	A				A	A		A
NM04-4	V3	117	85	168	156	149	167	583	447	722	440	401	512			A	A				A	A				A	A		A
NM04-4	V4	195	154	267	356	351	368	568	426	729	440	391	520			A	A				A	A				A	A		A
NM04-4	V5	193	151	268	387	383	398	567	426	728	440	391	520			A	A				A	A				A	A		A
NM05-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM05-1	V1	132	85	190	154	145	164	372	256	525	410	360	481	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM05-1	V2	131	85	190	154	145	164	413	290	549	410	361	472	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM05-1	V3	131	85	190	154	145	164	391	264	534	411	362	476	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM05-1	V4	267	214	330	359	352	380	370	254	523	410	360	481	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM05-1	V5	275	223	346	390	384	409	370	254	523	410	360	481	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM05-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM05-4	V1	129	87	183	154	145	164	506	378	664	424	374	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM05-4	V2	129	87	184	154	145	164	518	390	664	423	380	487	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM05-4	V3	129	87	184	154	145	164	511	379	662	425	378	494	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM05-4	V4	276	223	341	359	352	380	505	378	664	424	374	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM05-4	V5	286	237	348	390	384	409	505	378	664	424	374	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM06-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM06-1	V1	138	91	199	154	143	165	373	255	517	409	358	484		A	A	A	B		A	A	A	B		A	A	A	B	B
NM06-1	V2	138	91	199	154	143	165	418	290	558	409	361	472		A	A	A	B		A	A	A	B		A	A	A	B	B
NM06-1	V3	138	91	199	154	143	165	389	265	531	410	362	480		A	A	A	B		A	A	A	B		A	A	A	B	B
NM06-1	V4	284	226	343	358	352	387	371	253	512	409	358	484		A	A	A	B		A	A	A	B		A	A	A	B	B
NM06-1	V5	293	239	362	389	384	415	371	253	511	409	358	484		A	A	A	B		A	A	A	B		A	A	A	B	B
NM06-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM06-4	V1	135	90	198	154	143	165	508	374	672	424	371	508		A	A	A	A		A	A	A	A		A	A	A	A	A
NM06-4	V2	135	90	197	154	143	165	523	392	665	424	379	490		A	A	A	A		A	A	A	A		A	A	A	A	A
NM06-4	V3	135	90	197	154	143	165	516	378	671	425	377	496		A	A	A	A		A	A	A	A		A	A	A	A	A
NM06-4	V4	284	226	347	358	352	386	507	373	671	424	371	508		A	A	A	A		A	A	A	A		A	A	A	A	A
NM06-4	V5	295	241	360	390	384	414	506	373	670	424	371	508		A	A	A	A		A	A	A	A		A	A	A	A	A
NM07-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM07-1	V1	127	87	186	154	145	164	369	253	520	410	359	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-1	V2	127	87	186	154	145	164	402	283	540	409	364	470	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-1	V3	127	87	186	154	145	164	381	259	521	411	362	475	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-1	V4	248	198	311	358	352	380	365	249	516	410	359	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-1	V5	254	205	316	390	384	409	365	249	516	410	359	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Trial	Var	C Area Average Catch Med	5%	95%	C Area 1st 10 years Med	5%	95%	E Area Average Catch Med	5%	95%	E Area 1st 10 years Med	5%	95%	P final V1	2	3	4	5	P min V1	2	3	4	5	Combined V1	2	3	4	5	Overall
NM07-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM07-4	V1	129	87	182	154	145	165	506	377	661	424	374	509	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-4	V2	129	87	182	154	145	165	518	390	657	424	379	488	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-4	V3	129	87	182	154	145	165	513	379	658	425	378	494	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-4	V4	272	218	334	359	352	380	504	376	660	424	374	509	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM07-4	V5	279	230	340	390	384	409	504	376	659	424	374	509	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM10-1	V1	134	96	193	153	144	163	370	258	511	409	361	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-1	V2	134	96	193	153	144	163	410	300	543	410	374	466	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-1	V3	134	96	193	153	144	163	384	274	518	412	368	473	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-1	V4	266	220	340	360	352	383	369	258	510	409	361	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-1	V5	277	231	352	391	384	412	369	258	510	409	361	478	A	U	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM10-4	V1	134	96	190	153	144	164	506	388	652	424	371	501	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-4	V2	134	96	189	153	144	164	521	407	642	427	387	482	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-4	V3	134	96	189	153	144	164	513	394	644	426	378	489	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-4	V4	280	232	358	360	352	383	505	387	652	424	371	501	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM10-4	V5	291	244	369	391	384	412	505	387	651	424	371	501	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM12-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM12-1	V1	130	87	187	154	144	164	363	250	513	407	353	476	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM12-1	V2	130	87	187	154	144	164	407	279	541	408	361	470	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM12-1	V3	130	87	187	154	144	164	380	253	515	409	359	476	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM12-1	V4	265	211	322	358	352	382	360	247	511	407	353	476	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM12-1	V5	275	224	340	389	384	411	360	247	511	407	353	476	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM12-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM12-4	V1	127	86	189	154	144	164	509	382	672	423	371	505	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM12-4	V2	127	86	189	154	144	164	522	411	665	424	381	490	A	B	A	A	A	A	A	A	A	B	A	A	A	A	A	A
NM12-4	V3	127	86	189	154	144	164	516	390	670	425	375	495	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM12-4	V4	273	219	328	358	352	382	507	381	670	423	371	505	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM12-4	V5	281	232	340	389	384	411	507	380	670	423	371	505	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM13-1	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM13-1	V1	136	91	200	154	143	165	363	244	505	408	356	486		A	A	A	B		A	A	B	B		A	A	A	B	B
NM13-1	V2	136	91	200	154	143	165	407	281	539	410	361	479		A	A	A	B		A	A	A	B		A	A	A	B	B
NM13-1	V3	136	91	200	154	143	165	380	257	522	409	360	485		A	A	A	B		A	A	A	B		A	A	A	B	B
NM13-1	V4	283	226	353	358	351	386	358	241	502	408	356	486		A	A	A	B		A	A	B	B		A	A	A	B	B
NM13-1	V5	293	232	366	389	383	414	358	241	502	408	356	486		A	A	A	B		A	A	B	B		A	A	A	B	B
NM13-4	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM13-4	V1	134	91	198	154	143	166	514	386	675	424	372	515		A	A	A	A		A	A	A	A		A	A	A	A	A
NM13-4	V2	134	91	198	154	143	166	530	410	659	424	382	497		A	A	A	A		A	A	A	A		A	A	A	A	A
NM13-4	V3	134	91	198	154	143	166	520	396	668	425	375	503		A	A	A	A		A	A	A	A		A	A	A	A	A
NM13-4	V4	283	229	353	358	351	387	511	384	672	424	372	514		A	A	A	A		A	A	A	A		A	A	A	A	A
NM13-4	V5	293	239	366	389	383	415	511	384	671	424	372	514		A	A	A	A		A	A	A	A		A	A	A	A	A
NM01-1V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM01-1V	V1	155	114	213	153	147	159	383	263	517	414	368	478	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1V	V2	155	114	213	153	147	159	427	311	541	413	373	461	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1V	V3	155	114	213	153	147	159	399	279	513	413	370	469	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1V	V4	284	228	350	360	354	374	381	261	514	414	368	478	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-1V	V5	288	235	353	390	386	403	381	261	514	414	368	478	A	U	A	A	B	A	A	A	A	B	A	A	A	A	B	B
NM01-4V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM01-4V	V1	129	87	184	154	145	164	506	383	672	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4V	V2	129	87	184	154	145	164	517	395	669	425	382	493	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4V	V3	129	87	184	154	145	164	512	389	672	426	379	497	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4V	V4	277	221	341	359	352	380	505	382	671	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM01-4V	V5	288	233	351	390	384	409	505	382	671	425	375	507	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
NM02-1V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM02-1V	V1	138	91	202	154	144	165	368	253	511	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-1V	V2	138	91	201	154	144	165	417	283	551	408	362	478		A	A	A	B		A	A	A	B		A	A	A	B	B
NM02-1V	V3	138	91	202	154	144	165	385	263	530	410	361	483		A	A	A	B		A	A	A	B		A	A	A	B	B
NM02-1V	V4	285	225	347	358	351	386	366	250	509	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-1V	V5	293	236	365	389	384	414	366	249	508	409	357	485		A	A	A	B		A	A	B	B		A	A	A	B	B
NM02-4V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM02-4V	V1	135	92	200	154	143	165	507	376	674	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4V	V2	135	92	200	154	143	165	523	400	663	423	379	488		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4V	V3	135	92	200	154	143	165	517	381	672	424	377	499		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4V	V4	282	229	350	358	351	387	506	375	671	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM02-4V	V5	294	242	363	390	384	416	506	375	671	424	371	509		A	A	A	A		A	A	A	A		A	A	A	A	A
NM03-1V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM03-1V	V1	151	122	219	154	149	162	445	318	586	423	381	486			A					A					A			A
NM03-1V	V2	155	124	222	154	149	162	471	341	594	423	394	470			A					A					A			A
NM03-1V	V3	153	123	220	154	149	162	454	329	583	425	388	474			A					A					A			A
NM03-1V	V4	283	237	368	359	352	369	425	302	559	423	381	486			A					A					A			A
NM03-1V	V5	284	236	377	390	384	399	425	301	557	423	381	486			A					A					A			A
NM03-4V	V0	12	12	12	12	12	12	0	0	0	0	0	0																
NM03-4V	V1	149	120	212	154	149	162	447	308	581	429	387	496			A					A					A			A
NM03-4v	V2	150	120	213	154	149	162	449	321	575	429	400	477			A					A					A			A
NM03-4V	V3	149	120	212	154	149	162	450	313	579	430	393	484			A					A					A			A
NM03-4V	V4	279	236	363	359	352	369	436	299	569	429	387	496			A					A					A			A
NM03-4V	V5	279	235	371	390	384	399	436	298	568	429	387	496			A					A					A			A

Table 5

Summary of the conservation and catch performance of the five RMP variants for the North Atlantic common minke whales.

		No. of trials			C Medium Area				E Medium Area			
					Catch first ten years		Catch average		Catch first ten years		Catch average	
Variant	Trial weight	Acceptable	Border-line	Un-acceptable	Mean med	Mean 5%	Mean med	Mean 5%	Mean med	Mean 5%	Mean med	Mean 5%
1	H	9	0	0	132	90	154	144	506	380	424	373
2	H	9	0	0	132	90	154	144	520	398	424	380
3	H	9	0	0	132	90	154	144	514	385	425	378
4	H	9	0	0	280	225	358	352	506	378	424	373
5	H	9	0	0	291	238	390	384	506	378	424	373
1	M	82	9	0	134	94	154	145	451	326	420	370
2	M	82	9	0	134	94	154	145	477	352	420	379
3	M	82	9	0	134	94	154	145	461	334	421	375
4	M	82	9	0	266	214	358	352	446	321	420	370
5	M	82	9	0	273	222	389	384	445	321	420	370

3.3 Western North Pacific Bryde's whales

3.3.1 Report of the intersessional Workshop

Donovan summarised the report of the First Intersessional Workshop on the *Implementation Review* of western North Pacific Bryde's whales (SC/67a/Rep07). This Workshop, chaired by Donovan, was held in Tokyo from 21-24 March 2017 at the excellent facilities in the Ministry of Agriculture, Forestry and Fisheries Sanbancho Branch Office.

The Workshop made considerable progress with this being the first *Implementation Review* since the completion of the *Implementation* in 2007 as summarised below.

(1) The Workshop reviewed the new information relevant to stock structure and agreed to take forward two stock structure hypotheses - one of the four considered at the 2007 *Implementation* and one new hypothesis (Fig. 5).
  (a) *Hypothesis 2*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2.
  (b) *Hypothesis 5*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2 with mixing occurring in sub-area 1E. There are more animals from stock 1 than stock 2 in the mixing area.

(2) The Workshop reviewed new information on abundance estimates and developed a workplan to try to obtain agreed abundance estimates (including additional variance) for use in conditioning the trials and the *CLA*.

(3) The Workshop developed a new set of simulation trials for the *Implementation Review* that involve exploring the implications of uncertainty in stock structure, stock boundaries, MSYR, removals and additional variance.

(4) The Workshop developed an ambitious work plan to try to complete the *Implementation Review* at SC/67a in May 2017.

The sub-committee noted that the intersessional Workshop led to considerable progress towards completing the *Implementation Review* and had been conducted in an excellent spirit of co-operation among the participants. It thanked Donovan for chairing the meeting and all the participants for their contributions to the development of trial specifications and work plan.

3.3.2 Progress since the intersessional Workshop

Allison and de Moor stated that they had begun updating the previous *Implementation Simulation Trials* for the North Pacific Bryde's whales to include the new hypotheses and trials. However, no conditioning results are available at present. It will be necessary to update the trials to include density-dependence in *M*, as agreed last year (IWC, 2017). In addition, the future survey plan needs to be clarified. It was noted that the proposed intersessional Workshop would provide a forum to review further progress and to finalise the trials based on density-dependence in *M*.

SC/67a/RMP04 responded to a recommendation from the Workshop and provided estimates of abundance for 2008-15 based on data from the 2013-15 IWC-POWER and 2008, 2012 and 2014 JARPN II surveys, along with an estimate of additional variance. These estimates were adopted for use in trials and in the *CLA* (see Item 3.1.1.9 of Annex Q on Bryde's whales). The trial specifications will need to be updated to reflect this new information.

Wade noted that SC/67a/Rep07 reported that only 65% of samples could be aged using earplugs and suggested that the use of epigenetic methods for age determination should be explored for Bryde's whales. Other members noted that there is continuing debate on the value of the use of epigenetic methods (Jarman *et al.*, 2015; Polanowski *et al.*, 2014; SC/67a/Rep01). The sub-committee noted that the trials are no longer conditioned using age data unlike the *Implementation* (IWC, 2008), but that the value of alternative methods for age determination remains of general scientific interest.

3.3.3 Conclusions and recommendations

The *Implementation Review* is progressing well, but the ambitious work plan established at the March 2017 Workshop could not be achieved in the limited time available. Progress towards completing the *Implementation Review* will be enhanced if a Workshop were to take place during the intersessional period to finalise trial specifications and review initial conditioning results. This Workshop could be conducted in conjunction with the preparatory meeting proposed for the *Implementation Review* for the North Pacific minke whales (Item 3.2.2).

3.4 North Atlantic fin whales

There was no new information for the North Atlantic fin whales.

3.5 Review RMP *Implementation Review* schedule for the next six years

There is a system of regular (5-6 year) *Implementation Reviews* with established guidelines. The current schedule of *Implementation Reviews* (which may need to be adjusted if the *Implementation Reviews* that are scheduled first take longer than anticipated) is as follows:

(1) Western North Pacific Bryde's whales: started in 2017;
(2) Western North Pacific common minke whales: starting in 2018;

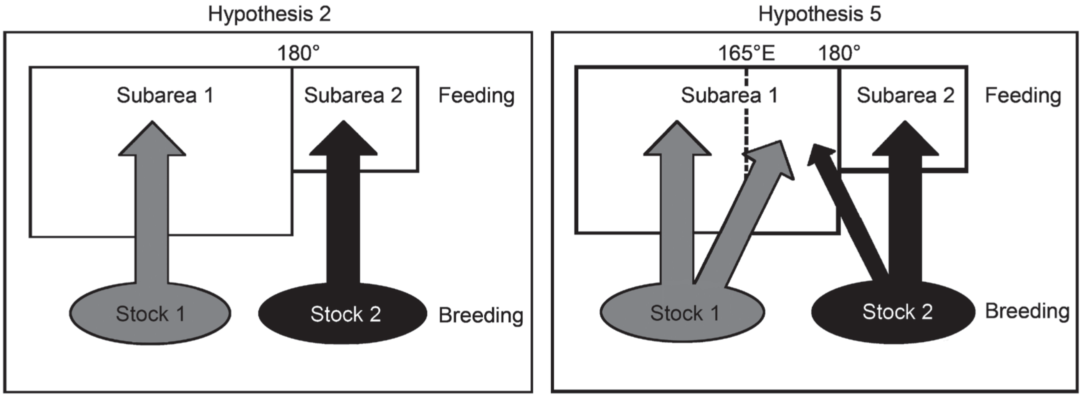


Fig. 5. The two hypotheses that will be considered in the *Implementation Simulation Trials* for the western North Pacific Bryde's whales.

(3) North Atlantic common minke whales: starting in 2022; and
(4) North Atlantic fin whales: starting in 2023.

This schedule should be considered to be tentative and periodically reviewed. The sub-committee **agrees** that it is not feasible to conduct more than one *Implementation* or *Implementation Review* simultaneously.

3.6 Work plan

Item	During the intersessional period	During SC/67b
Item 3.1: North Atlantic minke whales.	-	Review any new abundance estimates.
Item 3.2: Western North Pacific minke whales.	Conduct a preparatory meeting focused on synthesising information on stock structure.	Initiate the *Implementation Review.*
Item 3.3: Western North Pacific Bryde's whales.	(a) conduct the Second Intersessional Workshop; (b) code the resulting trials, condition the trials, and conduct projections under proposed RMP variants.	Conduct the work required for the Second Annual Meeting.
Item 3.4: North Atlantic fin whales.	-	Review any new abundance estimates.

4. EFFECTS OF SPECIFIC SCIENTIFIC PERMIT CATCHES ON STOCKS

4.1 Western North Pacific common minke whales

4.1.1 Panel summary

The conclusion of the Review Panel is as follows:

The Panel has two major concerns with the approach used to assess the potential effects of catches for common minke whales as summarised below.

(1) The approaches taken are based on projecting an SCAA model forward (O-stock) and an age- and sex-structure HITTER model (J-stock). However, the Scientific Committee and past expert panels have recommended that the impact of catches on stocks be based on trial framework (not the *CLA*) developed for RMP *Implementations* when these are available (IWC, 2010). The projections should be based on the anticipated Scientific Permit catches as well as any projected other human-caused removals (e.g. by-catches). In the case of common minke whales, use of the trials structure on which the 2013 *Implementation* was based would account for uncertainty regarding future by-catch and also assume that the amount of by-catch is related to population size rather than being assumed to be constant.
(2) The results are based on the assumption that there is a single J-stock and a single O-stock (Stock Hypothesis A). However, the 2013 *Implementation* considered scenarios in which there is a Y-stock in the Yellow Sea (Stock Hypothesis Y) and in which there are two J-stocks and two O-stocks (Stock Hypothesis C). The proponents consider Stock Hypothesis C to be implausible, but nevertheless Secondary Objective I(iii) involves investigating the likelihood of two O-stocks, which suggests that the proponents consider the possibility of there being two O-stocks is not fully resolved.

The Panel notes that stock size is projected to decline even under the optimistic situation of a single J-stock when $MSYR_{mat}$=1% - due primarily to bycatch. Population size is projected to be reduced further (by 20% in approximately 2030 if catches of 47 whales continue to be taken). While this reduction is probably overestimated owing to assuming $MSYR_{mat}$=1% rather than $MSYR_{1+}$=1% and assuming that bycatch will remain at current levels, any further reduction of J-stock is of **concern**. The Panel **recommends** that the assessment of the effects of catches on stocks be based on a subset of the trials on which the 2013 *Implementation* was based (including two levels for MSYR and all three stock hypotheses) as this will better account for uncertainty regarding current abundance and future bycatch, as well as time-variation in the J-O mixing proportion. The trials will also be able to account for the location (sub-area) and timing (month) of future catches. However, the trials on which the 2013 *Implementation* was based consider $MSYR_{mat}$=1%, whereas the Scientific Committee has agreed that the lower bound for MSYR should be $MSYR_{1+}$=1% (IWC, 2014). Furthermore, those trials did not use the most recent estimates of abundance. Thus, before a full consideration of the effects of the catches can be concluded, the Panel **recommends** that the proponents update the trials so that trials are conducted for $MSYR_{1+}$=1% and $MSYR_{mat}$=4% are fitted to the most recent estimates of abundance. The Panel **recognises** that modifying trials is a substantial undertaking (and must be accompanied by evidence of satisfactory conditioning) and it may not be possible to update even a subset of the trials prior to the 2017 Annual Meeting. However, the Panel **stresses** the importance of this being completed before the programme commences.

4.1.2 Proponent responses

Section 4 of SC/67a/SCSP13 provides results of additional assessments of potential effect of NEWREP-NP catches on the stocks of common minke and sei whales. In the case of the common minke whales, the baseline trials for stock structure hypotheses A and C developed in the previous *Implementation Review* were used to assess the effect of catches. The deterministic versions of the trials in question were reconditioned with $MSYR_{1+}$ values of 1%, 2%, 3% and 4% (only the value of MSYR was changed in this reconditioning). The constant future annual research catches considered when projecting under the proposed annual take of 170 minke whales were divided amongst sub areas as set out in Table 4.1.1 of Section 4 of SC/67a/SCSP13, which corresponds to the temporal and spatial allocation proposed. For $MSYR_{1+}$=2%, all stocks show increases and/or are well above 54% of their pre-exploitation levels under the research catches proposed, so there are no population conservation concerns. For $MSYR_{1+}$=1%, under Hypothesis A the J stock is currently less than 54% of its pre-exploitation level and is projected to continue to decline, while under Hypothesis C the same applies for the Jw stock (though this is a consequence of the bycatches only, as no research take from sub areas where this stock is present is planned) and the Ow stock, currently at 70.2% of its pre-exploitation level, decreases slowly to reach 66.3% by 2066. However, while these instances might be considered by some to be population conservation concerns, the proponents consider that issue not to be relevant, as recent information/analyses using the J:O ratio in bycatches and the close-kin analyses have shown the associated stock structure/MSYR combinations to be clearly implausible, for the reasons explained in Section 4 of SC/67a/SCSP13. In summary, the results provided therefore show that the research catches proposed will not adversely impact the stocks, so that no population conservation concern arises.

4.1.3 Discussion

The sub-committee noted that the analyses in Section 4 of SC/67a/SCSP13 address the major concerns raised by the Panel. Several members stated that the revised analyses involved considerable work in a short period of time and commended the proponents for conducting this work. The sub-committee also **agrees** that the analyses based on bycatch data are suggestive of $MSYR_{1+}$>0.01 and that the close-kin data suggest that a hypothesis of two O sub-stocks with different breeding grounds is implausible. However, there was insufficient time to fully evaluate the technical basis for these analyses, in particular whether adequate account had been taken of statistical properties of the data and uncertainty in the bycatch information. The sub-committee **recommends** that the full set of equations on which the analyses in Section 4 of SC/67a/SCSP13 be provided to the sub-committee for review next year and possible use in revised *Implementation Simulation Trials*. The poor fits to the bycatch rates by sub-area mentioned in SC/67a/SCSP13 provide further support for the need to revise the *Implementation Simulation Trials* for the western North Pacific minke whales.

4.2 North Pacific sei whales

4.2.1 Panel summary

The conclusion of the Review Panel is as follows:

The Panel **agrees** that approach on which the evaluation of the effects of catches for North Pacific sei whales was based was largely appropriate. However, the analysis is based on the (single) best estimate of abundance and $MSYR_{1+}$ values of 1% and 4%. The Panel **recommends** that the proponents consider additional analyses in which current abundance is assumed to equal to the lower 95% confidence bound for the current estimate of abundance and present results for $MSYR_{1+}$=1% and $MSYR_{mat}$=4%, as these are the values selected by the Scientific Committee (IWC, 2014).

4.2.2 Proponent responses

Figure 8 of Section 4 of SC/67a/SCSP13 shows projections of the cases considered for the North Pacific sei whales. The calculations were conducted based on conditioned age-/sex-structured models. Regardless of parameters assumed, there is no serious difference in the median trajectory between two catch scenarios (0 and 134 per year) over the 12-year research period, and therefore, it is evident that the impact of an annual catch of 134 whales is negligible.

4.2.3 Discussion

The sub-committee **agrees** that the proponents have adequately addressed the recommendations by the Panel.

4.3 Work plan

Item	During the intersessional period	During SC/67b
Item 4.1: North Atlantic minke whales	Further evaluate the information content of bycatch data for western North Pacific common minke whales in terms of estimating MSYR as part of the *Implementation Review* that will start with a preparatory meeting in early 2018.	-

5. BUDGET ISSUES

(1) A preparatory meeting (in early 2018) with a focus on stock structure to initiate the *Implementation Review* for Western North Pacific minke whales (Convenor: Donovan) (£5,000; Item 3.2).

(2) An intersessional Workshop (in early 2018) to conduct the *Implementation Review* for North Pacific Bryde's whales (Convenor: Donovan) (£10,000; Item 3.3).

The Workshop and meeting will occur back-to-back, with some consequent cost savings. The sub-committee supported the proposed meeting and Workshop, recognising that without meetings to co-ordinate and focus intersessional work it will be impossible to achieve the Committee's ambitious schedule for two-year *Implementation Reviews*.

6. ADOPTION OF REPORT

The Report was adopted at 14:21 on 17 May 2017. The sub-committee acknowledged the considerable work undertaken by Allison, de Moor, and Punt during the intersessional period to ensure that the Committee was in a position to complete the *Implementation Review* for the North Atlantic minke whales and to progress the *Implementation Review* for the western North Pacific Bryde's whales. The sub-committee expressed its deep appreciation to Robbins who stepped into the role of Chair of the sub-committee given Bannister's unfortunate unavailability, and excellently guided the sub-committee through an extremely complex and challenging agenda.

REFERENCES

Government of Japan. 2016. Results of the analytical work on NEWREP-A recommendations on sample size and relevance of age information for the RMP. Paper SC/66b/SP10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 24pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2005. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 7:77-113.

International Whaling Commission. 2007. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 9:88-128.

International Whaling Commission. 2008. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. Appendix 4. The specification for the *Implementation Simulation Trials* for western North Pacific Bryde's whales (final). *J. Cetacean Res. Manage. (Suppl.)* 10:105-15.

International Whaling Commission. 2009. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 11:145-68.

International Whaling Commission. 2010. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1-98.

International Whaling Commission. 2014. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.

International Whaling Commission. 2015. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 18:123-73.

Jarman, S.N., Polanowski, A.M., Faux, C.E., Robbins, J., De Paoli-Iseppi, R., Bravington, M. and Deagle, B.E. 2015. Molecular biomarkers for chronological age in animal ecology. *Mol. Ecol.* 24: 4,826-47. [Available at: doi:10.1111/mec.13357].

Polanowski, A.M., Robbins, J., Chandler, D. and Jarman, S.N. 2014. Epigenetic estimation of age in humpback whales. *Mol. Ecol. Resour.* 14(5): 976-87.

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair and appointment of rapporteurs
   1.3 Adoption of Agenda
   1.4 Available documents
2. General assessment issues with a focus on those related to the Revised Management Procedure
   2.1 Relationship between $MSYR_{mat}$ and $MSYR_{1+}$: evaluate energetics-based model
   2.2 Implications of *IST*s for consideration of 'status'
   2.3 General consideration of how to evaluate the effect of special permit catches on stocks
   2.4 Improvements in management performance (in relation to RMP and SCAA) by improved precision in biological parameters
   2.5 Work plan
3. RMP – *Implementation*-related matters
   3.1 North Atlantic common minke whales
      3.1.1 Report of the intersessional Workshop
      3.1.2 Completion of *Implementation Review*
      3.1.3 New information
      3.1.4 Conclusions and recommendations
   3.2 North Pacific common minke whales
      3.2.1 Review of new information
      3.2.2 Prepare for the next *Implementation*
   3.3 Western North Pacific Bryde's whales
      3.3.1 Report of the intersessional Workshop
      3.3.2 Progress since the intersessional Workshop
      3.3.3 Conclusions and recommendations
   3.4 North Atlantic fin whales
   3.5 Review RMP *Implementation Review* schedule for the next six years
   3.6 Work plan
4. Effects of specific scientific permit catches on stocks
   4.1 Western North Pacific common minke whales
      4.1.1 Panel summary
      4.1.2 Proponent responses
      4.1.3 Discussion
   4.2 North Pacific sei whales
      4.2.1 Panel summary
      4.2.2 Proponent responses
      4.2.3 Discussion
   4.3 Work plan
5. Budget issues
6. Adoption of Report

Appendix 2

GUIDELINES ON EVALUATING THE EFFECT OF SCIENTIFIC PERMIT CATCHES ON STOCKS

Projections should be conducted under the pre-specified series of catches as proposed in the special permit. In addition, projections should also be run with zero scientific, commercial and aboriginal catches (see details below) for comparison. Again, for comparative purposes, the time period considered and for which projections are reported should include:

(a) the specified time of the permit proposal;
(b) 50 years (with scientific permit and other commercial and aboriginal catches (but not incidental catches) set to zero after the specified time of the permit proposal); and
(c) 50 years (with catches set at the level specified in the proposal [plus any likely incidental catches]).

Where an *Implementation* has been completed
The default for such stocks would be to use the trials on which the most recent *Implementation/Implementation Review* was based. Results of projections should be presented for:

(a) base-case trials; and
(b) any other trials considered to be 'influential'; the guidelines for conducting *Implementations* and *Implementation Reviews* should be modified to include identification of 'influential' trials.

It is possible that research since the most recent *Implementation*/*Implementation Review* has shown that some (influential) trials are no longer considered plausible by the Committee. In such cases, the associated trials would not be run. In principle, the trials could be modified to reflect new information (such as a change to the lowest value of MSYR considered plausible). However, this may require changes to model structure and reconditioning of trials, which could be both time-consuming and difficult. Given the practical difficulties associated with changing *Implementation Simulation Trials*, it is not a requirement that the trials be modified if new information is available, although other computations indicating the likely impact of those new data on the effect of catches in some way should be presented. If the aim of the programme is to show that some of the factors on which the most recent *Implementation*/*Implementation Review* was based are implausible, those trials should be run for comparative purposes. Those trials should be highlighted, and arguments for the asserted implausibility need to be presented.

Stocks with an in-depth assessment
This case is similar to that above. The scenarios and model structures used in the in-depth assessment (to the extent that those have been adequately specified) should be used. Time periods for projections would be the same, with runs being undertaken for base case and 'influential' trials.

Other stocks
It is more challenging to evaluate the effects of scientific permit catches for other stocks. In developing a research plan, proponents should identify the core uncertainties for the region/species. The evaluations presented of the effects of catches upon stocks may require development of a simple modelling framework to broadly capture such uncertainties. They should call upon the advice of relevant experts when doing so.

Appendix 3

AUTHOR SUMMARY OF PAPER SC/67A/SCSP13

Annex 11 of SC/67a/SCSP13 provides the general background and the rationale for the sample size of common minke whale under NEWREP-NP in the Pacific side of Japan. Analyses in this Annex demonstrated first that self-evidently optimal management based on the scenario (and associated sensitivities) provided by the SCAA, which can estimate recruitment directly through the availability of age data, would be very different to that from the deterministic stock-recruitment relationship scenarios (as, e.g. the FITTER methodology has to assume), which at best would need to consider a very wide range of robustness tests, resulting in an inefficient approach (less allowable catch for the same perceived risk).

Annex 11 noted that the Punt *et al.* (2014) analysis constitutes an important step in contributing to the evolution of the RMP towards a more efficient version which is based on better conditioned operating models, and is stock specific rather than generic as at present. Age data contribute to this better conditioning through allowing much improved estimation of recruitment and its changes and may also be able to improve the performance of a refined version of the RMP, as has been demonstrated in the case of Antarctic minke whales (Government of Japan, 2016). The NEWREP-NP proposal, with its analyses, has the intent that the age data to be collected will contribute to this evolutionary process.

The JARPNII Final Review Workshop report, endorsed by the IWC SC, noted that 'if the *Implementation Simulation Trials* (*IST*s) for the western North Pacific minke whales are to be revised in future, the age data should be included in the conditioning process' (IWC, 2017). Age data, whenever potentially available, are needed for conditioning such trials so that recruitment and its changes may be reflected far better. This is the primary reason why the NEWREP-NP proponents support the use of age data for the conditioning of the next set of *ISTs* for the North Pacific common minke whale, which they understand to be endorsed also by the IWC SC. Naturally recruitment is hardly estimable for other than past years spanned by the collection of age data, so for future sets of *ISTs* also to best reflect underlying dynamics, age data must continue to be collected, notwithstanding the fact that the impact of data from the first few years of NEWREP-NP to the next NP common minke whale *Implementation Review* may not be that large.

The proponents' approach is entirely in line with fisheries management approaches elsewhere, including in the development of management procedures (MPs) in other Regional Fisheries Management Organizations (RFMO). There a high premium is placed on obtaining and improving age data and/or on equivalent information to provide information on recruitment changes. Further comments on this and other aspects of the use of age data in fisheries management may be found in Adjunct 1 of Annex 11. Furthermore Adjunct 2 of Annex 11 provides an example of how the availability of age data aids the estimation of the extent of the impact of environmental factors on recruitment trends – a matter of importance at this time given concerns about the possible impacts of climate change.

While age data could be used in a future RMP in a similar way to that in the proposal in Government of Japan (2016), the primary contribution of such data remains to be conditioning of *ISTs*, and (as has proven to be the preferred approach for other MPs internationally) their contribution to feedback adjustments to management measures might be through the regular re-conditioning of the *ISTs* rather than by changes to the MP itself.

Regarding the matter of sample size, Annex 11 summarises the proponents' rationale for the number advanced:

- age data are needed for improved conditioning of *ISTs* for testing management procedures, to inform better on recruitment changes and hence improve the trials' realism;
- simulation results (see Adjunct 2 of Annex 11) indicate that larger age samples would allow better estimation of recruitment changes for this NP minke situation;
- on the other hand, operational considerations regarding the practically maximum sample size and the effect on the population must also be taken into account in determining the optimal sample size; and
- therefore, the optimal sample size should meet both of these criteria: that it is operationally maximal and is also sufficient to provide meaningful improvement in the estimation of recruitment changes; simulation results (see Adjunct 3 of Annex 11) indicate that is the case for this North Pacific (NP) minke situation.

Given the clear and widely accepted benefits in principle of the inclusion of ageing data to the *IST* conditioning process, the only question that then remains is how much age data are needed to make a meaningful improvement to that NP minke whale conditioning. A detailed calculation for this would need to be based on the planned updated conditioned (including with the age data available at that time) set of NP minke *ISTs*, and consequently would need to await completion of that exercise which is the responsibility of the IWC SC.

However, in the interim, much simpler computations are adequate to bound the problem, and are conducted in Adjunct 3 of Annex 11. These are based on a simpler model broadly accepted when presented to the JARPNII review, which was intended to be illustrative and to assist this bounding.

Note first that the model showed performance improved with increases in the sample size aged, and that these improvements are meaningful over the sample sizes examined, which were consistent with what was operationally practical. This last consideration then provides the desirable sample size, but always provided that: (a) the criterion of no adverse effect on the population is met; and (b) that sample size is itself sufficient to provide a meaningful improvement in performance. The intent of the calculations of Adjunct 3 of Annex 11 is to address this last question, and this is successfully achieved – note that this is an exercise for which primarily only relative measures of performance when comparing results with, to those without, ageing data are needed. Once the updated conditioning is complete, that could be used to update these overall results, though any difference would not be expected to be large, the priority for such an update would not seem to be very high, and results from this bounding an illustrative exercise are sufficient to address the immediate question.

Given the relatively slow dynamics of minke whales, coupled to the nature of the information content of age data, the improvements to *IST*s achieved by use of these data take time to reveal their full extent (see the plots in Adjunct 3 of Annex 11), so that there is a need to show results for projections over a number of decades, extending beyond the time-frame of the current research program. Self-evidently the results for these larger numbers of years must be taken into account; otherwise the injudicious situation would arise that research with longer term benefits would never commence because those benefits never become evident in the short term.

In summary it is considered that the annual sample size of 107 common minke whales in sub-areas 7-9, which is the maximum feasible within the operational constraints of the program, is sufficient to result in meaningful improvement in the detection of minke whale recruitment changes.

This intended sample size applies to O stock whales. It is planned that 60% of this sample size be taken in coastal sub-areas (7CS and 7CN) and 40% in offshore sub-areas (7WR, 7E, 8 and 9). Evaluating an optimal coastal:offshore ratio for this sample would be an enormous task technically, but it seems reasonable to expect that a 50:50 split would be near optimal in terms of distinguishing possible differences between the two regions if any. Taking into account operational reasons as well, the ratio has been decided to be 60:40, noting that typically such 'distinguishability' performance behaves quadratically, so does not deteriorate much with relatively small movement away from the actual optimal split. Hence it is planned that 64 animals will be sampled in coastal sub-areas and 43 in offshore sub-areas. Because around 20% of the animals in sub-areas 7CS and 7CN are from the J stock (see Annex 7 of the revised NEWREP-NP research plan), the sample size in the coastal sub-areas needs to be adjusted upwards to 80 animals in total to achieve sampling of 64 O stock whales. Thus the total sample size planned on the Pacific side of Japan becomes 123 whales.

For the area north of Hokkaido (sub-area 11), the main objective is to estimate the J-O mixing proportion in this subarea annually with a standard error of no more than 0.1 irrespective of the true proportion. The sample size selected is 47. The basis for the selection of this value is explained in Adjunct 4 of Annex 11.

With 123 whales to be taken on the Pacific side of Japan, and 47 north of Hokkaido, the total sample size planned for common minke whales is 170.

Annex 16 introduces an approach to estimate the proposed sample size for the North Pacific sei whales to meet the Primary Objectives II, especially Secondary Objective II (ii). The approach followed is based on the age- and sex-structured model applied to this stock for conditioning and generating future data in a simulation. The target is to estimate the natural mortality rate, *M*, using the SCAA methodology.

Figure 4 of Annex 16 shows the performance measures for the four scenarios (true *M*/MSYR combinations) considered. Robust results across these scenarios are that for an annual sample size of 100 or above, bias reduces to close to zero, and RMSE stabilises at about 0.005. Figure 5 of Annex 16 illustrates how the variance of the distribution of *M* estimates narrows considerably as the sample size is increased from 40 to 100. This value makes no allowance for possible over-dispersion in the age data, and the sample sizes available are too small to estimate this reliably. Therefore the assumption has been made that this is the same as for minke whales, corresponding to a need to increase the sample size by a multiplicative factor of 1.34 (see Appendix D of Adjunct 3 of Annex 11). Consequently the proposed annual sample size for sei whales is 134.

REFERENCES

Government of Japan. 2016. Results of the analytical work on NEWREP-A recommendations on sample size and relevance of age information for the RMP. Paper SC/66b/SP10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 24pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2017. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.

Punt, A., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93-116.

Appendix 4

A RESPONSE TO SC/67A/SCSP08 REGARDING THE VALUE OF IMPROVING ESTIMATES OF NATURAL MORTALITY *M*

L.A. Pastene, T. Kitakado and D.S. Butterworth

The author of SC/67a/SCSP08 adds simulation results to complement the views expressed by the Review Panel for NEWREP-NP about the likely poor precision of attempts to simultaneously estimate the values of *M* and MSYR for North Pacific sei whales given the information currently available and planned to be obtained under NEWREP-NP.

It has already been pointed out by the Proponents in their responses during the Review that such joint estimation was not the purpose of the proposal (see their morning papers of 1 and 2 February, 2017) submitted to the Panel. Note also that the Panel seems not to have taken certain important comments in these papers into account in its report (SC/67a/SCSP01).

It is also certainly true that in the case on North Pacific sei whales, the limited data available (either now or in the short term future) would be insufficient to allow reliable direct estimation of MSYR, either on its own or in combination with *M*. However, this last point has little immediate pertinence, as at present the standard practice for *IST*s is to consider trials for fixed values of MSYR, and as explained in those morning papers, the NEWREP-NP proposal related to estimation of *M* conditional on a value for MSYR to secure *IST*s that more realistically reflected stock dynamics, as always needs to be the aim for such trials.

Those morning papers explained that the utility of having such an estimate of *M* related to transient effects in the stock dynamics. The higher the value of *M*, the more rapidly population abundance will respond to changes (for example in recruitment). SC/67a/SCSP13 (the Annex 16 section, Figure 5) reports that present data do not exclude values of *M* for North Pacific sei whale within the range of about [0.02; 0.10yr^{-1}]. This corresponds to a multiplicative range of a factor of five, about the same as typical for a cod compared to a sardine, for which fisheries management approaches certainly differ in consequence.

One example of the differential consequences of the value of M as a result of such transients emerges from projections based on the set of assessments for North Pacific sei whales presented in SC/67a/SCSP13 (Annex 16 section). The conditioning is simple given that this example is intended to purely as a simple illustration: commercial and research selectivities are taken to be fixed at their values for the *M*=0.04 and MSYR(1+)=1% case of the four scenarios considered in that Annex 16 section (in any case those selectivities do not differ greatly across those scenarios), and the resilience parameter A is adjusted for compatibility with MSYR(1+)=1% and a range on *M* values from 0.02 to 0.10yr^{-1}. For each value of *M*, a value of *K* for the mature female component of the population is found to secure the population trajectory passes through the abundance estimate for the stock as a whole for 2010. Finally projections are used to establish what constant future annual catch would result in the population reaching a depletion of 0.72 (the *CLA* equilibrium) of that component of *K* after 50 years.

Table 1 lists the values of this catch for each of the values of *M* considered. What is evident is that despite all these calculations being conducted for the same value of MSYR, the value of the annual catch changes by relatively substantial amounts as the value of *M* is changed. Such

Table 1

Values of a fixed annual catch that secures a depletion of 0.72 in terms of the mature female population of North Pacific sei whales after 50 years in relation to the value of natural mortality *M*.

M (yr^{-1})	Catch
0.02	153
0.04	93
0.06	57
0.08	30
0.10	6

differences would certainly be of interest to managers. Thus even if the value of MSYR is known/assumed, knowledge of the value of *M* remains important.

Moving beyond the current typical *IST*s, there is of course the general relationship evident for marine species that values for productivity and *M* across resources tend to be positively correlated (e.g. Andersen *et al.*, 2009), so that information on the value of *M* adds qualitatively at least to an evaluation of the plausibility of different values for MSYR.

But as SC/67A/SCSP01 states, the NEWREP-NP proposal considers the RMP not only in its current form, but as it will need to be modified for future improvement, particularly given the availability of age data. This allows for much improved estimation of annual recruitments and their changes over time, and moves the situation for the whale stock concerned much closer to that typical for the management (including under MPs) of fish populations. The calculation basis underlying SC/67a/SCSP08 is a class of assessment models (sometimes called age-structured production models) used in a 'data-limited' situation (as has applied in the past for most whale populations), and in particular relies heavily of an assumed stock-recruitment function and the assumption of a resource at equilibrium prior to the onset of exploitation. In contrast, the greater data set (particularly including age data) that is available for many fish stock assessments sees much less reliance on such assumptions to obtain more reliable results. The associated projections (including for MP testing purposes) are typically much more heavily based on estimates over a recent period of annual recruitments in relation to the reproductive component of the population. In these circumstances, the value of *M* has a much greater influence on assessment outputs and on the estimation of target levels for abundance. For whales there are already cases such as the Eastern North Pacific gray whale and the Indo-Pacific Antarctic minke whale that provide examples of violations of those assumptions regarding pre-exploitation equilibrium and standard stock- recruitment relationships. This adds weight to the desirability of moving whale stocks closer to the typical fish stock assessment situation, given especially the availability of age data; this process is likely to see the value of *M* start to play a more important role in the manner in which *IST*s are developed in the future.

REFERENCE

Andersen, K. H., Farnsworth, K. D., Pedersen, M., Gislason, H., and Beyer, J. E. 2009. How community ecology links natural mortality, growth, and production of fish populations. *ICES J. Mar. Sci.* 66: 1978-1984.

Appendix 5

RESPONSE TO APPENDIX 4 RE THE VALUE OF IMPROVING ESTIMATES OF NATURAL MORTALITY *M*

William de la Mare

Using the model in SC/67a/SCSP08 this appendix explores the conclusions that might be drawn about the conservation performance of management using different values of M, with and without increasing mortality for older animals.

In this demonstration it is assumed that the value of *M* for the bulk of animals in the population is known after the completion of the NEWREP-NP program. The proposed special permit catches are removed during this period. Thereafter a management procedure is applied that leads to a constant catch of 100 whales per year for 50 years.

The table below gives the mature population sizes in 1910 and 2080 and the depletion with constant catches of 100. The table also shows for reference the depletion in the mature stock without catches after NEWREP-NP.

These results show that the apparent conservation performance of the procedure is better (in terms of less depletion for a given catch) in the case conditioned where M is age-independent with a value=0.02. However, in the case where few whales reach an age of 50 because of age dependence in *M* the conservation performance of the procedure is now better than when the procedure is conditioned using *M*=0.10yr^{-1}.

M	Age dependence in *M*	N_{1910} (K)	N_{2080} with catch = 100	*D* without further catch	D_{100}
0.02	N	65,741	41,446	0.696	**0.632**
0.10	N	49,719	39,152	0.643	0.584
0.02	Y	72,654	40,425	0.615	0.556
0.10	Y	49,910	29,029	0.640	**0.582**

Age dependence in mortality is important to understanding the demonstrations in Appendix 4 and here. *M*=0.02 yr^{-1} gives a mean age of animals in a population at *K* of 50. *M*=0.10 yr^{-1} gives a corresponding mean age of 10. However, when few animals reach an age of 50 because of age-dependence in *M* there will be a much smaller difference between the average ages of populations with *M*=0.02 yr^{-1} and *M*=0.10 yr^{-1}. Consequently estimating age-dependence in mortality becomes as important as estimating its value for the bulk of the population.

It is important when considering the value of information in contributing to management that a realistic context is used. Although there are management procedures related to the demonstration in Appendix 4 that set target stock recoveries in the future, such procedures are very different from the RMP. These procedures usually integrate over uncertainty in *M*, and take into account both the target recovery level and a constraint on the probability of the populations becoming depleted.

Consequently, the possibility raised in Appendix 4 that a different constant catch can be taken on the way to recovery to 0.72 cannot be realised to the extent shown with the achievable bias and precision in estimates of *M* shown in SC/67a/SCSP08.

Setting a catch level, as in the demonstration here, is more like the RMP and the question of conservation performance for a given catch is closer to the approach used to evaluate RMP variants. The demonstration shows it is the details of how mortality is modelled and estimated are much more important than in the simple demonstration in Appendix 4.

Appendix 6

THE AWMP/RMP *IMPLEMENTATION SIMULATION TRIALS* FOR THE NORTH ATLANTIC MINKE WHALES

A. Basic concepts and stock-structure

The objective of these trials is to examine the performance of the RMP and AWMP when managing a fishery for North Atlantic minke whales. Allowance is made for both commercial and aboriginal subsistence catches. The underlying dynamics model allows for multiple stocks and sub-stocks, and is age- and sex-structured. The trials capture uncertainty regarding stock structure and MSYR, as well as uncertainty regarding selectivity.

The region to be managed (the Northern North Atlantic) is divided into 11 sub-areas (see Fig. 1). The term 'stock' refers to a group of whales from the same (putative) breeding ground. The 3-stock models assume there is western 'W' stock (which feeds at least in the 'WG' and 'WC' sub-areas), a central 'C' stock (which feeds at least in the 'CG', 'CIC', 'CIP', and 'CM' sub-areas), and an eastern 'E' stock (which feeds at least in the 'EN', 'EB', 'ESW', 'ESE', and 'EW' sub-areas). The 'E' and 'W' stocks are divided into sub-stocks for some of trials (sub-stocks 'E-1' and 'E-2' for the 'E' stock; sub-stocks 'W-1' and 'W-2' for the 'W' stock). There is no interchange between stocks, or sub-stocks. The rationale for the position of the sub-area boundaries is given in IWC (1993, p.194; 2004a, pp.12-13; 2009b, p.138).

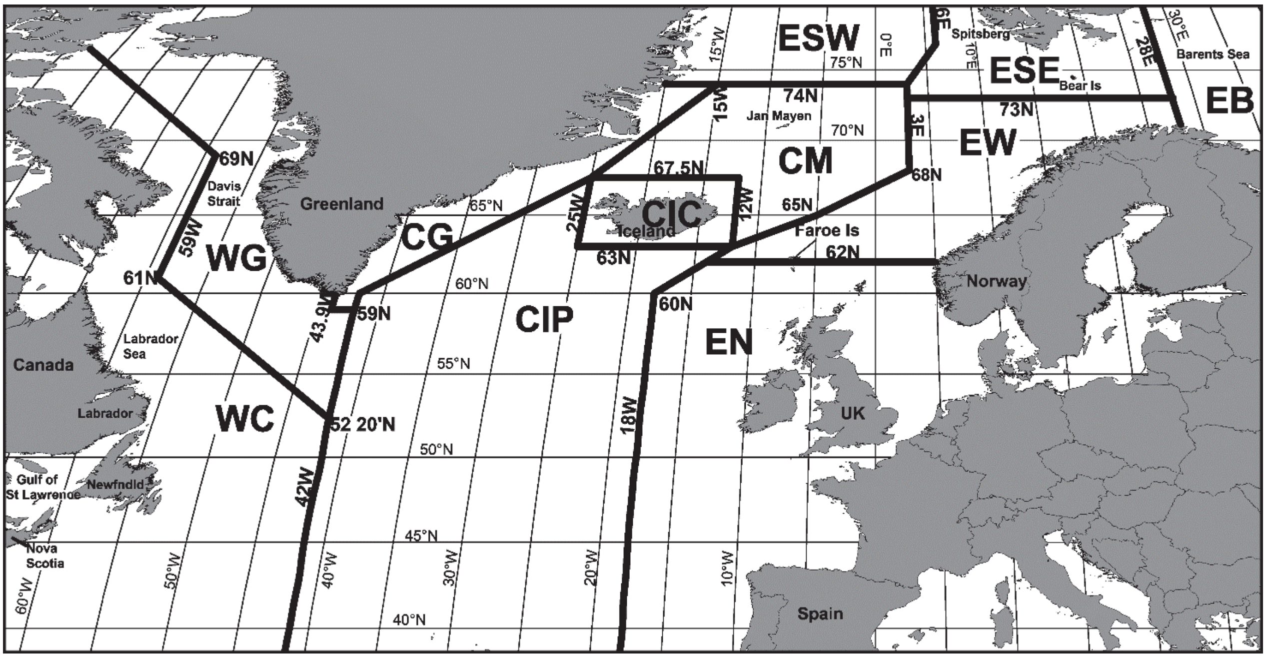


Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic minke whales.

There are three general hypotheses regarding stock structure (see IWC, 2015 for the rationale for these hypotheses).

(I) *Three stocks*. There are three stocks 'W', 'C', and 'E'. The 'W' stock consists of two sub-stocks ('W-1' and 'W-2') and the 'E' stock consists of two sub-stocks ('E-1' and 'E-2').

(II) *Two stocks*. There are two stocks 'W*', and 'E'. The 'W*' stock consists of two sub-stocks ('W' and 'C*') where the C* stock is the same as the 'C' stock for stock hypothesis I, except that the whales that occur primarily in the 'WG' sub-area are also part of this stock. The 'E' stock is defined as for stock hypothesis I.

(III) *One stock*. There is only a single ('O') stock of minke whales in the North Atlantic.

(IV) *Two cryptic stocks*. There are two stocks ('O-1' and 'O-2') of minke whales in the North Atlantic. The two stocks are found in all 11 sub-areas[1].

The trials (see Section H) include variants of these general hypotheses to capture further aspects of uncertainty regarding stock structure. The trials also allow for the difference in the catch sex-ratios between the primary catching season (i.e. before July) and the time when surveys are conducted (July onwards) (see details in Section G).

[1]This stock structure hypothesis was discussed by the April 2014 joint AWMP/RMP North Atlantic minke whale stock structure Workshop, though it was not included in the final report of that meeting (IWC, 2015).

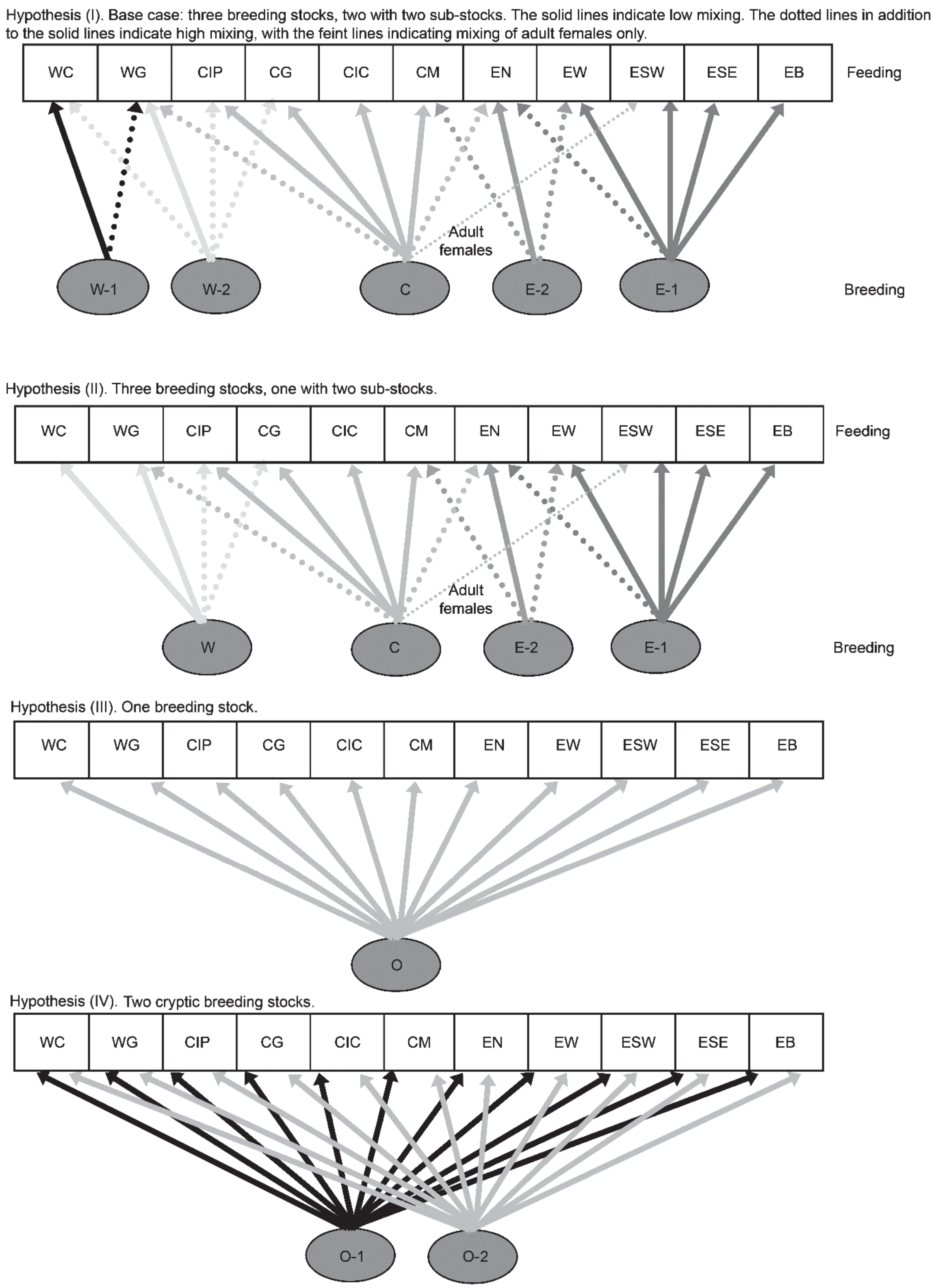


Fig. 2. Stock structure hypotheses for North Atlantic minke whales.

B. Basic dynamics

The dynamics of the animals in stock/sub-stock j are governed by equation B.1:

$$N^{g,j}_{t+1,a} = \begin{cases} 0.5\, b^{j}_{t+1} & \text{if } a = 0 \\ (N^{g,j}_{t,a-1} - C^{g,j}_{t,a-1})\tilde{S}_{a-1} & \text{if } 1 \le a < x \\ (N^{g,j}_{t,x} - C^{g,j}_{t,x})\tilde{S}_{x} + (N^{g,j}_{t,x-1} - C^{g,j}_{t,x-1})\tilde{S}_{x-1} & \text{if } a = x \end{cases} \qquad \text{(B.1)}$$

where:

$N_{t,a}^{g,j}$ is the number of animals of gender g and age a in stock/sub-stock j at the start of year t;

$C_{t,a}^{g,j}$ is the catch (in number) of animals of gender g and age a in stock/sub-stock j during year t (whaling is assumed to take place in a pulse at the start of each year);

b_t^j is the number of calves born to females from stock/sub-stock j at the start of year t;

$\tilde{S}_a$ is the survival rate = e^{-M_a} where M_a is the instantaneous rate of natural mortality (assumed to be independent of stock, time, and gender); and

x is the maximum age (treated as a plus-group);

Note that t=0, the year for which catch limits might first be set, corresponds to 2016.

C. Births

Density-dependence is assumed to act on the 1+ population. The convention of referring to the mature population is used here, although this actually refers to animals that have reached the age of first parturition.

$$b_t^j = B^j N_t^{f,j} \{1 + A^j (1 - (N_t^{f,j} / K^{f,j})^{z^j})\} \tag{C.1}$$

where:

B^j is the average number of births (of both sexes) per year for a mature female in stock/sub-stock j in the pristine population;

A^j is the resilience parameter for stock/sub-stock j;

z^j is the degree of compensation for stock/sub-stock j;

$N_t^{f,j}$ is the number of 'mature' females in stock/sub-stock j at the start of year t:

$$N_t^{f,j} = \sum_{a=3}^{x} \beta_a N_{t,a}^{f,j} \tag{C.2}$$

β_a is the proportion of females of age a that have reached the age-at-first partition; and

$K^{f,j}$ is the number of mature females in stock/sub-stock j in the pristine (pre-exploitation, written as t=-∞) population:

$$K^{f,j} = \sum_{a=3}^{x} \beta_a N_{-\infty,a}^{f,j} \tag{C.3}$$

The values of the parameters A^j and z^j for each stock/sub-stock are calculated from the values for $MSYL^j$ and $MSYR^j$ (Punt, 1999). Their calculation assumes harvesting equal proportions of males and females.

D. Catches

The historical (pre-2016) catch series used is listed in Adjunct 1 and includes commercial, aboriginal, special permit and incidental catches. The numbers of incidental catches are small so these are not modelled into the future.

Catch limits are set by *Small Area*. It is assumed that whales are homogeneously distributed across a sub-area. The catch/strike limit for a sub-area is therefore allocated to stocks/sub-stocks by sex and age relative to their true density within that sub-area and a catch mixing matrix V.

The catch mixing matrix for these trials is based on the sightings mixing matrix, with the selectivity pattern by sex adjusted for each sub-area. Two fishing selectivity patterns are modelled in the WG sub-area to reflect the different sex ratio shown in different hunts: the recent aboriginal hunt in this area compared to that in the earlier commercial catches. All other sub-areas have just one hunt type and thus a single fishing selectivity per sub-area. Details of the catch mixing matrices and how the parameters are set up are given in sections E and G.

$$C_{t,a}^{g,j} = \sum_k \sum_{h\in k} F_t^{g,h} V_{t,a}^{g,j,k} \tilde{S}_a^{g,h} N_{t,a}^{g,j} \tag{D.1}$$

$$F_t^{g,h} = \frac{C_t^{g,h}}{\sum_{j'} \sum_{a'} V_{t,a'}^{g,j',k} \tilde{S}_{a'}^{g,h} N_{t,a'}^{g,j'}} \tag{D.2}$$

where:

$F_t^{g,h}$ is the exploitation rate in hunt h (within sub-area k) on fully recruited ($S_a^g \rightarrow 1$) whales of gender g during year t;

$V_{t,a}^{g,j,k}$ is the fraction of animals in stock/sub-stock j of gender g and age a that is in sub-area k during year t;

$\tilde{S}_a^{g,h}$ is the fishing selectivity on animals of gender g and age a by the hunt h (within sub-area k) which is based on the reference selectivity $R_a^{g,h}$ (see Equation G.5):

$C_t^{g,h}$ is the observed catch of animals of gender g in hunt h (within sub-area k) during year t. See adjunct 1 for the historical catches. Future catches are allocated to sex using the modelled fishery sex ratio $\hat{\lambda}^{2,h}$ (see Equation G.7).

The maximum exploitation rate for future removals from the WG sub-area (catch as a proportion of the no. of 1+) is set equal to two times the maximum historical aboriginal exploitation rate achieved by aboriginal hunters (see Item 3.3 of SC/67a/Rep05, this volume). This limit is selected to be realistic given past exploitation rates achieved by aboriginal whalers, but not so low that the conservation performance of a candidate *SLA* would be impacted substantially, such that it would be difficult for any candidate to fail on conservation performance.

E. Mixing

The entries in the mixing matrix *V* are selected to model the distribution of each stock/sub-stock at the time when the catch is removed/when the surveys are conducted.

For the two and three stock hypotheses (Hypotheses I and II), the default mixing matrix for each year is the average of the 'high' and 'low' matrices (matrices A and B in Table 2).

In Hypothesis I, three constraints are imposed to eliminate the possibility of unrealistically low values for the size of the W-2 sub-stock prior to exploitation: a minimum value of 0.1 is imposed on γ_{10}, the ratio of the pristine sizes of sub-stocks W-2 to W-1 is limited to > 0.10, and the pristine size of sub-stock W-2 is constrained to be >2,000 mature females.

In the high mixing option for Hypotheses I and II, three sub-stocks (C, E-1 and E-2) are found in sub-area EN. There are no data on which to condition the proportions of these sub-stocks in the sub-area so the trials assume 50% of the whales in sub-area EN in the pristine state are from the E-2 sub-stock, with trials NM09 and NM10 testing sensitivity to this assumption.

Historical variation in abundance estimates is due both to spatial variation in abundance, and also to sampling error. In future years, additional variance is added to the mixing matrices, in order to model the hypothesis that in any one year, some subareas are more attractive to minke whales than others (e.g. due to prey availability)[2]. To account for this hypothesised difference in annual distribution, the CV used for a sub-area when determining the extent of variation in mixing is the square root of the difference between the CV^2 of the abundance estimates for that sub-area and the corresponding median of the sampling error CV^2s (see Table 1a).

For the two and three stock hypotheses (Hypotheses I and II), this variation in future abundance is implemented by applying a power parameter to the mixing matrix entries for each subarea and year. The power parameters are generated every year from $U[\max(0,1-\chi_k), 1+\chi_k]$, where the χ_k parameters defining the power parameter distributions are selected such that the realized variability of future populations over years 50-100 for the NM01-4 trial are close to the adjusted (target) CVs listed in Table 1a. Trials NM-0x 'v' test the alternative assumption that this future variability is half that of the baseline trials.

For the trials with one stock and two cryptic stocks (Hypotheses III and IV), the additional variance is implemented by multiplying the elements of the mixing matrix (just for the O-1 matrix for trials NM04-1 and NM04-4) by lognormal random variables $=\exp(\xi_k)$ where $\xi_k \sim N(0;\sigma_k^2)$. The values of σ_k^2 are listed in Table 1b and are selected such that the realized variability of future populations over years 50-100 are close to the adjusted (target) CVs listed in Table 1a.

Table 1a

Statistics related to the validation of the method used to generate spatial variation in abundance by sub-area (see Punt, 2016 for the derivation of the basic approach). χ is the parameter that defines the distribution for the power parameter for each year (by sub-area). The power parameter is generated from $U[\max(0,1-\chi), 1+\chi]$. 'Actual CVs' are the CVs of the point estimates of abundance for each sub-area, except that the longer series of relative abundance indices reported in Heide-Jørgensen and Laidre (2008) is used for the WG subarea. 'Adjusted' CVs equal the square root of the difference between the CV^2 of the abundance estimates for that subarea and the corresponding median of the sampling error CV^2s. (The values in this table were set before the 2015 abundance estimates became available).

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Actual CVs	-	0.6981	0.8301	1.0553	0.5747	0.6138	0.5905	0.2274	0.4993	0.2188	0.1623
Adjusted CVs	-	0.5951	0.7380	1.0087	0.5018	0.5462	0.5349	0.1510	0.4064	0.1085	0.1623[1]
Baseline χ	1.72	0.97	0.78	0.77	3.60	1.20	0.65	0.31	0.22	0.07	0.30
'v' trials χ	0.90	0.63	0.44	0.37	1.40	0.37	0.36	0.16	0.107	0.04	0.166

[1]value would be < 0 so the actual CV is used here.

Table 1b

The additional variances used for Hypotheses III and IV.

Hypothesis	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
III	0.48	1.19	1.48	2.02	1.00	1.09	1.07	0.30	0.81	0.22	0.32
IV	0.62	2.3	4	6	1.7	2	1.85	0.31	1.1	0.15	0.36

In Hypothesis IV, the ratio of the two pristine stocks is set equal to 4.

[2]It is unnecessary to model this variability in the past, as the purpose of the trials is to assess the effect of future catches.

F. Generation of data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the RMP are listed in Table 3. The proposed plan for future surveys is given in Table 4. The trials assume that it takes two years for the results of a sighting survey to become available for use by the RMP and *SLA*, e.g. a survey conducted in 2018 could first be used for setting the catch limit in 2019.

The future estimates of abundance for a survey area (a sub-area for these trials) (say survey area *K*) are generated using the formula (IWC, 1991):

$$\widehat{P} = PYw / \mu = P^* \beta^2 Yw \tag{F.1}$$

where:

Y is a lognormal random variable $Y=e^{\delta}$ where $\varepsilon \sim N(0;\sigma^2_{\varepsilon}$ and $\sigma^2_{\varepsilon}=ln(1+\alpha^2)$;

w is a Poisson random variable with $E(w) = \text{var}(w) = \mu = (P/P^*)/\beta^2$, Y and w are independent;

P is the current total (1+) population size in survey area K:

$$P = P_t^K = \sum_{k\in K}\sum_j\sum_g\sum_{a\geq 1} V_{t,a}^{g,j,k} N_{t,a}^{g,j} \tag{F.2}$$

and

P^* is the reference population level, and is equal to the total (1+) population size in the survey area prior to the commencement of exploitation in the area being surveyed.

Note that under the approximation $CV^2(ab) = CV^2(a) + CV^2(b)$, $E(\hat{P}) = P$, and $CV^2(\hat{P}) = \alpha^2 + \beta^2 P^*/P$. For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; 1994, p.85), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

$$CV^2(\hat{P}) = \tau\left(0.12 + 0.025P^*/P\right) \tag{F.3}$$

The value of τ is calculated from the survey sampling CV's of earlier surveys in area *K*. If $\overline{CV^2}$ is the average value of CV^2 estimated for each of these surveys, and $\overline{P}$ is the average value of the total (1+) population sizes in area *K* in the years of these surveys, then:

$$\tau = \overline{CV^2} / \left(0.12 + 0.025P^* / \overline{P}\right) \tag{F.4}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \quad \beta^2 = 0.025\tau \tag{F.5}$$

The above equations apply in the absence of additional variance. If this is present with a *CV* of CV_{add}, then the following adjustment is made:

$$\sigma_{\varepsilon}^2 = \ell n\left(1 + \alpha^2 + CV_{add}^2\right) \tag{F.6}$$

An estimate of the *CV* is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2\chi^2 P^* / \hat{P} \tag{F.7}$$

where $\sigma^2 = \ell n\left(1 + \alpha^2 + \beta^2 P^*/\hat{P}\right)$, and

χ^2 is a random number from a Chi-square distribution with n degrees of freedom, where n=10 as used for the North Pacific minke whale *Implementation Trials* (IWC, 2004b).

The CVs used by Norway when applying the RMP to the E *Medium Area* during the *catch cascading* process account for process error. However, the trials considered at the 2016 Scientific Committee ignored process error, which led to larger catch limits than would be expected in reality. The trials were therefore modified to multiply the CVs of abundance estimates for the E *Medium Area* by the slope of a regression of the CVs for the E *Medium Area* which took process error into account against the CVs for this Area when process error is ignored (1.43) (see SC/67a/Rep05, this volume).

Table 2

The mixing matrices. The γs and Ωs indicate that the entry concerned is estimated during the conditioning process. Note that the values for the γs and Ωs are the same for the high and low mixing matrices within each trial replicate.

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Stock structure hypothesis I (matrix Ai) [high mixing]											
Adult females (ages 10+)											
W-1	0.5	$0.5\gamma_{10}$	-	-	-	-	-	-	-	-	-
W-2	0.2	0.45	0.15	0.2	-	-	-	-	-	-	-
C	-	0.1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	$0.1\gamma_6$	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$0.2\ \Omega_{11}$	$0.45\ \Omega_{12}$	$0.15\ \Omega_{13}$	$0.2\Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \Omega_{12}$	$\gamma_2\ \Omega_{13}$	$\gamma_3\ \Omega_{14}$	$\gamma_4\ \Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\ \Omega_{17}$	-	-	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	$0.1\gamma_6\ \Omega_{19}$	$\gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-
Stock structure hypothesis I (matrix Bi) [low mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
E-1	-	-	-	-	-	-	-	γ_7	$5\gamma_6$	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	$\gamma_2\ \Omega_{13}$	$\gamma_3\ \Omega_{14}$	$2\ \gamma_4\ \Omega_{15}$	$\gamma_5\ \Omega_{16}$	-	-	-	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\ \Omega_{18}$	$5\gamma_6\ \Omega_{19}$	$5\ \gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-
Stock structure hypothesis II (matrix Aii) [high mixing]											
Adult females (ages 10+)											
W	0.55	0.2	0.1	0.15	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	$0.1\gamma_6$	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W	$0.2\ \Omega_{11}$	Ω_{12}	$0.1\ \Omega_{13}$	$0.2\ \Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \gamma_1\Omega_{12}$	$\gamma_2\ \Omega_{13}$	$\gamma_3\ \Omega_{14}$	$\gamma_4\ \Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\ \Omega_{17}$	-	-	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	$0.1\gamma_6\Omega_{19}$	$\gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-
Stock structure hypothesis II (matrix Bii) [low mixing]											
Adult females (ages 10+)											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
E-1	-	-	-	-	-	-	-	γ_7	$5\gamma_6$	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	$\gamma_1\ \Omega_{12}$	$\gamma_2\ \Omega_{13}$	$\gamma_3\ \Omega_{14}$	$2\ \gamma_4\ \Omega_{15}$	$\gamma_5\ \Omega_{16}$	-	-	-	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\ \Omega_{18}$	$5\gamma_6\ \Omega_{19}$	$5\ \gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-
Stock structure hypotheses III [high mixing]											
Adult females (ages 10+)											
O	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	γ_9	γ_{10}	1
Adult males (ages 10+) and juveniles											
O	$\gamma_1\ \Omega_{11}$	$\gamma_2\ \Omega_{12}$	$\gamma_3\ \Omega_{13}$	$\gamma_4\ \Omega_{14}$	$\gamma_5\ \Omega_{15}$	$\gamma_6\ \Omega_{16}$	$\gamma_7\ \Omega_{17}$	$\gamma_8\ \Omega_{18}$	$\gamma_9\ \Omega_{19}$	$\gamma_{10}\ \Omega_{20}$	Ω_{21}
Stock structure hypotheses IV [high mixing]											
Adult females (ages 10+)											
O-1	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	γ_9	γ_{10}	1
O-2	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	γ_9	γ_{10}	1
Adult males (ages 10+) and juveniles											
O-1	$\gamma_1\ \Omega_{11}$	$\gamma_2\ \Omega_{12}$	$\gamma_3\ \Omega_{13}$	$\gamma_4\ \Omega_{14}$	$\gamma_5\ \Omega_{15}$	$\gamma_6\ \Omega_{16}$	$\gamma_7\ \Omega_{17}$	$\gamma_8\ \Omega_{18}$	$\gamma_9\ \Omega_{19}$	$\gamma_{10}\ \Omega_{20}$	Ω_{21}
O-2	$\gamma_1\ \Omega_{11}$	$\gamma_2\ \Omega_{12}$	$\gamma_3\ \Omega_{13}$	$\gamma_4\ \Omega_{14}$	$\gamma_5\ \Omega_{15}$	$\gamma_6\ \Omega_{16}$	$\gamma_7\ \Omega_{17}$	$\gamma_8\ \Omega_{18}$	$\gamma_9\ \Omega_{19}$	$\gamma_{10}\ \Omega_{20}$	Ω_{21}
Stock structure hypothesis I, with no C stock in sub-area ESW (Trial NM05) (matrix A05) [high mixing]											
Adult females (ages 10+)											
W-1	0.5	$0.5\gamma_{10}$	-	-	-	-	-	-	-	-	-
W-2	0.2	0.45	0.15	0.2	-	-	-	-	-	-	-
C	-	0.1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	-	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	$0.1\gamma_6$	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$0.2\ \Omega_{11}$	$0.45\ \Omega_{12}$	$0.15\ \Omega_{13}$	$0.2\Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \Omega_{12}$	$\gamma_2\ \Omega_{13}$	$\gamma_3\ \Omega_{14}$	$\gamma_4\ \Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\ \Omega_{17}$	-	-	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	$0.1\gamma_6\ \Omega_{19}$	$\gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-

Cont.

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Stock structure hypothesis I, with no C stock in sub-area ESW (Trial NM05) (matrix B05) [low mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
E-1	-	-	-	-	-	-	-	γ_7	$5\gamma_6$	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	$\gamma_2\,\Omega_{13}$	$\gamma_3\,\Omega_{14}$	$2\ \gamma_4\ \Omega_{15}$	$\gamma_5\,\Omega_{16}$	-	-	-	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\,\Omega_{18}$	$5\gamma_6\,\Omega_{19}$	$5\ \gamma_8\,\Omega_{20}$	$\gamma_9\,\Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-
Stock structure hypothesis II, with no C stock in sub-area ESW (Trial NM06) (matrix A06) [high mixing]											
Adult females (ages 10+)											
W	0.55	0.2	0.1	0.15	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	-	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	$0.1\gamma_6$	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W	$0.2\ \Omega_{11}$	Ω_{12}	$0.1\ \Omega_{13}$	$0.2\ \Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \gamma_1\Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\,\Omega_{14}$	$\gamma_4\,\Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\,\Omega_{17}$	-	-	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	$0.1\gamma_6\Omega_{19}$	$\gamma_8\,\Omega_{20}$	$\gamma_9\,\Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-
Stock structure hypothesis II, with no C stock in sub-area ESW (Trial NM06) (matrix B06) [low mixing]											
Adult females (ages 10+)											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
E-1	-	-	-	-	-	-	-	γ_7	$5\gamma_6$	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	$\gamma_1\ \Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\ \Omega_{14}$	$2\ \gamma_4\,\Omega_{15}$	$\gamma_5\,\Omega_{16}$	-	-	-	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\ \Omega_{18}$	$5\gamma_6\ \Omega_{19}$	$5\ \gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-
Stock structure hypothesis I, without E-1 sub-stock in sub-area ESW (Trial NM12) (matrix A12) [high mixing]											
Adult females (ages 10+)											
W-1	0.5	$0.5\gamma_{10}$	-	-	-	-	-	-	-	-	-
W-2	0.2	0.45	0.15	0.2	-	-	-	-	-	-	-
C	-	0.1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	-	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$0.2\ \Omega_{11}$	$0.45\ \Omega_{12}$	$0.15\ \Omega_{13}$	$0.2\Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\,\Omega_{14}$	$\gamma_4\,\Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\,\Omega_{17}$	-	$\gamma_6\ \Omega_{19}$	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	-	$\gamma_8\,\Omega_{20}$	$\gamma_9\,\Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-
Stock structure hypothesis I, without E-1 sub-stock in sub-area ESW (Trial NM12) (matrix B12) [low mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	γ_4	γ_5	-	-	$5\gamma_6$	-	-
E-1	-	-	-	-	-	-	-	γ_7	-	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	$\gamma_2\,\Omega_{13}$	$\gamma_3\ \Omega_{14}$	$2\ \gamma_4\ \Omega_{15}$	$\gamma_5\,\Omega_{16}$	-	-	$5\gamma_6\ \Omega_{19}$	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\,\Omega_{18}$	-	$5\ \gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-
Stock structure hypothesis II, without E-1 sub-stock in sub-area ESW (Trial NM13) (matrix A13) [high mixing]											
Adult females (ages 10+)											
W	0.55	0.2	0.1	0.15	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	$0.5\ \gamma_4$	γ_5	0.05	-	γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	-	γ_8	γ_9
E-2	-	-	-	-	-	0.1	0.8	0.1	-	-	-
Adult males (ages 10+) and juveniles											
W	$0.2\ \Omega_{11}$	Ω_{12}	$0.1\ \Omega_{13}$	$0.2\ \Omega_{14}$	-	-	-	-	-	-	-
C	-	$0.1\ \gamma_1\Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\,\Omega_{14}$	$\gamma_4\,\Omega_{15}$	$\gamma_5\ \Omega_{16}$	$0.05\,\Omega_{17}$	-	$\gamma_6\Omega_{19}$	-	-
E-1	-	-	-	-	-	-	$0.1\ \Omega_{17}$	$\gamma_7\ \Omega_{18}$	-	$\gamma_8\,\Omega_{20}$	$\gamma_9\,\Omega_{21}$
E-2	-	-	-	-	-	$0.1\Omega_{16}$	$0.8\ \Omega_{17}$	$0.1\ \Omega_{18}$	-	-	-
Stock structure hypothesis II, without E-1 sub-stock in sub-area ESW (Trial NM13) (matrix B13) [low mixing]											
Adult females (ages 10+)											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	γ_1	γ_2	γ_3	γ_4	γ_5	-	-	$5\gamma_6$	-	-
E-1	-	-	-	-	-	-	-	γ_7	-	$5\ \gamma_8$	γ_9
E-2	-	-	-	-	-	-	1	-	-	-	-
Adult males (ages 10+) and juveniles											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	$\gamma_1\ \Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\ \Omega_{14}$	$2\ \gamma_4\,\Omega_{15}$	$\gamma_5\,\Omega_{16}$	-	-	$5\gamma_6\ \Omega_{19}$	-	-
E-1	-	-	-	-	-	-	-	$\gamma_7\ \Omega_{18}$	-	$5\ \gamma_8\ \Omega_{20}$	$\gamma_9\ \Omega_{21}$
E-2	-	-	-	-	-	-	1	-	-	-	-

Table 3

The estimates of abundance and their sampling standard errors.

Year	Sub-area	Abundance	CV	Year	Sub-area	Abundance	CV
2007	WC	20,741	0.3	1989	EN	8,318	0.25
1987	WG*	3,266	0.31	1995	EN	22,536	0.23
1993	WG*	8,371	0.43	1998	EN	13,673	0.25
2005	WG	10,792	0.59	2004	EN	6,246	0.47
2007	WG	9,853[$]	0.43	2009	EN	6,891	0.31
2015	WG	5,241	0.49	1989	EW	20,991	0.17
1988	CIP	8,431	0.245	1995	EW	34,986	0.12
2001	CIP	3,391	0.82	1996	EW	23,522	0.13
2007	CIP	1,350	0.38	2006	EW	27,152	0.218
2015	CIP	6,306	0.345	2011	EW	21,218	0.32
1995	CIP+CG*	4,854	0.27	1995	ESW	2,691	0.29
1987	CG	1,555	0.26	1999	ESW	1,932	0.68
2001	CG	7,349	0.31	2008	ESW	5,009	0.29
2007	CG	1,048	0.6	1989	ESE	13,370	0.19
2015	CG	5,408	0.344	1995	ESE	23,278	0.11
1987	CIC	24,532	0.32	1999	ESE	16,241	0.25
2001	CIC	43,633	0.19	2003	ESE	19,377	0.33
2007	CIC	20,834	0.35	2008	ESE	22,281	0.18
2009	CIC	9,588	0.24	1989	EB	21,868	0.21
2015	CIC	12,710	0.53	1995	EB	29,712	0.18
1988	CM	4,732	0.23	2000	EB	25,885	0.24
1995	CM	12,043	0.28	2007	EB	28,625	0.23
1997	CM	26,718	0.14	2013	EB	34,125	0.34
2005	CM	26,739	0.39				
2010	CM	10,991	0.36				

*Only used when applying the *CLA* to *Small* or Combination Areas consisting of both CIP and CG, and not used for CIP or CG sub-areas separately (e.g. when allocating a catch limit for a Combination Area to its component *Small Areas*). [$]This replaces an earlier estimate of 16,609 (CV 0.428) as it takes into account improved information on availability bias (see SC/67a/Rep02, this volume).

Table 4a

Sighting survey plan. The pattern of surveys from 2020-25 will be repeated every 6 years in the E areas, every 7 years in the C areas and every 10 years in the WG sub-area. The years when Assessments are run are also shown (assessments are run every 6 years from 2021[&] on).

	Country			Assessment
Season	Norway	Iceland	Greenland	Year
2014	-	-	-	-
2015		CIC, CIP, CG	WG	-
2016	CM*, EB, EW, ESW, ESE[Δ]	-	-	Yes
2017	EN	-	-	-
2018	-	-	-	-
2019	-	-	-	-
2020	EW	-	-	-
2021	ESW, ESE	-	-	Yes[&]
2022	EB	CIC, CIP, CG, CM	-	-
2023	EN	-	-	-
2024	-	-	-	-
2025	-	-	WG	-

*CM was covered as a NAMMCO joint effort in TNASS-2015 but the combined survey estimate is not yet available. [Δ]The results of the surveys conducted in sub-areas CM, EW, ESW and ESE during 2014 and 2015 are not yet available and are therefore assumed to apply to 2016. [&]The trials are based on the assumption that assessments were run every 6 years from 2021 onwards.

Table 4b
List of past and planned sightings surveys and the constituents used in setting estimates for areas that are combinations of sub-areas. -=no survey; 1=survey.

	CIP	CG	CIC	CM	CIP, CIC, CM	All C subareas	EN	EW	ESW	ESE	EB	EB, ESW, ESE, EW	EB, EW	ESW, ESE	All E subareas
1987	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
1988	1	-	-	1	1=1987-8	1=1987-8	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	1	1	-	1	1	1=1989	1=1989	1=1989	1=1989
1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	1*	1*	-	1	-	-	1	1	1	1	1	1=1995	1=1995	1=1995	1=1995
1996	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1997	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	1	1	-	-	-	1=1999	-
2000	-	-	-	-	-	-	-	-	-	-	1	1=1996-2000	1=1996-2000	-	1=1996-2000
2001	1	1	1	-	1=1995-2001	1=1995-2001	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	1	-	-	-	1=2003	-
2004	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
2005	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2007	1	1	1	-	-	-	-	-	-	-	1	1=2003-7	1=2006-7	-	1=2003-7
2008	-	-	-	-	-	-	-	-	1	1	-	-	-	1=2008	-
2009	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
2010	-	-	-	1	1=2005-10	1=2005-10	-	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-	-	1	1=2008-13	1=2011-13	-	1=2008-13
2014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2016	-	-	-	1	1=2015-6	1=2015-6	-	1	1	1	1	1=2016	1=2016	1=2016	-
2017	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1=2016-7
2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-	1	1	-	0	0	1=2021	-
2022	1	1	1	1	1=2022	1=2022	-	-	-	-	1	1=2020-22	1=2020-22	-	-
2023	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1=2020-23
2024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2026	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2027	-	-	-	-	-	-	-	-	1	1	-	-	-	1=2027	-
2028	-	-	-	-	-	-	-	-	-	-	1	1=2026-28	1=2026-28	-	-
2029	1	1	1	1	1=2029	1=2029	1	-	-	-	-	-	-	-	1=2026-29

*Only used when applying the *CLA* to *Small* or Combination Areas consisting of both CIP and CG, and not used for CIP or CG sub-areas separately.

G. Parameters and conditioning

The values for the biological and technological parameters are listed in Tables 5a and 5b.

Table 5a
The values for the biological parameters that are fixed.

Parameter	Value
Plus group age, x	20 years
Natural mortality, M	$M_a \begin{cases} 0.085 & \text{if } a \le 4 \\ 0.0775 + 0.001875a & \text{if } 4 < a < 20 \\ 0.115 & \text{if } a \ge 20 \end{cases}$
Maturity (first parturition), β_a	$a_{50} = 8$; $\delta = 1.2$
Maximum Sustainable Yield Level, *MSYL*	0.6 in terms of the 1+ population

Table 5b
The values for the selectivity parameters by area.

Parameter	Value
West *Medium Area* (commercial)	$a_{50}^{g,k}=5$; $\delta^{g,k}=1.2$
West Greenland (aboriginal)	$a_{50}^{g,k}=1$; $\delta^{g,k}=1.2$
Central *Medium Area*	$a_{50}^{g,k}=4$; $\delta^{g,k}=1.2$
Eastern *Medium Area*	$a_{50}^{g,k}=5$; $\delta^{g,k}=1.2$

The 'free' parameters of the operating model are the initial (pre-exploitation) sizes of each of the sub-stocks/stocks, the values that determine the mixing matrices (i.e. the γ and Ω parameters) and the hunt factors that allow for differences between survey and fishery selectivity (the ω^h parameters). The process used to select the values for these 'free' parameters is known as conditioning. The conditioning process involves first generating 100 sets of 'target' data as detailed in steps (a) and (b) below, and then fitting the population model to each (in the spirit of a bootstrap). The number of animals in sub-area k at the start of year t is calculated starting with guessed values of the initial population sizes and projecting the operating model forward to 2016 to obtain values of abundance and sex ratios by sub-area for comparison with the generated data.

The likelihood function used when fitting the model consists of three components. Equations G.2, G.3 and G.6 list the negative of the logarithm of the likelihood for each of these components so the objective function minimised is L_1+L_2+L_3. An additional penalty is added to the likelihood if the full historical catch is not removed.

(a) Abundance estimates
The 'target' values for the historical abundance by sub-area are generated using the formula:

$$P_t^k = O_t^k \exp[\mu_t^k - (\sigma_t^k)^2/2];\ \mu_t^k \sim N[0;(\sigma_t^k)^2] \qquad \text{(G.1)}$$

where:

P_t^k is the abundance for sub-area k in year t;

O_t^k is the actual survey estimate for sub-area k in year t (Table 3); and

σ_t^k is the CV of O_t^k.

The contribution to the likelihood from the abundance data is given by:

$$L_1 = 0.5\sum_n \frac{1}{(\sigma_n)^2}\ell n\left(P_n / \hat{P}_n\right)^2 \qquad \text{(G.2)}$$

where $\hat{P}_n$ is the model estimate of the 1+ abundance in the same year and sub-area as the n^{th} estimate of abundance P_n (the target abundances).

(b) Sex ratios
The parameters used to define the catch and the sightings mixing matrices are set up during the conditioning process. The data on catch sex-ratios by month (see Adjunct 2) for North Atlantic minke whales suggest that the relative proportion of males differs between the primary catching season (i.e. before July) and the time when surveys are conducted and thereafter (July onwards) for at least sub-areas ES and EB.

In principle, the entries of the catch and sightings mixing matrices can be estimated given information on the numbers of animals by sub-area and their age-/sex-structure when catching/sighting surveys take place. However, there is insufficient information to allow estimation in this case so the parameters are set as detailed below.

(I) SEX RATIO DURING SIGHTING SURVEYS
The sighting mixing matrix is used to calculate the number of animals in each sub-area by stock, sex and age in order to generate the sightings abundance estimates on which *SLA*s and the RMP are based (see equation F.2).

The 'observed' values for the pristine sex-ratios by sub-area are obtained by assigning sex ratios (the 'survey' sex ratios) to each sub-area. These 'survey' sex-ratios are not measured directly, so they have to be inferred (and hence are not strictly data in the customary meaning of the word). The operating models are conditioned to values intended to reflect such ratios at the time when whaling commenced. These values and their associated standard errors are estimated from catch-by-sex information for the earliest period of relatively substantial whaling in each sub-area for the month in which surveys take place (in September for WG and in July for all other areas). The details of the estimation process are given in Punt (2016) and the data on which they are based are given in Adjunct 2. The conditioning uses the values as estimated for each area, but rounded values for their standard errors, which were agreed to be 0.05 for all sub-areas except that CIP and ESW (for which there is less past information because of fewer catches) which were agreed to be 0.1 (these values are somewhat larger than the averages of corresponding values in Punt (2016) because the estimation process used there is negatively biased, for example because of overdispersion of the samples compared to the binomial variance assumption made). The proportions and the standard deviations used are listed in Table 6. The 'target' values ($\lambda^{1,k}$) are generated as normal variates of these values, bounded by 0.02 and 0.98.

Table 6
The proportion of females in the surveys (the 'observed' survey sex-ratios).

Sub-area (k)	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
'Survey' sex ratio	0.527	0.556	0.276	0.429	0.399	0.584	0.403	0.446	0.562	0.481	0.437
SE	0.05	0.05	0.1	0.05	0.05	0.05	0.05	0.05	0.1	0.05	0.05

The contribution to the likelihood from the survey sex ratios is given by:

$$L_2 = 0.5\sum_k \left(\hat{\lambda}^{1,k} - \lambda^{1,k}\right)^2 / \left(\sigma^{1,k}\right)^2 \qquad \text{(G.3)}$$

where:

$\lambda^{1,k}$ is the target sex-ratio (proportion of females) for sub-area k in the pristine population during the month in which surveys take place;

$\hat{\lambda}^{1,k}$ is the model-estimate of the sex-ratio for sub-area k in the pristine population:

$$\hat{\lambda}^{1,k} = \frac{\sum_a \sum_j V^{f,j,k}_{-\infty,a} S^{f,k}_a N^{f,j}_{-\infty,a}}{\sum_g \sum_{a'} \sum_{j'} V^{g,j',k}_{-\infty,a'} S^{g,k}_a N^{g,j'}_{-\infty,a'}} \tag{G.4}$$

$\sigma^{1,k}$ is the between-period variation in the sex-ratios for sub-area k during the month in which surveys take place (see Table 6).

$S^{g,k}_a$ is the survey selectivity for gender g in subarea k and is equal to the 'Reference' selectivity $R^{g,h\in k}_a$ where

$$R^{g,h}_a = (1 + e^{-(a - a^{g,h}_{50})/\delta^{g,h}})^{-1} \tag{G.5}$$

$a^{g,h}_{50}$, $\delta^{g,h}$ are the parameters of the (logistic) selectivity ogive for gender g and hunt h (see Table 5b); and in sub-area WG (where there are two hunts), the survey selectivity is based on the reference selectivity of the commercial hunt ($R^{g,h=\text{WG-com}}_a$) rather than the aboriginal hunt (see Table 7 for the relationship between the 'Reference' selectivity and the survey selectivity values).

Table 7

Relationship between hunts, sub-areas and the selectivity arrays.

Hunt (h)	WC	WG-com	WG-ab	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Sub-area (k)	WC	WG	-	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Parameters used in setting the Reference selectivity $R^{g,h}_a$ (see equation G.5):												
$a^{g,h}_{50}$	5	5	1	4	4	4	4	5	5	5	5	5
$\delta^{g,h}$	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
The survey selectivity:												
$S^{g,k}_a$ =	$R^{g,h}_a$	$R^{g,h=\text{WG-com}}_a$	-	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$	$R^{g,h}_a$
Fishing selectivity parameters (see equation G.8)												
ω^h	1	1	Est.	1	Est.	Est.	1	Est.	Est.	1	Est.	Est.

(II) FISHERY SEX RATIOS

The catch mixing matrix for these trials is based on the sightings mixing matrix, with the selectivity pattern by sex adjusted so that the split of the catch to sex in a sub-area matches that actually observed over a recent period if the whalers selected whales at random from those available. In the base-case, the most recent period (2008-13) is used to estimate the parameters by sub-area to adjust the selectivity pattern given that this period is likely to be best reflective of how future whaling operations will occur, and is trial-dependent. Trials NM07-1 and NM07-4 test the effect of using sex-ratios based on catches from the 2002-07 period.

These 'fishery' sex-ratios apply to the season as a whole. Since catch-by-sex data are available for all sub-areas/hunts and seasons for which future catches will be simulated (see Table 8), the fishery sex-selectivity parameter estimated for these sub-areas/hunts provides the flexibility for an exact fit by the model to this information.

Two fishing selectivity patterns are modelled in the WG sub-area to reflect the different sex ratio shown in different hunts: the recent aboriginal hunt in this area compared to that in the earlier commercial catches. All other sub-areas have just one hunt type and thus a single fishing selectivity per sub-area.

The 'target' values ($\lambda^{2,h}$) for the fishery sex ratios are generated as normal variates from the estimated proportion of females over a recent period bounded by 0.02 and 0.98. The estimated female proportions are given in Table 8; details of the estimation process is given in Punt (2016) and the data on which they are based are given in Adjunct 2.

Table 8

The proportion of females in recent catches (the 'observed' fishery sex-ratios and their standard errors).

Hunt	WG-ab	CG	CIC	EN	EW	ESE	EB
Baseline Fishery sex ratio (using years 2008-13)	0.722	0.436	0.267	0.738	0.434	0.926	0.662
SE $\sigma^{2,h}$	0.023	0.12	0.058	0.096	0.023	0.014	0.071
Fishery sex ratio in Trial 07 (using years 2002-07)	0.747	0.665	0.502	0.506	0.496	0.944	0.691
SE	0.015	0.156	0.051	0.042	0.018	0.016	0.094

The contribution to the likelihood from the fishery sex ratios is given by:

$$L_3 = 0.5 \sum_h \left(\hat{\lambda}^{2,h} - \lambda^{2,h}\right)^2 / \left(\sigma^{2,h}\right)^2 \tag{G.6}$$

where:

$\lambda^{2,h}$ is the target fishery sex-ratio (proportion of females) for hunt h (see Table 8);

$\hat{\lambda}^{2,h}$ is the model-estimate of the sex-ratio for hunt h:

$$\hat{\lambda}^{2,h} = \sum_t \left\{ \left(C_t^{\mathrm{m},h} + C_t^{\mathrm{f},h} \right) \frac{\sum_a \sum_j \sum_{k \in h} V_{t,a}^{\mathrm{f},j,k} \tilde{S}_a^{\mathrm{f},h} N_{t,a}^{f,j}}{\sum_g \sum_{a'} \sum_{j'} \sum_{k \in h} V_{t,a'}^{g,j',k} \tilde{S}_{a'}^{g,h} N_{t,a'}^{f,j'}} \right\} / \sum_{t'} \left(C_{t'}^{\mathrm{m},h} + C_{t'}^{\mathrm{f},h} \right) \tag{G.7}$$

$\tilde{S}_a^{g,h}$ is the fishing selectivity on animals of gender g and age a by the hunt h (within sub-area k) which is based on the reference selectivity $R_a^{g,h}$ (see Equation G.5 and Table 7):

$$\tilde{S}_a^{\mathrm{m},h} = \omega^h R_a^{\mathrm{m},h} \quad \text{and} \quad \tilde{S}_a^{\mathrm{f},h} = R_a^{\mathrm{f},h} \tag{G.8}$$

ω^h is the difference in male selectivity in the catches over the year compared to the value at the time of the survey in hunts h for which a future catch is set (and is set to 1 in other hunts); and

$\sigma^{2,h}$ is the between-period variation in the catch sex-ratios for hunt h (see Table 8).

H. Trials

The *Implementation Simulation Trials* for the North Atlantic minke whales are listed in Table 9. All trials are based on the assumption that $g(0)=1$. The majority of the sensitivity tests are based on stock structure hypothesis I because this hypothesis is likely to be the most challenging from a conservation standpoint.

Table 9

The *Implementation Simulation Trials* for North Atlantic minke whales.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Trial weight	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	M	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	H	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	M	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	H	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	M	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	M	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	M	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	M	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM10-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM10-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM12-1	I	1%[1]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM12-4	I	4%[2]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM13-1	II	1%[1]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM13-4	II	4%[2]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM01-1v	I	1%[1]	3	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM01-4v	I	4%[2]	3	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM02-1v	II	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM02-4v	II	4%[2]	2	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM03-1v	III	1%[1]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM03-4v	III	4%[2]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-1v	IV	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-4v	IV	4%[2]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value

[1]1+; [2]mature.

I. Management options

All the Management variants are based on applying catch cascading from the C and E *Combination areas* (which are identical to the C and E *Medium areas*). In all cases aboriginal catch limits are set for sub-areas WG and CG based on an *SLA*[3] and WC is a residual area. The following management variants will be considered:

V1 Sub-areas CIC, CM, CG, CIP, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the ESW+ESE *Small Area* is all taken in the ESE sub-area. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);

V2 Sub-areas CIC, CM, CG, CIP, EN and EB+ESW+ESE+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ ESW+ESE +EW *Small Area* is all taken in the EW sub-area. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);

[3]In the absence of an agreed *SLA*, the interim *SLA* (IWC, 2009b) is used to set the quota in the WG sub-area, assuming a need level of 164 whales for each of the 100 years. A fixed quota of 12 whales/year is set for the CG sub-area.

V3 Sub-areas CIC, CM, CG, CIP, EN, ESW+ESE, and EB+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ EW *Small Area* is all taken in the EW sub-area and the catch from the ESW+ESE *Small Area* is taken in the ESE sub-area. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG);

V4 As for V1, except that sub-areas CIC+CIP+CM are a single *Small Area* and all of the catches from this *Small Area* are taken in the CIC sub-area. The catch limits set for the CG *Small Area* are not taken (except that the Aboriginal catch is taken); and

V5 Sub-areas CIP+CIC+CG+CM, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for the E *Small Areas* based on catch cascading from the E *Combination Area*. All the catches from CIP+CIC+CG+CM *Small* Area are taken in the CIC sub-area (after taking the Aboriginal catch from CG) and those for the ESW+ESE *Small Area* are taken in the ESE sub-area.

If the RMP catch limit for the *Combination Area* or *Small Area* containing the CG sub-area is:

(i) ≤ the aboriginal strike limit, the catch limit for that *Combination Area* or *Small Area* is set to zero and the aboriginal catch is equal to the strike limit; or

(ii) > the aboriginal strike limit, the RMP catch limits are set as usual.

J. Output statistics

The population-size statistics are produced for each feeding ground and stock, while the catch-related statistics are for each sub-area.

(1) Total catch (TC) distribution: (a) median; (b) 5th value; (c) 95th value.

(2) Initial mature female population size (P_{initial}) distribution: (a) median; (b) 5th value; (c) 95th value.

(3) Final mature female population size (P_{final} distribution: (a) median; (b) 5th value; (c) 95th value.

(4) Lowest mature female population size (P_{lowest}) distribution: (a) median; (b) 5th value; (c) 95th value.

(5) Average catch by sub-area over the first ten years of the 100-year management period: (a) median; (b) 5th value; (c) 95th value.

Average catch by sub-area over the last ten years of the 100-year management period: (a) median; (b) 5th value; (c) 95th values. Plots are produced showing following types of outputs for all variants and the no-catch scenarios:

(a) the median population size trajectories by stock;

(b) the 5%-ile, median and 95%-ile of the population depletion trajectories by stock (from 2000 to the end of the projection period);

(c) the median catch trajectories from 2000 onwards); and

(d) ten individual population trajectories for each stock.

In addition, plots and tables are produced summarising the application of the procedure for defining 'acceptable' - A, 'borderline' - B and 'unacceptable' - U performance, by comparison with the equivalent single stock trials – see IWC (2005). These final statistics will be based on comparison with projections with aboriginal catches in the WG and CG sub-areas set by the 'Interim *SLA*' (IWC, 2009a) but no commercial catches.

K. References

Heide-Jørgensen, M.P. and Laidre, K.L. 2008. Fluctuating abundance of minke whales in West Greenland. Paper SC/60/AWMP5 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 19pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1991. Report of the Sub-Committee on Management Procedures, Appendix 4. Report of the *ad-hoc* trials subgroup. *Rep. int. Whal. Comm.* 41:108-12.

International Whaling Commission. 1993. Report of the Scientific Committee, Annex I. Report of the Working Group on *Implementation Trials*. *Rep. int. Whal. Comm.* 43:153-96.

International Whaling Commission. 1994. Report of the Scientific Committee, Annex D. Report of the Sub-Committee on Management Procedures, Appendix 2. Minimum Standards Trials. *Rep. int. Whal. Comm.* 44:85-88.

International Whaling Commission. 2004a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 6:1-60.

International Whaling Commission. 2004b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 10. North Pacific minke whale *Implementation Simulation Trial* specifications. *J. Cetacean Res. Manage. (Suppl.)* 6:118-29.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. Appendix 2. Requirements and Guidelines for *Implementation*. *J. Cetacean Res. Manage. (Suppl.)* 7:84-92.

International Whaling Commission. 2009a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). Appendix 7. Report of the working group on the North Atlantic minke whales RMP *Implementation Review*. *J. Cetacean Res. Manage. (Suppl.)* 11: 132-40.

International Whaling Commission. 2015. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

Punt, A.E. 1999. Report of the Scientific Committee. Annex R. A full description of the standard BALEEN II model and some variants thereof. *J. Cetacean Res. Manage. (Suppl.)* 1: 267-76.

Punt, A.E. 2016. Report of the RMP Intersessional Workshop on the Implementation Review for North Atlantic Minke Whales, 16-20 February 2015, Copenhagen, Denmark. Annex D. An initial attempt to estimate mean sex ratios and associated standard errors. *J. Cetacean Res. Manage. (Suppl.)* 17: 503-06.

Adjunct 1

The Catch Series

C. Allison

The catch series used in the trials is given in table 1 and includes all known direct and indirect catches. Details of the sources of the direct catch data are given in Allison (2015) and of the indirect catches in IWC (2015, pp.123-24). The 2 known catches prior to 1900 are ignored. The Faroes catches (125 whales) are allocated to the EW sub-area as they were all taken from land stations in the north of the Faroes. The Norwegian catch data from 1938 on includes detailed positions except for 16 records; these have been allocated to sub-area in accordance with the ratio of other catches in the same year. Table 2 lists the catches known by sex and sub-area/hunt. The average sex ratio for the hunt is assumed for all other catches.

Table 1

The 'best' catch series.

Year	WC	WG-comm.	WG-aborig.	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB	Total
1914	0	0	0	0	0	1	0	0	0	0	0	0	1
1915	0	0	0	0	0	10	0	0	0	0	0	0	10
1916	0	0	0	0	0	6	0	0	0	0	0	0	6
1917	0	0	0	0	0	6	0	0	0	0	0	0	6
1918	0	0	0	0	0	6	0	1	0	0	0	0	7
1919	0	0	0	0	0	6	0	5	3	0	0	0	14
1920	0	0	0	0	0	6	0	0	0	0	0	0	6
1921	0	0	0	0	0	20	0	0	0	0	0	0	20
1922	0	0	0	0	0	20	0	0	0	0	0	0	20
1923	0	0	0	0	0	20	0	0	0	0	0	0	20
1924	0	0	0	0	0	20	0	0	0	0	0	0	20
1925	0	0	0	0	0	20	0	0	0	0	0	0	20
1926	0	0	0	0	0	9	0	0	4	0	0	0	13
1927	0	0	0	0	0	9	0	0	4	0	0	0	13
1928	0	0	0	0	0	9	0	0	0	0	0	0	9
1929	0	0	0	0	0	9	0	2	4	0	0	0	15
1930	0	0	0	0	0	9	0	28	10	0	0	0	47
1931	0	0	0	0	0	7	0	0	175	0	0	0	182
1932	0	0	0	0	0	5	0	0	350	0	0	0	355
1933	0	0	0	0	0	10	0	0	525	0	0	0	535
1934	0	0	0	0	0	4	0	30	670	0	0	0	704
1935	0	0	0	0	0	2	0	50	828	0	0	0	880
1936	0	0	0	0	0	1	0	84	909	0	30	30	1,054
1937	0	0	0	0	0	1	0	125	996	0	60	50	1,232
1938	0	0	0	0	0	1	0	266	907	0	112	68	1,354
1939	0	0	0	0	0	1	0	137	762	1	12	6	919
1940	0	0	0	0	0	1	0	35	503	0	1	13	553
1941	0	0	0	0	0	5	0	186	1,914	0	4	6	2,115
1942	1	0	0	0	0	18	0	158	1,976	0	0	0	2,153
1943	0	0	0	0	0	16	0	158	1,455	0	0	0	1,629
1944	0	0	0	0	0	15	0	97	1,252	0	0	0	1,364
1945	0	0	0	0	0	16	0	165	1,611	0	0	10	1,802
1946	0	0	0	0	0	34	0	305	1,337	0	140	101	1,917
1947	16	0	0	0	0	34	0	373	1,810	0	136	237	2,606
1948	38	0	4	0	0	102	0	358	2,035	0	559	535	3,631
1949	38	0	5	0	0	106	7	241	1,206	0	701	1,693	3,997
1950	3	0	9	0	0	80	0	106	1,173	0	274	437	2,082
1951	55	0	16	0	0	63	0	89	1,836	0	155	672	2,886
1952	17	0	32	0	0	64	0	122	1,273	0	101	1,829	3,438
1953	0	0	32	0	0	79	0	63	1,231	0	62	1,079	2,546
1954	0	0	22	0	0	54	0	359	1,508	0	88	1,544	3,575
1955	13	0	22	0	6	57	1	435	2,138	1	56	1,679	4,408
1956	57	0	22	0	0	21	3	441	1,611	10	483	1,111	3,759
1957	37	0	24	1	0	37	0	593	1,417	12	612	1,000	3,733
1958	42	0	30	0	0	36	0	639	1,658	3	498	1,543	4,449
1959	18	0	55	0	14	35	2	575	900	15	495	1,091	3,200
1960	11	0	56	4	12	82	0	628	1,039	14	369	1,223	3,438
1961	22	0	35	1	3	108	72	377	1,322	13	208	1,187	3,348
1962	50	0	72	0	3	134	158	400	1,302	22	113	1,225	3,479
1963	18	0	166	5	10	115	80	340	1,043	5	324	1,355	3,461
1964	54	0	162	1	8	153	151	400	1,057	10	233	769	2,998
1965	41	0	196	3	0	147	255	268	1,062	5	534	253	2,764
1966	11	0	225	15	87	123	88	330	633	1	288	671	2,472
1967	40	0	244	44	143	193	66	181	901	91	536	118	2,557
1968	0	20	315	62	211	409	45	355	893	90	656	114	3,170
1969	60	165	269	22	94	214	21	479	667	22	397	467	2,877
1970	88	126	207	8	159	222	13	350	632	20	628	282	2,735
1971	84	263	196	38	29	228	17	410	385	0	524	483	2,657
1972	214	123	156	32	139	199	0	319	231	0	158	1,467	3,038
1973	3	221	276	24	222	147	0	200	267	3	253	839	2,455
1974	3	252	217	12	102	127	15	172	291	0	26	931	2,148
1975	4	102	222	15	217	193	0	186	269	0	324	651	2,183

Year	WC	WG-comm.	WG-aborig.	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB	Total
1976	3	187	191	3	81	216	0	186	148	0	365	1,190	2,570
1977	1	75	285	0	1	194	0	118	281	0	749	551	2,255
1978	2	75	180	0	130	199	3	83	312	0	162	826	1,972
1979	9	75	250	0	119	198	1	76	446	0	62	1,202	2,438
1980	10	78	258	0	119	202	0	67	259	0	477	1,004	2,474
1981	8	61	204	0	45	201	0	62	385	0	714	610	2,290
1982	4	66	250	0	109	212	0	60	344	0	655	723	2,423
1983	4	68	268	0	98	204	15	36	158	0	623	871	2,345
1984	6	70	235	0	25	178	90	19	219	0	183	209	1,234
1985	7	52	222	0	44	145	55	23	171	0	209	231	1,159
1986	4	0	145	0	2	0	50	33	129	0	128	39	530
1987	8	0	86	0	4	0	50	34	92	0	157	40	471
1988	9	0	109	0	10	0	0	0	29	0	0	0	157
1989	10	0	63	0	10	0	0	0	1	0	16	0	100
1990	11	0	89	0	6	0	0	0	5	0	0	0	111
1991	5	0	109	0	10	0	0	0	1	0	0	0	125
1992	8	0	110	0	11	0	0	0	37	0	36	22	224
1993	5	0	113	0	9	0	13	8	120	0	51	34	353
1994	5	0	104	0	5	0	41	9	94	0	31	105	394
1995	7	0	155	0	9	0	42	3	38	0	46	89	389
1996	0	0	170	0	13	0	40	24	75	0	112	137	571
1997	2	0	148	0	14	0	20	40	74	0	129	240	667
1998	5	0	169	0	10	0	57	137	85	0	129	217	809
1999	9	0	172	0	14	0	58	122	158	0	112	141	786
2000	1	0	147	0	10	0	57	65	192	0	103	70	645
2001	10	0	139	0	17	0	31	104	247	0	120	50	718
2002	9	0	140	0	10	2	35	74	253	0	146	126	795
2003	6	0	185	0	14	37	21	98	157	0	150	221	889
2004	8	0	179	0	11	25	17	93	199	0	113	125	770
2005	6	0	176	0	4	41	5	9	244	0	99	284	868
2006	2	0	181	0	3	62	0	34	373	0	118	23	796
2007	7	0	167	0	2	45	0	99	176	0	295	28	819
2008	6	0	154	0	1	38	31	98	160	0	230	22	740
2009	0	0	165	0	4	81	0	50	182	0	250	4	736
2010	5	0	187	0	9	60	1	35	145	0	270	18	730
2011	4	0	179	0	10	58	0	14	218	0	201	100	784
2012	0	0	148	0	4	52	0	14	200	0	244	6	668
2013	0	0	175	0	6	35	0	2	242	0	282	68	810
2014	0	0	146	0	11	24	0	20	231	0	377	108	917
2015	0	0	133	0	6	29	0	4	137	0	426	93	828
Total	1,244	2,079	9,973	290	2,479	6,423	1,727	13,574	55,002	338	18,720	36,596	148,445

Table 2
Catches known by sex.

Year	WC		WG-com		WG-ab		CIP		CG		CIC		CM		EN		EW		ESW		ESE		EB	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1914	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1916	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	13	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	98	463	386	0	0	50	50	47	19
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	70	383	323	1	0	5	7	4	2
1940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	25	257	207	0	0	0	0	9	4
1941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	78	1,003	863	0	0	2	2	3	3
1942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	64	1,112	853	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	69	844	592	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	52	658	585	0	0	0	0	0	0

Year	WC		WG-com		WG-ab		CIP		CG		CIC		CM		EN		EW		ESW		ESE		EB	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	55	891	705	0	0	0	0	7	3
1946	0	0	0	0	0	0	0	0	0	0	0	0	0	0	190	114	737	588	0	0	58	78	65	35
1947	0	0	0	0	0	0	0	0	0	0	9	3	0	0	202	166	1,013	779	0	0	47	89	162	72
1948	24	14	0	0	0	0	0	0	0	0	38	28	0	0	207	148	1,100	905	0	0	234	317	321	200
1949	24	14	0	0	0	0	0	0	0	0	38	33	3	4	141	99	652	542	0	0	250	446	841	826
1950	2	1	0	0	0	0	0	0	0	0	0	0	0	0	61	44	649	510	0	0	62	212	179	254
1951	26	29	0	0	0	0	0	0	0	0	0	0	0	0	68	20	1,030	791	0	0	68	87	243	428
1952	10	7	0	0	0	0	0	0	0	0	1	1	0	0	75	46	704	561	0	0	59	42	632	1,185
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	26	721	504	0	0	37	24	436	642
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	204	149	795	702	0	0	54	34	688	852
1955	5	8	0	0	7	8	0	0	1	5	4	9	0	1	244	181	1,156	972	1	0	18	37	620	1,053
1956	27	27	0	0	5	15	0	0	0	0	0	0	3	0	288	149	906	694	4	6	159	323	451	659
1957	6	12	0	0	6	18	1	0	0	0	1	0	0	0	380	210	772	634	1	11	151	457	347	651
1958	0	0	0	0	5	6	0	0	0	0	0	0	0	0	412	225	950	704	2	1	152	346	470	1,052
1959	6	12	0	0	2	17	0	0	9	5	1	0	0	2	423	149	483	414	1	14	121	373	594	480
1960	5	6	0	0	3	15	3	1	4	8	7	2	0	0	436	187	531	482	2	12	114	253	443	779
1961	8	14	0	0	7	9	1	0	3	0	42	8	45	27	236	140	779	530	9	4	65	143	349	821
1962	0	0	0	0	18	43	0	0	3	0	48	24	82	75	261	137	704	583	8	14	34	79	364	839
1963	2	16	0	0	32	47	3	2	9	1	40	28	33	47	214	126	592	450	2	3	115	209	517	836
1964	12	42	0	0	26	37	1	0	5	3	85	22	88	63	278	121	549	500	4	6	65	168	289	478
1965	7	4	0	0	19	30	2	1	0	0	51	36	112	143	175	93	583	477	3	2	151	381	112	137
1966	0	0	0	0	24	49	13	2	69	18	31	28	12	76	218	111	362	249	1	0	96	192	171	498
1967	15	25	0	0	7	42	31	13	108	35	78	38	42	24	125	53	553	338	31	60	154	381	59	59
1968	0	0	7	13	10	47	33	29	106	104	163	157	32	13	233	117	528	329	51	39	346	304	59	54
1969	33	27	119	46	14	42	11	11	64	30	37	17	6	15	300	173	444	221	12	10	80	317	177	289
1970	22	66	74	52	12	20	4	4	91	68	56	32	6	7	197	148	383	245	7	13	239	389	62	218
1971	20	63	86	177	6	25	2	4	23	6	47	34	6	11	281	115	212	166	0	0	177	345	183	299
1972	84	130	32	91	6	40	16	16	74	65	42	23	0	0	189	126	116	111	0	0	39	119	446	1,014
1973	0	0	67	154	8	39	17	6	159	62	13	7	0	0	109	90	149	117	0	3	54	199	334	503
1974	1	0	43	209	6	34	7	4	73	28	60	62	1	14	89	81	144	136	0	0	3	23	290	636
1975	0	0	11	91	1	17	7	8	84	132	89	80	0	0	131	55	156	109	0	0	66	257	246	405
1976	0	1	38	149	2	20	3	0	57	23	114	87	0	0	115	71	64	74	0	0	85	279	351	839
1977	0	0	21	54	15	39	0	0	0	0	103	86	0	0	70	48	186	90	0	0	231	517	223	328
1978	0	0	10	65	2	13	0	0	72	58	85	113	3	0	54	29	152	159	0	0	13	148	251	574
1979	0	1	31	44	0	1	0	0	75	43	111	87	1	0	41	32	296	148	0	0	14	48	409	783
1980	2	2	14	64	0	0	0	0	77	39	120	81	0	0	54	12	182	73	0	0	155	320	388	604
1981	0	0	15	46	1	1	0	0	10	35	113	77	0	0	36	25	209	168	0	0	257	454	256	354
1982	0	0	24	42	0	0	0	0	84	24	127	85	0	0	44	16	168	174	0	0	184	471	233	476
1983	0	0	25	42	0	0	0	0	51	38	117	87	1	14	23	13	88	67	0	0	182	440	315	543
1984	0	0	20	49	0	0	0	0	6	9	91	71	28	62	17	2	164	54	0	0	65	118	89	119
1985	0	0	28	24	0	0	0	0	15	15	92	50	3	52	19	2	142	28	0	0	56	153	103	126
1986	0	0	0	0	0	0	0	0	0	0	0	0	6	44	24	9	109	19	0	0	66	62	27	12
1987	0	0	0	0	14	29	0	0	0	4	0	0	12	38	20	14	46	46	0	0	61	96	27	13
1988	0	0	0	0	5	35	0	0	1	4	0	0	0	0	0	0	21	8	0	0	0	0	0	0
1989	0	0	0	0	16	34	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	15	0	0
1990	0	0	0	0	14	62	0	0	0	5	0	0	0	0	0	0	4	1	0	0	0	0	0	0
1991	0	0	0	0	19	63	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	1	0	0	18	75	0	0	0	8	0	0	0	0	0	0	22	13	0	0	15	20	14	8
1993	1	0	0	0	25	71	0	0	0	2	0	0	5	8	1	7	79	36	0	0	4	45	6	26
1994	0	0	0	0	20	77	0	0	0	5	0	0	3	38	5	3	61	29	0	0	5	25	57	47
1995	0	1	0	0	46	105	0	0	0	2	0	0	4	38	1	2	14	23	0	0	2	43	13	76
1996	0	0	0	0	37	126	0	0	1	12	0	0	1	39	5	18	18	56	0	0	2	110	27	107
1997	0	0	0	0	42	102	0	0	1	10	0	0	0	19	9	29	33	41	0	0	1	126	70	168
1998	1	0	0	0	41	124	0	0	1	9	0	0	8	49	50	82	31	53	0	0	2	125	37	177
1999	0	3	0	0	35	133	0	0	1	13	0	0	9	46	47	69	67	81	0	0	2	104	37	95
2000	0	0	0	0	37	103	0	0	2	8	0	0	23	33	25	39	101	85	0	0	1	96	24	43
2001	0	0	0	0	32	91	0	0	0	14	0	0	4	27	31	71	150	92	0	0	0	116	11	39
2002	0	2	0	0	33	97	0	0	0	10	1	1	6	29	37	33	140	111	0	0	21	114	22	102
2003	2	2	0	0	57	118	0	0	1	11	23	13	1	19	45	48	73	82	0	0	5	135	89	127
2004	0	3	0	0	44	129	0	0	4	7	10	15	0	17	35	55	95	102	0	0	2	109	23	100
2005	1	0	0	0	34	135	0	0	3	1	20	15	4	1	6	3	108	133	0	0	5	92	31	249
2006	0	0	0	0	44	127	0	0	2	0	31	28	0	0	11	21	200	166	0	0	9	108	0	22
2007	0	1	0	0	38	121	0	0	0	1	14	28	0	0	52	44	86	88	0	0	12	271	20	8
2008	0	1	0	0	55	87	0	0	0	1	28	7	5	26	44	50	99	55	0	0	9	220	12	10
2009	0	0	0	0	47	107	0	0	3	1	64	14	0	0	29	21	83	98	0	0	13	237	1	3
2010	1	0	0	0	54	122	0	0	4	2	47	12	0	1	5	29	80	65	0	0	11	256	6	12
2011	0	0	0	0	39	133	0	0	0	9	45	13	0	0	1	13	121	95	0	0	26	173	15	83
2012	0	0	0	0	34	108	0	0	0	4	38	11	0	0	1	13	113	84	0	0	26	214	4	2
2013	0	0	0	0	37	127	0	0	1	3	13	22	0	0	1	0	144	94	0	0	28	253	21	47
2014	0	0	0	0	27	115	0	0	1	9	16	7	0	0	7	11	122	108	0	0	79	297	28	79
2015	0	0	0	0	26	101	0	0	0	6	21	8	0	0	3	1	60	77	0	0	75	351	21	72
Total	347	535	665	1,412	1,214	3,531	155	101	1,360	1,021	2,425	1,690	598	1,122	8,036	5,058	28,011	21,840	140	198	5,050	13,444	13,481	22,758

References

Allison, C. 2015. IWC Summary catch database version 5.5. IWC Secretariat, Cambridge, UK.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). Appendix 5. *Implementation Review* for North Atlantic common minke whales. *J. Cetacean Res. Manage. (Suppl.)* 16:112-36.

Adjunct 2

Data used to estimate the survey and fishery sex ratios (see Appendix 6, Tables 6 and 8, this volume, pp.144-45)

C. Allison

The sex ratios in the catches of North Atlantic minke whales have been shown to be both spatially and seasonally variable (IWC, 2015, pp.120-22). The trials allow for the difference in the catch sex-ratios between the primary catching season (i.e. before July) and the time when surveys are conducted (July onwards) (see details in Section G of Appendix 6, pp.143-46).

‘Survey’ sex-ratio data

The ‘Survey’ sex-ratios are intended to reflect such ratios at the time when whaling commenced, and are estimated from catch-by-sex information for the earliest period of relatively substantial whaling in each sub-area for the month in which surveys take place (in September for WG and in July for all other areas). The data used are listed in Table 1. In areas where the catches in the survey month are relatively small (WC, CIP, CG, CIC and CM), the ‘survey’ sex ratios are estimated using data from all years (see Table 1). Catches in the CIC area from the 1986-92 period are excluded as they were primarily taken during a scientific whaling program and hence may be more widely distributed across the area than commercial catches and have a different sex ratio. The ‘Survey’ sex-ratio for the WG sub-area is estimated using the data from 1986 onwards as the sex ratio from the recent aboriginal hunt differs from that in the earlier commercial catches (IWC, 2015, pp,120-22). Bycatch data are omitted.

Table 1

Catches used to estimate ‘survey’ sex ratios by sub-area.

Month:	July		September		July		July		July		July		July	
Years:	All		<1986		All		All		All		All		All	
Sub-area:	WC		WG		CIP		CG		CIC		CM		ESW	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1948	10	5							16	10				
1949	15	6							21	18	3	4		
1950	0	1												
1951	8	4												
1952	2	2							1	1				
1953	5	3												
1954	9	14												
1955	2	1							3	7	0	1		
1956	8	6									3	0		
1957	4	8												
1959	3	7												
1960	4	2	0	1					1	1				
1961	4	7	1	2			3	0	20	3	10	5		
1962	0	0	6	11			0	0	6	3	42	41	6	10
1963	0	0					1	0	3	3	11	25	0	0
1964	0	2					1	3	6	4	29	25	1	2
1965	5	3					0	0	22	18	50	29	0	0
1966	1	3			6	1	0	0	6	4	1	3	0	0
1967	3	11			6	3	52	14	39	27	32	1	0	0
1968	0	0	0	0	0	0	7	11	22	17	14	3	8	7
1969	9	12	0	0	0	1	3	1	0	0	3	7	1	0
1970	4	12	11	13	3	2	30	24	31	15	2	3	0	3
1971	3	4	11	16	0	0	1	1	20	26	5	11		
1972	22	22	1	0	2	1	7	4	29	16				
1973			0	0	10	3	26	16	5	1				
1974			0	1	1	0	9	6	6	4				
1975			0	0	1	2	25	55	24	18				
1976			0	0			22	6	25	21				
1977			0	0			0	0	44	28				
1978			0	0			55	36	51	39				
1979			6	4			43	28	37	25	1	0		
1980			0	0			17	8	63	32				
1981			1	0					26	32				
1982			2	2					30	19				
1983			8	6					30	28	1	5		
1984			7	15					40	22	25	52		
1985			5	2			6	14	31	21	0	10		
1986											4	29		
1987			3	1							9	12		
1988			1	6										
1989			3	7										
1990			4	12										
1991			4	14										
1992			3	13										
1993			8	10							3	4		
1994			7	10							0	7		
1995			9	16							1	4		
1996			11	22							0	16		
1997			14	18							0	1		
1998			4	30							1	0		
1999			7	33							0	1		

Month:	July		September		July		July		July		July		July	
Years:	All		<1986		All		All		All		All		All	
Sub-area:	WC		WG		CIP		CG		CIC		CM		ESW	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2000			2	11							2	12		
2001			5	15							0	0		
2002			9	13							1	2		
2003			7	20							0	5		
2004			8	23					3	6				
2005			11	26					11	7				
2006			15	32					8	17				
2007			4	10					3	2				
2008			11	14					12	0	5	25		
2009			7	16					20	6				
2010			7	17					10	3				
2011			13	28					18	2				
2012			5	14					6	4				
2013									6	5				

Month:	July		July		July		July	
Years:	<1960		<1960		<1960		<1960	
Sub-area:	EN		EW		ESE		EB	
Year	M	F	M	F	M	F	M	F
1927	0	0	1	2	0	0	0	0
1929	2	0	1	1	0	0	0	0
1930	6	6	0	0	0	0	0	0
1938	70	34	128	104	20	19	21	7
1939	14	12	138	105	0	0	0	0
1940	2	9	91	59	0	0	6	1
1941	29	24	334	268	2	2	2	2
1942	27	12	292	233	0	0	0	0
1943	23	14	146	124	0	0	0	0
1944	7	9	186	147	0	0	0	0
1945	26	13	280	205	0	0	5	0
1946	58	36	232	172	29	35	56	28
1947	54	37	228	196	1	2	134	61
1948	56	45	464	375	104	86	162	89
1949	33	23	172	136	39	41	354	369
1950	11	6	87	95	8	7	24	26
1951	7	0	133	102	8	4	16	37
1952	9	3	104	63	0	0	87	142
1953	0	1	90	75	0	0	7	9
1954	14	15	96	96	0	0	116	118
1955	45	47	225	211	0	0	0	0
1956	20	13	185	137	0	0	0	0
1957	97	62	152	127	0	0	0	0
1958	66	38	195	152	0	0	21	22
1959	50	22	98	79	0	0	76	27

'Fishery' sex-ratio data

The 'Fishery' sex ratios are estimated for all future hunts and are based on recent catches as this is likely to be best reflective of how future whaling operations will occur. In the base case all catches from the 2008-13 period are used (except any by-catches) and for trials NM07-1 and NM07-4 the 2002-07 period is used. The data are listed in Table 2.

Table 2

Catches used to estimate 'fishery' sex ratios (for all future hunts).

Year	WG-ab	WG-ab	CG	CG	CIC	CIC	CM	CM	EN	EN	EW	EW	ESE	ESE	EB	EB
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2002	33	97	0	10	0	0	6	29	37	33	140	111	21	114	22	102
2003	57	118	1	11	23	13	1	19	45	48	73	82	5	135	89	127
2004	44	129	4	7	10	15	0	17	35	53	95	102	2	109	23	100
2005	34	135	3	1	20	14	4	1	6	1	108	133	5	92	31	249
2006	44	127	2	0	31	28	0	0	10	20	200	166	9	108	0	22
2007	38	121	0	1	14	28	0	0	52	44	86	88	12	271	20	8
2008	55	87	0	1	28	7	5	25	43	48	99	55	9	220	12	10
2009	47	107	3	1	64	14	0	0	28	21	83	98	13	237	1	3
2010	54	122	4	2	47	12	0	1	4	29	80	65	11	256	6	12
2011	39	133	0	9	45	13	0	0	1	13	121	95	26	173	15	83
2012	34	108	0	4	38	11	0	0	1	13	113	84	26	214	4	2
2013	37	127	1	3	13	22	0	0	1	0	144	94	28	253	21	47

Reference

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). Appendix 5. *Implementation Review* for North Atlantic common minke whales. *J. Cetacean Res. Manage. (Suppl.)* 16:112-36.

Appendix 7

CURRENT TRIAL SPECIFICATIONS (WESTERN NORTH PACIFIC BRYDE'S WHALES)

[See Specifications in SC/67a/Rep07, this volume, pp.587-593]

Annex E

Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures

Members: Donovan (Convenor), Allison, Brandão, Butterworth, de la Mare, Enmikau, Fortuna, George, Givens, Goodman, Gunnlaugsson, Gushcherov, Hielscher, Holm, Iñíguez, Johnson, Litovka, Moor, Morita, H., Morita, Y., Punt, Reeves, Rendell, Scordino, Slugina, Stimmelmayr, Suydam, Tiedemann, Víkingsson, Von Duyke, Walløe, Witting, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants. He noted that the main topics this year were to: (1) work towards completion of the remaining *SLA*s for the Greenland hunts and a draft AWS at the 2018 Scientific Committee meeting; and (2) review new information for all stocks subject to aboriginal subsistence hunts and provide the annual review of management advice. He reminded participants that the next block of catch/strike limits would be considered at the 2018 Commission meeting.

1.2 Election of Chair and appointment of rapporteurs

Donovan was elected Chair. Givens, Scordino and Brandão acted as rapporteurs with assistance from the Chair.

1.3 Adoption of Agenda

The adopted agenda is given as Appendix 1.

1.4 Documents available

The documents available included SC/67a/Rep06 and SC/67a/AWMP01-13.

2. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS

At its 2018 meeting, the Commission will be setting new block quotas for aboriginal stocks, including for the Greenlandic hunts. The Commission had approved the interim safe approach for providing advice for the Greenland hunts developed by the Committee in 2008 (IWC, 2009) that would last for up to two quota blocks. Thus advice will be required at the 2018 Commission meeting and the SWG **reiterated its strong desire** and intention to complete and recommend *SLA*s for all of the Greenland hunts by the 2018 Scientific Committee meeting. The Commission had endorsed the *Humpback SLA* in 2014 (IWC, 2017a) and the *WG-Bowhead SLA* in 2016 (IWC, 2017b). Work on fin and common minke whales is provided below. The Working Group on ASI (Annex Q) had reviewed the new Greenland abundance estimates referred to it by the AWMP intersessional workshop (SC/67a/Rep06) and had endorsed the estimates that had been provided in Table 1 of that report for use in the *SLA* development process and implementation.

2.1 Fin whales

2.1.1 Review results of intersessional Workshop

At the Workshop (SC/67a/Rep06), it was noted that the point estimate of a comparable 2015 survey estimate of fin whales off West Greenland was only one tenth the size of the previous one (465 in 2015 compared to 4,470 in 2007). It had agreed that the difference between these estimates is certainly too large to attribute to hunting, and that there was no evidence to suggest a real decline in abundance. Consequently, the Workshop examined the possibility that in some years, only part of this population is present off West Greenland. The Workshop therefore agreed to model these abundance estimates by means of a two-component process whereby each year either all whales in the population entered the West Greenland region, or only a proportion of those whales, where the proportion was drawn randomly from a probability distribution. The Workshop agreed that this issue must be reflected in the manner in which future survey estimates for this region are generated when testing *SLA*s and that the trials incorporate conservative and realistic testing scenarios.

The SWG endorsed the recommendations from the report and thanked Donovan and Butterworth for chairing the workshop, noting that without these intersessional workshops, it would be impossible to be in a position to recommend an *SLA* to the Commission for all Greenlandic hunts by 2018.

2.1.2 Intersessional progress and new information

Simulating proportions of the stock of fin whales present required reconditioning the trials and Brandão reported that this had been completed. A review of the conditioning results identified two trials (GF24-2 and GF24-4) where the abundance data were not adequately fitted by the model. This was because these trials assumed a prior for the proportion of the population off West Greenland that had a mean which was twice the value inferred by comparing the estimates of abundance for 2005 and 2007 with those for 1987 and 2015. After discussion, the SWG adopted the conditioned trials, except for trials GF24-2 and GF24-4 which were considered low plausibility and trials GF08-1, GF08-2 and GF08-4, which required reconditioning based on the variation on calf abundance on data for humpback whales off West Greenland (rather than the B-C-B bowheads). Table 1 shows the trial structure as agreed at this meeting and Appendix 2 shows the final trial specifications.

SC/67a/AWMP06 described a candidate *SLA* for the West Greenland fin whales. This *SLA* is a variant of that proposed earlier for humpback, bowhead and fin whales off West Greenland. It is a relatively simple procedure that multiplies a growth rate by a lower percentile of an abundance measure, with a trend modifier included, and a new abundance filter that excludes very low abundance estimates from the statistical analysis. There are two tunings of the *SLA*, where the percentile parameter of the *SLA* is adjusted to ensure the 5th percentile of the D10 statistic ('relative recovery'; the ratio of the final to initial depletion) is unity for the base case trial with a $MSYR_{1+}$=1%, given the medium (B) and high (C) need envelopes. These tunings can provide much better need satisfaction than that obtained by the interim procedure, while providing satisfactory conservation performance, with the lower 5th percentile of the D10 statistic being very close to or above unity for the evaluation trials with $MSYR_{1+}$ of 1% or 2.5%.

Table 1a

The *Evaluation Trials* for fin whales. Values given in bold type show differences from the base case values. For all trials the probability *p* that all animals are off West Greenland when a survey takes place = 0.5; if some whales are not off West Greenland, the proportion off West Greenland is generated from a beta distribution with parameters (3,7).

Trial	Description	*MSYR*$_{1+}$	Need scenarios	Survey freq.	Historical survey bias	No. of replicates	Future survey CV
01-4	MSYR$_{1+}$ = 4%	4%	A, B, C	10	1	400	0.40
01-2	MSYR$_{1+}$ = 2.5%	2.5%	A, B, C	10	1	400	0.40
01-1	MSYR$_{1+}$ = 1%	1%	A, B, C	10	1	400	0.40
01-7	MSYR$_{1+}$ = 7%	7%	A, B, C	10	1	400	0.40
02-4	5 year surveys	4%	A, B	5	1	400	0.40
02-2	5 year surveys; MSYR$_{1+}$ =2.5%	2.5%	A, B, C	5	1	400	0.40
03-4	15 year surveys	4%	A, B	15	1	400	0.40
03-2	15 year surveys; MSYR$_{1+}$ =2.5%	2.5%	A, B, C	15	1	400	0.40
03-1	15 year surveys; MSYR$_{1+}$ =1%	1%	A, B, C	15	1	400	0.40
04-4	Survey bias = 0.8	4%	A, B	10	0.8	400	0.40
04-2	Survey bias = 0.8; MSYR$_{1+}$ =2.5%	2.5%	A, B	10	0.8	400	0.40
05-4	Survey bias = 1.2	4%	A, B	10	1.2	400	0.40
05-2	Survey bias = 1.2; MSYR$_{1+}$ =2.5%	2.5%	A, B	10	1.2	400	0.40
06-4	3 episodic events	4%	A, B	10	1	400	0.40
06-2	3 episodic events; MSYR$_{1+}$ =2.5%	2.5%	A, B, C	10	1	400	0.40
06-1	3 episodic events; MSYR$_{1+}$ =1%	1%	A, B, C	10	1	400	0.40
07-4	Stochastic events every 5 years	4%	A, B	10	1	100	0.40
07-2	Stochastic events every 5 years	2.5%	A, B	10	1	100	0.40
08-4	Asymmetric environmental stochasticity	4%	A, B	10	1	100	0.40
08-2	Asymmetric environmental stochasticity	2.5%	A, B, C	10	1	100	0.40
08-1	Asymmetric environmental stochasticity	1%	A, B, C	10	1	100	0.40
09-2	MSYR$_{1+}$ = 2.5% with future survey CV 0.35	2.5%	A, B, C	10	1	400	0.35
10-2	MSYR$_{1+}$ = 2.5% with future survey CV 0.45	2.5%	A, B, C	10	1	400	0.45

Table 1b

The *Robustness Trials* for fin whales.

Trial no.	Factor	*MSYR*$_{1+}$	Need scenario	No. of rep.	Future survey CV
21-4	Linear decrease in *K* in future	4%	A, B	100	0.40
21-2	Linear decrease in *K* in future	2.5%	A, B	100	0.40
22-4	Linear increase in *M* in future	4%	A, B	100	0.40
22-2	Linear increase in *M* in future	2.5%	A, B	100	0.40
23-4	Strategic surveys	4%	A, B	100	0.40
23-2	Strategic surveys	2.5%	A, B	100	0.40
~~24-4~~	~~*p*=0.5; Propn generated from beta (7,3)~~	~~4%~~	~~A, B~~	~~100~~	~~0.40~~
~~24-2~~	~~*p*=0.5; Propn generated from beta (7,3)~~	~~2.5%~~	~~A, B~~	~~100~~	~~0.40~~
25-4	*p*=0.5; Propn generated from beta (2,10)	4%	A, B	100	0.40
25-2	*p*=0.5; Propn generated from beta (2,10)	2.5%	A, B	100	0.40
26-4	*p*=0.189 (Propn generated from beta (3,7)	4%	A, B	100	0.40
26-2	*p* =0.189 (Propn generated from beta (3,7))	2.5%	A, B	100	0.40
27-4	*p* =0.811 (Propn generated from beta (3,7))	4%	A, B	100	0.40
27-2	*p* =0.811 (Propn generated from beta (3,7))	2.5%	A, B	100	0.40
28-2	Baseline with future survey CV 0.2	2.5%	A, B	100	0.20
29-2	*p*=0.5; Propn generated from beta (2,10)	2.5%	A, B	100	0.20

SC/67a/AWMP12 presented results for the West Greenland fin whale *Evaluation Trials* for two potential *SLA*s. For comparison purposes, results for a modified version of the *Interim SLA* (including a filter), which is based on the most recent estimate of abundance are also given. The proposed *SLA*s are based on a weighted-average *Interim SLA* that uses all abundance estimates, but earlier abundance estimates are down-weighted compared to more recent ones. These *SLA*s also apply an adjustment to the multiplier of the abundance estimate in the *Interim SLA*, which depends on the trend of the abundance indices. This approach allows for an additional reduction of the strike limit if the time series of abundances shows a reasonably precise downward trend.

A filter to remove 'very low' abundance indices was applied by both proposed *SLA*s to account for the possibility that only a proportion of the population of West Greenland fin whales might be present during surveys in some years. The candidate *SLA*s range from fully meeting the conservation performance criterion for all *Evaluation Trials* with MSYR$_{1+}$ of 1% and medium and high need envelopes, to an alternative that sacrifices performance on this count to improved need satisfaction. Need is satisfied over the first 20 years, but not over 100 years for the two *SLA*s in these trials.

The *SLA*s in SC/67a/AWMP06 and SC/67a/AWMP12 both cope with sporadic low abundance estimates by ignoring them, at least for a certain period. Such a feature has not been explicitly included in any previous *SLA*, and the concept clearly must be carefully tested. The SWG noted that there was a balance to be struck between designing new trials to test the conservation risk associated with an *SLA* eliminating low abundance estimates, and allowing *SLA*s to treat the data in any manner, in which case the acceptability of the approach would be determined mostly by *SLA* performance in realistic trials regardless of design features. The SWG considerations were as follows.

(1) *Evaluation of how* SLA*s of this type could ignore low abundance estimates without substantially increasing conservation risk.* There are currently only a few trials relevant to this question - specifically those including episodic events. It would also be useful to see how the *SLA* would react to a sequence of several low estimates of abundance.

(2) *Recognition that it would be wrong to design trials purely to cause the* SLA *to fail, if such trials were insufficiently realistic.* To varying degrees, some members believed that an *SLA* could be evaluated as a black box: judged by its performance rather than its internal calculations.

Although some *Evaluation Trial*s should specifically test the effect of disregarding outlying abundance estimates, the SWG **agreed** that the *Robustness Trials* were well suited for more speculative exploration of performance of such *SLA*s. This issue will be considered further at the proposed first intersessional Workshop (see Item 6).

2.1.3 Conclusions and recommendations

It would easier to develop additional trials after several more abundance estimates have been obtained. Further, with such additional data, candidate *SLA*s might be designed to treat unusually low estimates in a more sophisticated manner than considered thus far. For these reasons, the SWG considered whether it would be advisable to develop a shorter-term *SLA* e.g. one that was intended to be used for the next 20 years. However, it agreed that doing this would effectively remove the feedback mechanism that is crucial for ensuring stock conservation. Rather, it **agreed** that the mechanism of *Implementation Reviews* will allow this issue to be regularly reviewed and action taken if necessary.

In summary, the SWG noted that there was still considerable additional work required before final selection of an *SLA* for West Greenland fin whales. Tasks included: (a) development of new trials exploring the implications of *SLA*s that disregard low abundance estimates; (b) updating conditioning; and (c) developing a format for tabular and graphical display of the behaviour of such *SLA*s that integrates aspects of the D1 and D10 statistics, with the goal of better understanding when and how often the *SLA*s disregard abundance estimates, and the performance implications thereof.

The SWG agreed that this work could not be completed at this meeting. It **recommended** that the work should be completed intersessionally prior to planned SWG workshop in late October (see Item 6) under the auspices of the AWMP Steering Group, with the intent that the final review of results and selection of an *SLA* would be completed at that time.

2.2 Common minke whales

2.2.1 Review results of intersessional workshop

The intersessional workshop reviewed the results of the RMP intersessional workshop (SC/67a/Rep05), given the previous agreement to use the operating model framework of the North Atlantic common minke whale RMP *Implementation Review* as the starting point for the AWMP development process. The workshop also received the new 2015 abundance estimate for West Greenland common minke whales, and noted that one explanation for the large difference in the abundance estimates was movement of whales from the west (WG) to the east coast (CG) of Greenland (Hansen *et al.*, 2016). Allison and Punt were requested to evaluate whether the *Implementation Simulation Trials* for the North Atlantic common minke whales (Annex D, Appendix 6) exhibited behaviour consistent with negative spatial correlation in abundance between West and East Greenland that might be associated with whale movement between regions.

2.2.2 Intersessional progress and new information

Punt and Allison reported that the RMP *Implementation Simulation Trials* structure successfully introduced negative correlation in the simulated abundances between East and West Greenland.

Tiedemann reviewed stock structure inferences agreed upon during the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales (IWC, 2015b) with special reference to Greenland (sub-areas WG and CG – see Fig. 1). In summary, according to stock structure hypotheses I and II (see Fig. 2), animals occurring in the WG sub-area belong to the W stock (or the W-2 sub-stock) and those in the CG sub-area to the C stock. According to hypotheses III and IV, the same stock(s) are present in these subareas, either as a single stock (hypothesis III) or a mixture of two cryptic breeding stocks (hypothesis IV). Tiedemann reported on additional genotyping of further specimens from Greenland and Iceland as well as inclusion of Canadian samples (sub-area WC). The dataset comprises currently 1,605 samples typed at 16 microsatellites and mitochondrial DNA, including 17 from CG, 314 from WG and 36 from WC. Kinship analysis revealed 10 putative parent-offspring pairs (POPs; thereof three mother/foetus pairs), relating WG individuals to sub-

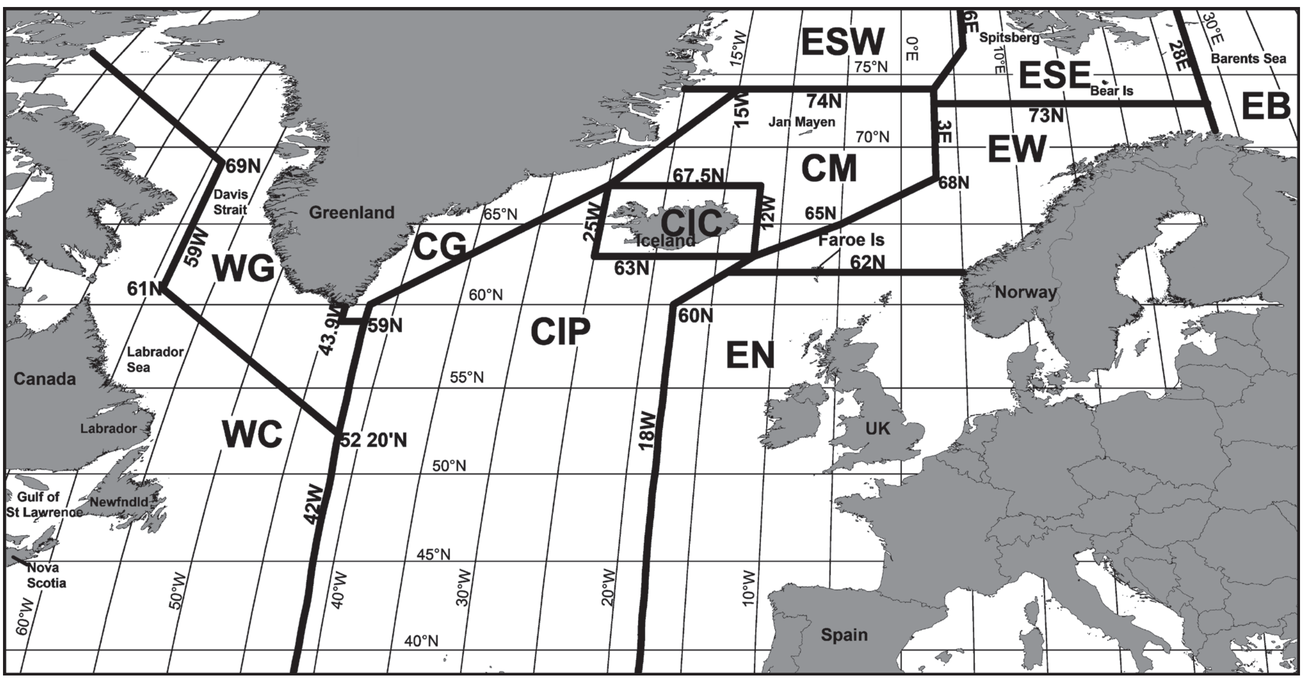


Fig.1. Sub-areas used in the *Implementation Review*.

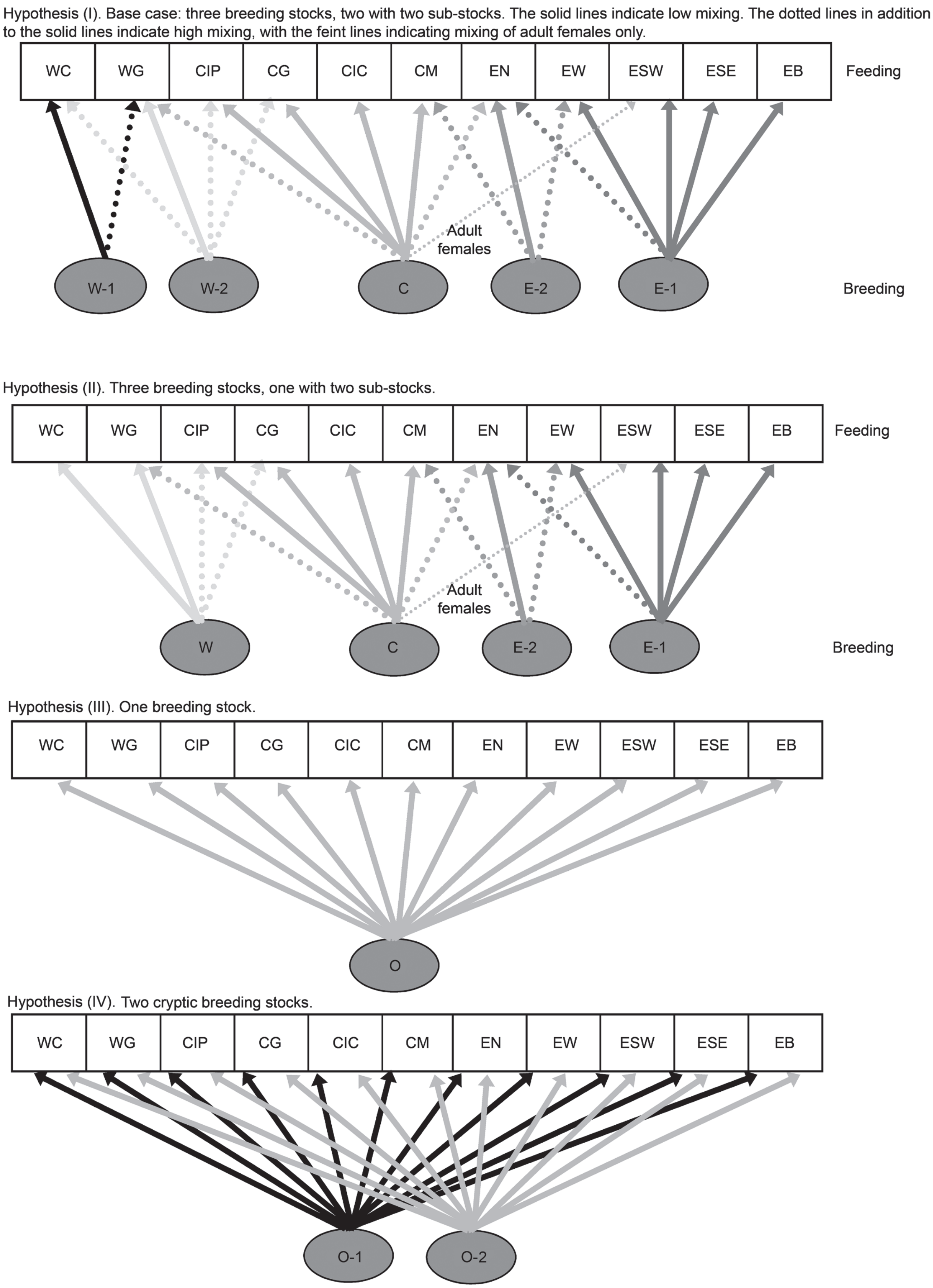


Fig. 2. Stock hypotheses considered in the *Implementation Review.* Hypotheses I and II are considered high priority whilst Hypotheses III and IV are considered medium priority.

area ESE (2 POPs) or to sub-area CIC (3 POPs). One POP each occurred within WG and CG. Tiedemann suggested these POPs be validated using the approach applied for North Pacific common minke whales (SC/67a/SDDNA01), i.e., by typing 10 additional microsatellite loci. It was further suggested to add additional previously unanalysed specimens from Iceland (2016) and Greenland (2013-16) and to try to acquire further samples from Canada. Validation of POPs and analysis of Icelandic samples can be accomplished before October 2017, pending availability of funds. Greenlandic and Canadian samples can be included in these analyses as soon as they become available. Depending on the number of additional samples, time needed for completion of the analysis may need to be extended.

The SWG **agreed** that these additional analyses will be extremely valuable in facilitating the development of an *SLA* for the Greenland hunts of common minke whales. It **agreed** that the AWMP Developers' Fund should contribute £2,000 towards this work to enable it to be completed by the proposed first intersessional workshop (see Item 6).

SC/67a/AWMP05 used an age- and sex-structured population model with density regulated growth to estimate source-sink-like migration of common minke whales in West Greenland waters. The hunt of this species in West Greenland is relatively large compared with the estimates of absolute abundance for the area, but a constant female biased sex ratio in the catches indicates that the hunt is sustainable. This suggests that available animals probably include whales from other areas. SC/67a/AWMP05 shows that it is possible to estimate this influx of whales using an open population model and a likelihood function that includes both the abundance data from West Greenland and the reported catches of females and males. The average influx is estimated to 110 (90% CI:68 to 150) individuals per year with 83% (90% CI:69% to 95%) of the individuals being females.

In discussion, it was noted that an even more realistic model would allow movement rates between regions to depend on relative local depletion levels. Witting therefore developed an extension to his approach (in SC/67a/AWMP05rev) that provided such dynamics and improved the handling of sex stratification.

Reviewing this additional work, the SWG **agreed** that the approach in SC/67a/AWMP05rev provided a good basis for designing some additional trials to those already available. The SWG **agreed** that such trials should be developed. It considered two alternative approaches for modelling the effect in SC/67a/AWMP05rev: (a) the proportion of the West Greenland sub-stock that feeds off West Greenland is density-dependent, i.e. the mixing matrices are density-dependent, and (b) there is density-dependent dispersal between the W-1 stock (in trials with two W stocks) and the W-2 sub-stock and between the C stock and the W-2 sub-stock. The SWG **agreed** that these options should be pursued, including developing trial specifications and conditioning the new trials. Appendix 3 outlines the changes the specifications of the operating model. An intersessional correspondence group (Allison, Brandão (Chair), Butterworth, Donovan, Givens, Punt, Witting, de Moor) was established to further develop technical specifications and guide implementation.

2.2.3 Finalise work plan to complete SLA in 2018

Development of an *SLA* for the Greenlandic hunt of common minke whales constitutes the largest remaining task of the SWG. Moreover, it is the most complex case that has been undertaken. Development of earlier *SLA*s have required up to five years. Despite the advantage of being able to build upon the RMP work, the SWG **agreed** that it is essential to hold two intersessional meetings before the 2018 Scientific Committee meeting if it is to be able to successfully recommend an *SLA* at the 2018 meeting.

At the first workshop, the SWG will evaluate the trial structure, provisional conditioning, and identify any required modifications. Candidate *SLA*s will be presented. Subsequently, necessary modifications to the trial structure will be coded and final conditioning undertaken. The second intersessional workshop will evaluate this work and ideally be able to examine initial performance results from candidate *SLA*s. Final evaluation of *SLA*s based on the full set of agreed trials will occur at the 2018 Scientific Committee meeting.

2.3 West Greenland bowhead whales

2.3.1 Modelling issues

At the intersessional Workshop in 2016 it was agreed that the same exercise to investigate the number of replicates to be used in the development of an *SLA* for West Greenland humpback and fin whales should be undertaken on all the *WG-Bowhead SLA Evaluation Trials*. SC/67a/AWMP04 reported on the results of this simulation exercise to determine the precision of the 5th percentile of the D10 recovery statistic as the number of replicates increases from the customary 100 replicates. Examination of the results shows that for one trial not even 1,000 replicates would be sufficient to provide sufficient precision for the estimated probability interval of the D10 statistic to include the threshold value of 1.

It was noted that the *WG-Bowhead SLA* had been tested on conservative scenarios because the catches from Canada are not subject to IWC management and it is not known whether future surveys in Canada will take place or how regularly. Since there is Monte Carlo error in the estimates of the performance statistics and recognising the diminishing returns in precision obtained as the number of replicates increase, the SWG **agreed** to set the number of replicates for *Evaluation Trials* to 400 for the bowhead whale case (the number of replicates for other development cases will be determined on a case-specific basis). Given this discussion, the SWG **agreed** that Allison and Brandão should rerun a selection of the trials with 400 replicates to verify the original trial conclusions. The results should be presented at the proposed first workshop.

3. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)

AWS provisions are one of the last major remaining components of the comprehensive aboriginal subsistence whaling management framework first requested by the Commission in 1994 and developed with an enormous expenditure of scientific effort and resources over the last two decades. The Commission has agreed that the AWS is a key component of this framework. Accordingly, in consultation with the Commission and its ASW sub-committee, the Scientific Committee informed the Commission in 2015 (IWC, 2015c) that it intends to develop recommendations for all scientific components and aspects of an AWS. Ideally, this work will be completed well in advance of the 2018 Commission meeting when new aboriginal whaling limits are due to be established. Last year (IWC, 2017b, pp.181-184), the Committee made considerable progress on this work and developed an outline ('Some ideas on draft principles and scientific provisions of a potential Aboriginal Whaling Scheme (AWS)'(IWC, 2017c)). The focus of discussions last year had related to the interim allowance strategy and carryover provisions.

3.1 Review results of intersessional Workshop

The intersessional Workshop (SC/67a/Rep06) considered two main issues: the interim allocation strategy and the carryover provisions.

3.1.1 The interim allowance strategy

The 'interim allowance' strategy deals with the situation where an abundance estimate is temporarily and unintentionally delayed more than 10 years from the previous survey (IWC, 2016). It was first tested using the *Bowhead SLA* and found to be acceptable in that case (IWC, 2017b). The Workshop thanked Punt for developing code for testing the interim allowance strategy for West Greenland bowhead, humpback and fin whales.

3.1.2 Carryover provision

A review of the originally proposed (IWC, 2003) AWS provision for the carryover of unused strikes to provide the necessary flexibility for hunters to meet need when the hunts operate in unpredictable and difficult environmental conditions began two years ago. During the initial development of *Strike Limit Algorithms* and the AWS, the Commission had agreed (IWC, 2001, p.20):

> …that blocks of five years with an inter-annual variation of fifty percent were satisfactory in terms of allowing for the likely variability in hunting conditions. It therefore agreed that these values are appropriate for use in trials. It was recognised that this does not commit the Commission to these values in any final aboriginal whaling management procedure.

At that time, the Committee also agreed that the same 50% allowance could be carried over between the last year of one block and the first year of the next. The rationale for this limitation has not changed: from a scientific perspective, *SLA*s are robust with respect to this carryover provision.

Considerable work on carryover provisions was undertaken at the 2016 Annual Meeting and this was reported to the Commission who were informed that the Committee hoped to be able to present a proposed carryover provision in 2018 as part of a revised AWS. It was noted that there is a lack of clarity and consistency in the way this issue is dealt with in the present *Schedule*.

This work continued at the intersessional workshop thanks to extensive work by Givens (Givens, 2016). The Workshop developed two possible options (the 'block-based option' and the 'annual expiration[1]' option) and provided examples of how these might work. The Workshop **agreed** that whatever approach or approaches may be ultimately proposed to the Commission, it is important that they are presented as simply as possible to facilitate Commission discussion and adoption.

3.2 Intersessional progress and new information

3.2.1 The interim allowance strategy

The SWG was pleased to receive SC/67a/AWMP01 which presented the results of testing for the West Greenland humpback whale case. The SWH **agreed** that the strategy was acceptable for this *SLA* and thanked Punt and Brandão for undertaking this work. Future testing for other cases is considered under Item 3.3.1.

3.2.2 Carryover provision

The SWG thanked the Workshop for its extensive work. It noted that there were strengths and weakness in both options and agreed that these could continue to be considered and developed intersessionally. Discussion at this meeting focussed on how best to provide advice to the Commission, taking into account the difficulties that had been experienced in previous Commission discussions of the use of carryover provisions when adopting catch/strike limit blocks.

[1]Now called 'rollover'.

The SWG **recognised** that its role was to provide scientific advice on any carryover provisions that meet the conservation objectives of the Commission whilst providing adequate flexibility to the hunts. It **reiterates** its previous agreement that that *SLA*s are robust with respect to a 50% inter-annual variability within blocks and also to the same 50% allowance between the last year of one block and the first year of the next.

3.3 Finalise work plan to complete AWS in 2018

3.3.1 The interim allowance strategy

The SWG **agreed** that testing for West Greenland bowhead whales should occur intersessionally. Similarly, testing for fin and common whales will be able to be undertaken once those *SLA*s have been developed. The SWG **agreed** that testing the interim allowance strategy for the *SLA* for eastern north Pacific gray whales should occur during the next *Implementation Review* for this stock.

3.3.2 Carryover provision

To take work on carryover provisions further, the SWG **recommended** that:

(a) Donovan should raise the issue of carryover with the Commission's ASW-WG which will meet in the intersessional period, summarising the work the Committee has done so far and noting its willingness to review any options referred to it at the 2018 Scientific Committee meeting; and
(b) members of the SWG who are from countries with subsistence hunts should also draw attention to the willingness of the Committee to review any options referred to it at the 2018 Scientific Committee meeting.

The SWG also **agreed** that whatever approach was adopted, it was important to establish an initialisation year for the carryover calculations to begin. It **agreed** that this was a matter for the Commission but noted that from a scientific perspective, it was acceptable to go back up to 3-4 blocks (unless there had been a quota reduction during the period). To assist the Commission, Appendix 4 summarises the situation regarding carryover for each hunt for up to four blocks.

3.3.3 The full AWS

The SWG did not have time to further review the other issues on the draft AWS developed last year. It **agreed** that this item will be included on the agenda of the intersessional Workshops. To facilitate completion of this task by the 2018 annual meeting, the SWG established an intersessional correspondence group (Givens [Convenor], Allison, Donovan, George, Suydam, Scordino) to review the existing draft and provide a discussion document for the first intersessional workshop.

4. *IMPLEMENTATION REVIEWS*

4.1 Prepare for the next Bering-Chukchi-Beaufort Seas bowhead whale *Implementation Review*

The Workshop noted that the next *Implementation Review* for B-C-B bowhead whales is scheduled to start in 2018. Guidelines for *Implementation Reviews* are provided in IWC (2013). The primary objectives of an *Implementation Review* are to:

(1) review the available information (including biological data, abundance estimates and data relevant to stock structure issues) to ascertain whether the present situation is as expected (i.e. within the space tested during the development of the *SLA* and determine whether new simulation trials are required to ensure that the *SLA* still meets the Commission's objectives; and

Table 2
AWMP *Implementation* and *Implementations Reviews.*

Hunt	Year *SLA* developed (IRs completed)	Next *Implementation Review*
B-C-B bowhead	2002 (2007, 2012)	Start 2018
Chukotka gray/Makah gray	2004 (2010)/2013	Start 2019
West Greenland humpback	2014	Start 2020
West Greenland bowhead	2015	Start 2021
West Greenland fin	2017/18 est.	2023 estimated
West Greenland/East Greenland common minke	2018	2024 estimated

(2) to review information required for the *SLA*, i.e. catch data and, when available at the time of the *Review*, new abundance estimates (note that this can also occur outside an *Implementation Review* at an Annual Meeting).

The SWG agreed that at present, there is no information that suggests that the situation for this stock is outside the tested parameter space. Given that, it **agreed** that it should be possible to complete the *Implementation Review* at the 2018 Annual Meeting. It established a Steering Group (Suydam [Convenor], Donovan, George) to prepare for the *Review* and to ensure: (a) that the appropriate Data Availability Guidelines are publicised and met; and (b) that the necessary information to complete the *Review* is presented.

4.2 Review timetable for *Implementation Reviews* for next six years

The Workshop agreed to the provisional timetable for *Implementation Reviews* given in Table 2.

5. STOCKS SUBJECT TO ASW (NEW INFORMATION AND MANAGEMENT ADVICE)

The SWG noted that the Commission had reached agreement on strike limits for Greenland at the 2014 Annual Meeting (IWC, 2015a). The SWG reviewed the management advice related to those limits.

5.1 Eastern Canada/West Greenland bowhead whales

5.1.1 New information (including catch data)

SC/67a/AWMP13 reported detailed information from Canada on their bowhead hunt: one 8.23m female was taken in Igloolik on 20 August 2016 and one 11.74m female was taken in Pangnirtung, 9 September 2016. Samples of liver, skin, blubber, and muscle were collected from both of the landed whales. There were no struck and lost animals in the hunt in 2016. The Canadian quota for the eastern Canada - West Greenland bowhead whale population is 7 for 2017. No bowhead whales were taken off Greenland in 2016.

The SWG **thanked** the Government of Canada for supplying their catch information. The SWG noted that the reported catch was within the parameter space that was tested for the *WG-Bowhead SLA*.

Last year, the SWG received two draft abundance estimates for eastern Canada: a line transect abundance estimate for 2013 (Doniol-Valcroze *et al.*, 2015) and a genetic mark-recapture of abundance for the period of 2008 to 2012 (Frasier *et al.*, 2015). The SWG **agreed** that the authors of those papers should be invited to the next Annual Meeting with a view to reviewing and endorsing the new abundance estimates.

The SWG recalled that it had agreed that the mark-recapture estimate of 1,274 (CV=0.12) in 2012 provided the best estimate of abundance for the number of whales visiting West Greenland (IWC, 2015b).

The SWG noted that in recent years, Greenland has undertaken a large-scale biopsy sampling programme that has produced valuable information on abundance and stock structure. It **recommended** continuation of this programme and **encouraged** continued collaboration with Canada on genetic and other work related to stock structure and abundance.

The SWG noted that the *WG-Bowhead SLA* had been developed on the conservative assumption that the number of animals estimated off West Greenland represented the total abundance of animals in West Greenland-Eastern Canada.

5.1.2 Management advice

Based on the agreed 2012 estimate of abundance for West Greenland (1,274, CV=0.12), the catch of two whales in Canada in 2016, and using the agreed *WG-Bowhead SLA*, the SWG **repeated its advice** that an annual strike limit of two whales will not harm the stock.

5.2 North Pacific gray whales

5.2.1 New information (including catch data)

New abundance estimates for the Pacific Coast Feeding Group (PCFG) (SC/A17/GW05), the eastern North Pacific (ENP) (SC/A17/GW06), the Sakhalin Island feeding group, and the larger Sakhalin Island and Southern Kamchatka feeding group (SC/67a/NH11) were available. These have been reviewed and accepted (see Annex Q).

SC/67a/AWMP11 reported that from 2012 to 2016, during the May to December hunting season, 640 gray whales were landed by hunters from 20 Chukotka villages, 165 of which were investigated by Russian scientists. During harvest monitoring and coastal and vessel surveys, no whales were observed in poor body condition. Sex ratio, stomach fullness, and body index of landed whales were consistent during the time period. Twelve ‘stinky’ whales with a strong medical smell and taste were landed between 2012 and 2016; the authors stated that these whales had been excluded from the quota because they were inedible. From 2013 to 2016 a total of 71 gray whales were photo-identified during surveys in the Mechigmensky Bay and were of sufficient quality to put in the Chukotka regional catalogue. The Chukotka catalogue is available online at: *https://yadi.sk/i/9qx1eUiNs6t6s* and will be updated this autumn with whales from 2016. A comparison of the gray whale catalogue from Chukotka to the catalogues for Kamchatka and Sakhalin waters showed no positive matches. Research on gray whale body condition and qualitative assessment of seasonal abundance in hunt area suggests that hunting has not negatively impacted gray whale use of Chukotka waters.

The SWG thanked the authors for the update on the harvest of gray whales in Russia. The SWG further noted the photo-identification results and **encouraged** the authors to continue to collect photographs of live and harvested whales, and genetic samples and biological observations of harvested whales.

SC/67a/AWMP03 reported the results of aboriginal subsistence whaling in Chukotka during 2016. Whale hunting was conducted at 15 local communities. A total of 120 gray whales were struck in 2016 during the hunting season. No whales were struck and lost; one landed whale was 'stinky' (inedible). Harpoons, darting guns and rifles were used during hunt. Mean numbers of harpoons and darting guns used for each whale were same as in 2015 season while total and mean numbers of cartridges were slightly higher. Time to death had a median value of 20 minutes. The furthest whale towing distance to coast was 30km, while the closest was 0.3km. Ice coverage of Chukchi Sea and adjacent waters in summer 2016 was average in multiannual trend and ice density was not high. The mean body length of gray whales taken in Chukotka waters in 2016 was 9.7m. In 60 cases tissue sampling was performed. All whaling products were registered in appropriate logbooks and used for local subsistence purposes. A total biomass of about 1,188 tons were acquired (excluding any bowhead whale harvest) from which about 581 tons of edible products were available for consumption. Total demand for whale products is estimated to be at least 1400 tons in Chukotka. An alternative estimate of harvested gray whale weights was performed using the date of hunt as a correction factor to account for whale growth during the feeding season and was found to be within 1.5% of the current approach for estimating weights. Influence of age and sex factors on gaining weight during the feeding season should be explored further in future. The mean number of annual strikes in 2013-16 was 124 (including so-called 'stinky' and struck-and-lost whales); the authors noted that this may cause the six-year catch quota by Chukotka native hunters to be exceeded if the hunt remains at the current level.

The SWG thanked the authors for exploring alternative techniques for estimating the weight of landed gray whales, as was requested last year, and for presenting harvest data.

At the 2016 Commission meeting, the Russian Federation expressed concern that the present catch limits were insufficient to meet subsistence needs due to the landing of inedible, stinky whales counting against the catch limit for gray whales. In response to the concern, the Commission instructed the Scientific Committee to examine two scenarios that bracket the likely range of stinky whales landed and struck and lost whales in future hunts (IWC/66/21). The examination was to be undertaken using the existing *Gray Whale SLA* assuming that:

(a) from 2019, the number of killed animals in each year is increased by ten whales (to include both inedible and struck-and-lost whales); and
(b) from 2019, the number of killed animals in each year is increased by 6% of the landed (this includes both inedible and struck-and-lost).

The SWG noted that *SLA*s: (a) deal only with the number of strikes taken regardless of whether the animals are landed, lost and/or stinky; and (b) count every strike as a dead animal. The SWG reviewed the request and determined that it is possible to run the *SLA* for both scenarios. The SWG interpreted scenario (a) to read that if the catch limit would average 134 whales per year during the block instead of the current average of 124 whales per year. Scenario (b) would be modelled by taking the ratio of landed whales to the number of struck and lost whales and inedible, stinky whales in recent years to determine a multiplier to increase the catch limit for running the *SLA*.

Allison reported that, depending on scenario, the above changes would lead to a block quota starting in 2019 of between 789 to 815 strikes (or an average of 132-136 strikes per year). These strike limits are allowed by the *SLA*. Details of the scenarios, catches and abundance estimates used are given in Appendix 5.

5.2.2 Management advice

As in previous years, the sub-committee **agreed** that the *Gray Whale SLA* remains the appropriate tool to provide management advice for eastern North Pacific gray whales. It was also **agreed** that the proposed Makah Tribe's whaling management plan remains the appropriate tool to provide management advice for hunts in Washington State, USA, provided that a research programme monitors the relative probability of harvesting a PCFG whale in the Makah Usual and Accustomed Fishing Grounds (IWC, 2014). The SWG **agreed** that the present block quota was in agreement with the *SLA* and would not harm the stock.

Weller reported that the US Government is currently reviewing a revised whaling management plan for the Makah hunt in Washington State and proposes to present this analysis to the Scientific Committee in 2018 with the goal of receiving management advice in advance of the 2018 Commission meeting. This analysis will require a substantial amount of work that will be conducted by the USA and will be presented intersessionally to the fifth Range-Wide Workshop on Gray Whale Stock Structure and Status and potentially also at the intersessional meeting of the AWMP. The SWG **strongly encouraged** the USA to provide the Committee with any revised plans as early as possible in order to allow consideration of the revised hunt management plan to occur intersessionally, such that, should they be deemed necessary, there is time for additional trials to be developed and the results of runs obtained before the Annual Meeting in 2018. An *Implementation Review* for gray whales is currently planned for 2019.

5.3 Bering-Chukchi-Beaufort (B-C-B) Seas bowhead whale

5.3.1 New information (including catch data)

Harvest data from the aboriginal hunt for bowhead whales in Alaska were presented in SC/67a/AWMP02rev1. In 2016, 59 bowhead whales were struck resulting in 47 animals landed. Total landed for the hunt in 2016 was higher than the average over the past 10 years (2006-15: mean of landed=40.1; *SD*=7.2). Efficiency (no. landed/no. struck) in 2016 was 80%, which was also higher than the average for the past 10 years (mean of efficiency=75%; *SD*=7%). Of the landed whales, 28 were females, 18 were males, and sex was not determined for one whale. Based on total length or pregnancy, nine of the 28 females were presumed mature (>13.4m in length). Eight of those animals were examined and five were pregnant, three with term foetuses and two with small foetuses, suggesting a high pregnancy rate in 2016.

SC/67a/AWMP03 reported that Chukotkan natives in the Russia Federation took two bowhead whales in 2016 (average length 15.5m).

The SWG thanked the authors for the updates on the aboriginal hunts of bowhead whales in Alaska and Chukotka.

SC/67a/AWMP10 summarised the health status of B-C-B bowhead whales. George emphasised it represented the work of many researchers over 35 years; he was essentially the editor. At the 2016 IWC Scientific Committee meeting, it was agreed that an annual or biennial report on the B-C-B bowhead whale stock summarising various health-related statistics would be helpful for management, tracking the status of the B-C-B population and providing input for the

2018 *Implementation Review*. SC/67a/AWMP10 is the first of the expected series. The report summarised basic information on: calf production (aerial surveys); body condition; presence of domoic acid/saxitoxins associated with harmful algal blooms (HABS); cyamid prevalence; hunter observations; proportion of whales injured from line entanglement; killer whale attacks and/or ship strikes; gross pathological findings from post-mortem examinations of landed whales; number of dead floating and beach-cast bowhead whales; radionuclide levels in landed whales; proportion of landed whales showing evidence of feeding; and population size and trend. The health metrics that are most relevant to the *Implementation Review* (population size and trend, calf production and crude pregnancy rates) show stable or positive trends. No serious health issues were identified but the authors suggested that some indicators should be carefully monitored. These included: the number of bowhead carcasses recorded during aerial marine mammal surveys; killer whale predation on calves; entanglement of fishing gear; and general pathological findings. The authors referred to the excellent collaboration between the NOAA Marine Mammal Laboratory (Seattle, WA), the North Slope Borough science programs, and many other researchers. The authors thanked the whale hunters of the Alaskan coast communities, as none of these studies would have been possible without their cooperation.

The SWG thanked the authors for providing a comprehensive summary of a robust set of data, as requested last year. These long-term data provide a foundation for tracking ecosystem changes in the Pacific Arctic sector. One example of this comes from the diet data, which shows that bowhead whales have been eating krill (euphausiids) since the 1980s. If not for the bowhead diet data, oceanographers would have incorrectly concluded that the occurrence of krill was a recent climate driven change to the ecosystem. It was suggested that future presentations of this paper could be improved by adding time series plots for more of the bowhead health variables presented.

The SWG **encourages** other aboriginal subsistence whaling groups, and other bowhead researchers, to collect similar data to those reported in SC/67a/AWMP10 using the same methodology, which in many cases does not require specialist equipment. This would allow consideration of differences in parameters such as prevalence of killer whale scarring in different ecosystems or the identification of health parameters that differ between healthy, growing populations and those with conservation concerns.

The SWG discussed whether the B-C-B bowhead whale population could be approaching carrying capacity (*K*) noting that Brandon and Wade (2006) estimated *K* at 13,850 (90% credibility interval 9,470, 28,480). There are currently no signs that the population is approaching *K* in terms of individual bowhead whale health and population trajectory. Furthermore, it was noted that it was possible that bowhead whales could expand their range to reoccupy the Bering Sea during the summer. Continued collection of data such as that discussed in SC/67a/AWMP10 may provide early indicators on when the bowhead population is approaching *K*.

SC/67a/AWMP09 presented new photo-identification data that were collected from a 2011 aerial survey of Bering-Chukchi-Beaufort Seas bowhead whales. These images were scored for photo quality and whale identifiability, then matched to existing images from 1985, 1986, 2003, 2004, and 2005. Other inter-year comparisons between this set of years were also conducted to generate a complete matching matrix for the 6 years. These data were used to estimate bowhead survival rate and population abundance using Huggins models embedded in a Robust Design capture-recapture analysis. Bayesian Information Criteria (BIC) was used to selected covariates, and rank, compare, and average models. The estimated survival rate was 0.996 with approximate lower confidence bound 0.976, which is consistent with previous estimates and with research showing that bowheads exhibit great longevity (up to 200 years).

The SWG thanked the authors for this new estimate of survival noting that is within the range of previous estimates of bowhead survival. The author's choice to make survival time invariant was useful for population modelling. The high estimated adult survival rates are consistent with the known longevity of bowhead whales. The point estimate, and the lower 5th percentile of the estimate, project that some whales could live to at least 200 years of age.

SC/67a/AWMP07 provided an update about plans for the next population survey for B-C-B bowhead whales. In 2016, the authors informed the Scientific Committee that a survey was planned for spring 2017. That survey did not occur for a variety of reasons. There are several factors that will affect when the next survey will occur, including funding, and environmental conditions. The last successful survey was in 2011; thus, the authors intend to produce a new estimate by 2021. They will keep the Committee informed about when the next survey will occur.

Whilst recognising the difficulties, the SWG noted the importance of acquiring a new abundance estimate for B-C-B bowhead whales within the next few years. It noted that estimates from approaches other than the ice-based census (e.g. using photo-identification data) would be acceptable provided that the CVs fell within the range considered when developing the *Bowhead SLA*. It noted that *Bowhead SLA Evaluation Trials* used estimated survey CVs up to 0.25, and *Robustness Trials* up to 0.34. The 2011 photo-identification abundance estimate (SC/67a/AWMP09, not yet accepted by the Scientific Committee) reported an abundance estimate CV of 0.21. Thus, the next B-C-B bowhead abundance estimate CV may exceed 0.25 since ice and lead conditions may deteriorate further. If a CV greater than 0.25 is obtained, the SWG may decide that an *Implementation Review* is necessary in order to consider trials with larger survey CVs. This possibility should not discourage the acquisition of a new estimate, even if is likely to produce a larger CV; nor would such a CV preclude the Committee from adopting the associated abundance estimate as the best available for the current time, regardless of its status for the purposes of providing management advice.

The SWG hoped that an ice-based estimate can be completed, noting that the methodology has produced some of the best series of estimates available for cetaceans. The SWG **recommended** that funding is made available to complete such a survey. It was noted that it is unlikely that a survey will be completed in 2018 due to the need to prepare for the *Implementation Review*.

5.3.2. Management advice

The SWG **agreed** with their past advice that the *Bowhead Whale SLA* continues to be the most appropriate way for the Committee to provide management advice for this population of bowhead whales. The Commission adopted catch limits for a six-year block in 2012, i.e. 2013-18. The total number of whales landed shall not exceed 336 and the number of annual strikes shall not exceed 67; however, there is a carryover provision that allows any unused portion of a strike quota from any year (including 15 unused strikes from the previous block quota) to be carried forward and added to the strike quotas of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year. The SWG agreed that these limits will not harm the stock.

5.4 Common minke whales off East Greenland

5.4.1 New information (including catch data)

In the 2016 season, 15 common minke whales were landed in East Greenland, and none were struck and lost. Three of the landed whales were males, 12 were females, and genetic samples were obtained from 12 of the landed whales. The SWG **encouraged** the continued collection of samples and collaborative studies (see Item 5.1.1).

5.4.2 Management advice

Catches of common minke whales off East Greenland are believed to come from the large Central stock. The most recent strike limit of 12 represents a very small proportion of the Central stock (IWC, 2016, p.189). The SWG **repeated its advice** of last year that the strike limit of 12 will not harm the stock.

5.5 Common minke whales off West Greenland

5.5.1 New information (including catch data)

In the 2016 season, 146 common minke whales were landed in West Greenland and two were struck and lost. Of the landed whales, there were 110 females, 35 males and one of unknown sex. Genetic samples were obtained from 114 of these common minke whales in 2016 and the SWG was pleased to note that samples from the West Greenland hunt are included in ongoing genetic analyses of common minke whales in the North Atlantic. The SWG **encouraged** the continued collection of samples and the collaborative approach of the genetic analysis.

The SWG noted that one common minke whale died because of entanglement in West Greenland in 2016.

5.5.2 Management advice

In 2009, the Committee was able to provide management advice for this stock for the first time. This year, noting that an *SLA* for this stock is expected at the Scientific Committee meeting next year, the SWG **advised** as last year, an annual strike limit of 164 will not harm the stock.

5.6 Fin whales off West Greenland

5.6.1 New information (including catch data)

A total of eight fin whales (four females and four males) was landed, and one was struck and lost, off West Greenland during 2016. The SWG was pleased to note that genetic samples were obtained from seven of these, and that the genetic samples of fin whales off West Greenland are analysed together with the genetic samples from the hunt in Iceland. It **encouraged** the continued collection of samples and collaborative work on analyses.

The SWG noted that one fin whale died because of entanglement in West Greenland in 2016.

5.6.2 Management advice

Noting that an *SLA* for this stock is expected at the Scientific Committee meeting next year, the SWG advised as last year that an annual strike limit of 19 whales will not harm the stock.

5.7 Humpback whales off West Greenland

5.7.1 New information (including catch data)

A total of five (one male and four females) humpback whales were landed and none were struck and lost in West Greenland during 2016. The SWG was pleased to learn that genetic samples were obtained from all the landed whales and that Greenland was contributing fluke photographs to the North Atlantic catalogue, both from captured whales and other field studies. The SWG again **emphasised** the importance of collecting genetic samples and photographs of the flukes from these whales.

The SWG noted that three humpback whales were observed entangled in fishing gear in West Greenland in 2016, which is considerably lower than the ten whales that were entangled in 2015. Of these, two were permitted to be killed, and one was disentangled by fishermen.

The SWG noted that some bycaught whales had been included in the scenarios for the development of the *Humpback SLA*. If high levels continued, then this would need to be taken into account in any *Implementation Review.* It noted the IWC efforts with respect to disentanglement and prevention and **welcomed** the news that the Greenland authorities obtained IWC disentanglement training in 2016 and that they successfully disentangled one humpback whale.

5.7.2 Management advice

Based on the *Humpback SLA* that was agreed by the Commission in 2014, the SWG **agreed** that an annual strike limit of 10 whales will not harm the stock.

5.8 Humpback whales off St Vincent and The Grenadines

5.8.1 New information (including catch data)

No whales were taken by St Vincent and The Grenadines in 2016.

The SWG **recommended** that the status and disposition of genetic samples collected from past harvested whales be determined and reported next year. The SWG also **reiterated** the recommendation that photographs for photo-identification and genetic samples are collected from all whales landed in future hunts.

5.8.2 Management advice

The SWG has agreed that the animals found off St Vincent and The Grenadines are part of the large West Indies breeding population (the last agreed abundance estimate was 11,570 (95% CI 10,290-13,390), for 1992/93). The Commission adopted a total block catch limit of 24 for the period 2013-18 for Bequians of St Vincent and The Grenadines. The SWG **repeated** its advice that this block catch limit will not harm the stock.

However, the SWG also **reiterated** its concern that there is no officially agreed abundance estimate from the more recent MONAH programme that took place in 2004 and 2005. The recent NOAA status review (Bettridge *et al.*, 2015) referred to that programme and provided an estimate of 12,312 (95% CI 8,688-15,954) for 2004/05 but referenced this as 'NMFS, unpublished data'. The SWG **reiterated its request** that NOAA provides a paper to the next meeting that will allow it to properly review this abundance estimate and, if appropriate, adopt it as an estimate suitable for providing management advice.

The SWG also **requested** that a scientific representative from the St Vincent and The Grenadines attends next year's Scientific Committee meeting, especially since next year the Commission will review aboriginal whaling quotas.

6. SUMMARY WORK PLAN (INCLUDING WORKSHOPS AND INTERSESSIONAL GROUPS)

The SWG **agreed** to the work plan provided in Table 3 including the intersessional groups provided in Annex W.

To achieve this work plan, the SWG **stressed** that it is essential that two intersessional workshops are held, one at the end of October 2017 and one in February/March 2018. It is hoped to hold these in Copenhagen. The cost of each workshop will be £8,000 with an additional £2,000 as a

Table 3

Proposed work plan.

Topic	Intersessional	2018 Annual Meeting
(1) Development of Greenland *SLA*s	SG-AWMP, two workshops (autumn, spring)	Complete and recommend
Fin whales (review results)	Finalise at first workshop	Recommend *SLA*
Common minke whales (develop)	Both workshops	Recommend *SLA*
WG-Bowhead SLA trials (review results)	Finalise at first	Confirm *SLA*
(2) Aboriginal Whaling Scheme	ICG-AWS, Short review of progress at workshops	Recommend draft
Interim allowance strategy	ICG-AWS	Complete
Carryover provisions	Donovan to consult ASW-WG	Complete
Remaining issues	ICG-AWS	Complete
(3) B-C-B bowhead *Implementation Review*	SG-B-C-B	Complete
(4) Review new Makah hunt proposal	Workshops if proposal submitted	Complete if possible
(5) Provide catch/strike limit advice	-	Recommend limits

contribution towards the genetic analyses of common minke whales being undertaken for the first workshop. There is no request for additional funds from the Scientific Committee budget to that already allocated (£10,000) since the difference can be made up from underspends in previous years.

7. ADOPTION OF REPORT

The report was adopted subject to final editing at 19:10 on 17 May 2015. The Chair thanked the participants for their thoughtful and positive contributions to discussions. He particularly thanked the rapporteurs, developers and those undertaking the computing work: Allison, Brandão, Givens, Punt, Scordino and Witting. The SWG thanked Donovan for his usual effective and good-humoured chairing of the meeting.

REFERENCES

Bettridge, S., Baker, C.S., Barlow, J., Clapham, P.J., Ford, M., Gouveia, D., Mattila, D.K., Pace, R.M., III, Rosel, P.E., Silber, G.K. and Wade, P.R. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the endangered species act. *NOAA Tech. Mem.* NOAA-TM-NMFS-SWFSC-540: 263pp.

Brandon, J. and Wade, P.R. 2006. Assessment of the Bering-Chukchi-Beaufort Sea stock of bowhead whales using Bayesian model averaging. *J. Cetacean Res. Manage.* 8(3): 225-40.

Doniol-Valcroze, T., Gosselin, J.-F., Pike, D., Lawson, J., Asselin, N., Hedges, K. and Ferguson, S. 2015. Abundance estimate of the Eastern Canada-West Greenland bowhead whale population based on the 2013 High Arctic Cetacean Survey. Department of Fisheries and Oceans, *Can. Sci. Advis. Sec. Res. Doc.* 2015/058. v + 27pp.

Frasier, T.R., Petersen, S.D., Postma, L., Johnson, L., Heide-Jørgensen, M.P. and Ferguson, S.H. 2015. Abundance estimates of the Eastern Canada-West Greenland bowhead whale (*Balaena mysticetus*) population based on genetic capture-mark-recapture analyses. Department of Fisheries and Oceans, *Can. Sci. Advis. Sec. Res. Doc*., 2015/008. iv + 21pp.

Givens, G.H. 2016. On the simple carryover of strikes. Paper SC/D16/AWMP05 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 6pp. [Paper available from the Office of this Journal].

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.S., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2016. Abundance of whales in east and west Greenland in 2015. Paper SC/D16/AWMP06rev1 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 38pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2001. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 3:1-76.

International Whaling Commission. 2003. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 5:154-255.

International Whaling Commission. 2009. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2013. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.

International Whaling Commission. 2014. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.

International Whaling Commission. 2015a. Report of the AWMP Intersessional Workshop on Developing SLAs for the Greenland hunts, 8-11 January 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:433-58.

International Whaling Commission. 2015b. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

International Whaling Commission. 2015c. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 16:1-87.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 17:185-203.

International Whaling Commission. 2017a. Report of the AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS, 14-17 December 2015, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 18:489-515.

International Whaling Commission. 2017b. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 18:174-84.

International Whaling Commission. 2017c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. Appendix 2. Some ideas on draft principles and scientific provisions of a potential Aboriginal Whaling Scheme (AWS). *J. Cetacean Res. Manage. (Suppl.)* 18:181-84.

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair and appointment of rapporteurs
   1.3 Adoption of Agenda
   1.4 Documents available
2. *SLA* development for the Greenlandic hunts
   2.1 Fin whales
      2.1.1 Review results of intersessional Workshop
      2.1.2 Intersessional progress and new information
      2.1.3 Conclusions and recommendations
   2.2 Common minke whales
      2.2.1 Review results of intersessional Workshop
      2.2.2 Intersessional progress and new information
      2.2.3 Finalise workplan to complete *SLA* in 2018
   2.3 Bowhead whales
      2.3.1 Modelling issues
3. Aboriginal Whaling Management Scheme (AWS)
   3.1 Review results of intersessional Workshop
   3.2 Intersessional progress and new information
   3.3 Finalise workplan to complete AWS in 2018
4. *Implementation Reviews*
   4.1 Prepare for the next Bering-Chukchi-Beaufort Seas bowhead whale *Implementation Review*
   4.2 Review timetable for *Implementation Reviews* for next six years
5. Stocks subject to ASW (new information and management advice)
   5.1 Eastern Canada/West Greenland bowhead whales
   5.2 North Pacific gray whales
   5.3 Bering-Chukchi-Beaufort Seas bowhead whale
   5.4 Common minke whales off East Greenland
   5.5 Common minke whales off West Greenland
   5.6 Fin whales off West Greenland
   5.7 Humpback whales off West Greenland
   5.8 Humpback whales off St Vincent and The Grenadines
6. Summary work plan
7. Other business

Appendix 2

SPECIFICATIONS FOR THE WEST GREENLAND FIN WHALE TRIALS

Please see *J. Cetacean Res. Manage. (Suppl.)* 18: 501-510 for the latest version of these specifications. This should be read in conjunction with Punt, 2018, p.559 in this volume which details updates to the model. A final version of the specification will be published in next year's *Supplement*.

Appendix 3

CHANGES TO THE SPECIFICATIONS OF THE OPERATING MODEL FOR TRIALS OF NORTH ATLANTIC MINKE WHALES

The hunt of minke whales in West Greenland is relatively large compared with the estimates of absolute abundance for the area, but a constant female biased sex ratio in catches over the last 20 years indicates that the hunt is sustainable and that the hunt is likely to be supported by whales from other areas. Two alternative models are developed below which allow movement rates between regions to depend on relative local depletion levels.

1. Source-sink dynamics A: Density-dependent mixing

The proportion of the West Greenland sub-stock that feeds off West Greenland is density-dependent, i.e. the mixing matrices are density-dependent. The proportion of the females/males in the W stock (stock hypothesis II) and the W-2 sub-stock (stock hypothesis I) is density-dependent, according to:

$$Q_t^g = (1+e^{d^g})^{D_t^{g,\mathrm{WG}}}; D_t^{g,\mathrm{WG}} = 1 - \widetilde{N}_t^{g,\mathrm{WG}} / N_{-\infty}^{g,\mathrm{WG}} \tag{1.1}$$

where Q_t^g is the density-dependence effect on mixing for gender g during year t, d^g is the density-dependence parameter for gender g, $\tilde{N}_t^{g,\mathrm{WG}}$ is the number of 1+ animals of gender g that would be in sub-area k=WG at the start of year t without density dependent mixing:

$$\tilde{N}_t^{g,k} = \sum_j \sum_{a=0}^{x} \tilde{V}_{t,a}^{g,j,k} N_{t,a}^{g,j} \tag{1.2}$$

$N_{-\infty}^{g,k}$ is the number of 1+ animals of gender g in sub-area k at unexploited equilibrium, $N_{t,a}^{g,j}$ is the number of animals of gender g and age a in stock/sub-stock j at the start of year t, and $\tilde{V}_{t,a}^{g,j,k}$ is the fraction of animals in stock/sub-stock j of gender g and age a that is in sub-area k during year t (before Q_t^g is applied – i.e. without density dependent mixing).

After setting Q_t^g, the mixing matrix is adjusted to incorporate Q_t^g, as set out in Table 1 (trials 14 and 15), and the model advanced to year t+1.

The catch sex-ratio data for the west Greenland sub-area are included in the likelihood:

$$-\ell nL = \sum_t \left(\ell n\sigma_C + \tfrac{1}{2\sigma_C^2}[\mathrm{logit}(\phi_t^{\mathrm{WG}}) - \mathrm{logit}(\hat{\phi}_t^{\mathrm{WG}})]^2 \right) \tag{1.3}$$

where ϕ_t^{WG} is the observed catch sex ratio in the West Greenland sub-area during year t for years 1994-2015, $\hat{\phi}_t^{\mathrm{WG}}$ is the model-estimate corresponding to ϕ_t^{WG} (see Equation G.7), and σ_C quantifies the extent of variability in catch sex-ratio.

The additional estimable parameters for the model are the density-dependence parameter d^g for the two sexes.

The model may require modification after inspection of the conditioning results, but the Ω parameters may be sufficient. The essential thing is that when the D ratios of Eqn 1.1 are zero (and all areas are at $N_{-\infty}^k$), the simulated sex ratio in West Greenland must be the average of the observed sex ratio.

2. Source-sink dynamics B: Density-dependent dispersal

This model is based on Hypothesis I, but the animals move between areas by dispersal to other stocks, rather than by mixing. It includes dispersal between the W-1 and W-2 sub-stocks and between the C stock and the W-2 sub-stock by modifying the basic population dynamics equation as follows:

$$N_{t+1,a}^{g,j} = \begin{cases} 0.5\, b_{t+1}^{j} & \text{if } a = 0 \\ (N_{t,a-1}^{g,j} + I_{t,a-1}^{g,j} - C_{t,a-1}^{g,j})\tilde{S}_{a-1} & \text{if } 1 \le a < x \\ (N_{t,x}^{g,j} + I_{t,x}^{g,j} - C_{t,x}^{g,j})\tilde{S}_{x} + (N_{t,x-1}^{g,j} + I_{t,x-1}^{g,j} - C_{t,x-1}^{g,j})\tilde{S}_{x-1} & \text{if } a = x \end{cases} \tag{2.1}$$

where $I_{t,a}^{g,j}$ is the net dispersal of animals of gender g and age a into stock j during year t:

$$I_{t,a}^{g,j} = \sum_{k \neq j} (d^{g,k,j})^{\tilde{D}_t^{g,k,j}} N_{t,a}^{g,j} - \sum_{k \neq j} (d^{g,j,k})^{\tilde{D}_t^{g,k,j}} N_{t,a}^{g,k} \tag{2.2}$$

where $\tilde{D}_t^{g,j,k}$ is the depletion ratio gender g and age a between stocks j and k:

$$\tilde{D}_t^{g,j,k} = \frac{N_t^{g,j} / N_{-\infty}^{g,j}}{N_t^{g,k} / N_{-\infty}^{g,k}} \tag{2.3}$$

Note that the values for $d^{g,k,j}$ and $d^{g,j,k}$ are related according to:

$$d^{g,k,j} = d^{g,j,k} N_t^{g,k} / N_t^{g,j} \tag{2.4}$$

The catch sex-ratio data for West Greenland are included in the likelihood. There are four estimable parameters for this model. Table 2 lists the (initial) updated set of trials.

Table 1

Revisions to the mixing matrices for trials NM14 and 15, to incorporate density dependent mixing and dispersal. See Annex D, Appendix 6 for the original full matrices. Only rows for the W and C stocks/sub-stocks are shown here as the E sub-stocks are unaffected by this change. The γs and Ωs indicate that the entry concerned is estimated during the conditioning process. Note that the values for the γs and Ωs are the same for the high and low mixing matrices within each trial replicate.

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Stock structure hypothesis I, trial NM14 [high mixing]											
Adult females (ages 10+)											
W-1	0.5	0.5 $\gamma_{10} Q_t^{fem}$	-	-	-	-	-	-	-	-	-
W-2	0.2	0.45 Q_t^{fem}	0.15	0.2	-	-	-	-	-	-	-
C	-	0.1 Q_t^{fem}	γ_2	γ_3	0.5 γ_4	γ_5	0.05	-	γ_6	-	-
Adult males (ages 10+) and juveniles											
W-1	0.5 Ω_{11}	0.5 $\gamma_{10} Q_t^{mal}$	-	-	-	-	-	-	-	-	-
W-2	0.2 Ω_{11}	0.45 $\Omega_{12} Q_t^{mal}$	0.15 Ω_{13}	0.2 Ω_{14}	-	-	-	-	-	-	-
C	-	0.1 $\Omega_{12} Q_t^{mal}$	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	$\gamma_4 \Omega_{15}$	$\gamma_5 \Omega_{16}$	0.05 Ω_{17}	-	-	-	-
Stock structure hypothesis I, trial NM14 [low mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	2 γ_4 Ω_{15}	$\gamma_5 \Omega_{16}$	-	-	-	-	-
Stock structure hypothesis II, trial NM15 [high mixing]											
Adult females (ages 10+)											
W	0.55	0.2 Q_t^{fem}	0.1	0.15	-	-	-	-	-	-	-
C	-	$\gamma_1 Q_t^{fem}$	γ_2	γ_3	0.5 γ_4	γ_5	0.05	-	γ_6	-	-
Adult males (ages 10+) and juveniles											
W	0.2 Ω_{11}	$\Omega_{12} Q_t^{mal}$	0.1 Ω_{13}	0.2 Ω_{14}	-	-	-	-	-	-	-
C	-	0.1 $\gamma_1 \Omega_{12} Q_t^{mal}$	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	$\gamma_4 \Omega_{15}$	$\gamma_5 \Omega_{16}$	0.05 Ω_{17}	-	-	-	-
Stock structure hypothesis II, trial NM15 [low mixing]											
Adult females (ages 10+)											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	$\gamma_1 Q_t^{fem}$	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
Adult males (ages 10+) and juveniles											
W	1	-	-	-	-	-	-	-	-	-	-
C	-	$\gamma_1 \Omega_{12} Q_t^{mal}$	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	2 $\gamma_4 \Omega_{15}$	$\gamma_5 \Omega_{16}$	-	-	-	-	-
Stock structure hypothesis I trials NM16-18 [high mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	0.5 γ_4	γ_5	0.05	-	γ_6	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	0.2 Ω_{11}	0.45 Ω_{12}	0.15 Ω_{13}	0.2Ω_{14}	-	-	-	-	-	-	-
C	-	-	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	$\gamma_4 \Omega_{15}$	$\gamma_5 \Omega_{16}$	0.05 Ω_{17}	-	-	-	-
Stock structure hypothesis I trials NM16-18 [low mixing]											
Adult females (ages 10+)											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	γ_2	γ_3	γ_4	γ_5	-	-	-	-	-
Adult males (ages 10+) and juveniles											
W-1	1	-	-	-	-	-	-	-	-	-	-
W-2	-	1	-	-	-	-	-	-	-	-	-
C	-	-	$\gamma_2 \Omega_{13}$	$\gamma_3 \Omega_{14}$	2 γ_4 Ω_{15}	$\gamma_5 \Omega_{16}$	-	-	-	-	-

Table 2

The *Implementation Simulation Trials* for North Atlantic minke whales.

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Trial weight	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	M	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	H	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	M	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	H	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	M	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	M	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	M	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	M	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM09-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 10%
NM09-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 10%
NM10-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM10-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM12-1	I	1%[1]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM12-4	I	4%[2]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM13-1	II	1%[1]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM13-4	II	4%[2]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM01-1v	I	1%[1]	3	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM01-4v	I	4%[2]	3	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM02-1v	II	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM02-4v	II	4%[2]	2	Baseline	2008-13	H	CV of future abundance = ½ basecase value
NM03-1v	III	1%[1]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM03-4v	III	4%[2]	1	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-1v	IV	1%[1]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM04-4v	IV	4%[2]	2	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM14-1	I	1%[1]	3	Baseline	2008-13	??	Density-dependent mixing
NM14-4	I	4%[2]	3	Baseline	2008-13	??	Density-dependent mixing
NM15-1	II	1%[1]	2	Baseline	2008-13	??	Density-dependent mixing
NM15-4	II	4%[2]	2	Baseline	2008-13	??	Density-dependent mixing
NM16-1	I	1%[1]	3	Baseline	2008-13	??	Density-dependent dispersal (WC:WG:C)
NM16-4	I	4%[2]	3	Baseline	2008-13	??	Density-dependent dispersal (WC:WG:C)
NM17-1	I	1%[1]	3	Baseline	2008-13	??	Density-dependent dispersal (WC:WG only)
NM17-4	I	4%[2]	3	Baseline	2008-13	??	Density-dependent dispersal (WC:WG only)
NM18-1	I	1%[1]	3	Baseline	2008-13	??	Density-dependent dispersal (WG:C only)
NM18-4	I	4%[2]	3	Baseline	2008-13	??	Density-dependent dispersal (WG:C only)

[1]1+; [2]mature.

Appendix 4

SUMMARY OF CARRYOVER VALUES FOR EACH ABORIGINAL HUNT FOR UP TO FOUR BLOCKS

Details of the provisions given in the Schedule are listed for each aboriginal hunt, followed by a list of the catches and strikes taken in the last four blocks (or from the year of the first limit listed in the Schedule).

B-C-B BOWHEAD WHALES

(1) For the years 1998, 1999, 2000, 2001 and 2002, the number of bowhead whales landed shall not exceed 280. For each of these years the number of bowhead whales struck shall not exceed 67, except that any unused portion of a strike quota from any year (including 15 unused strikes from the 1995-97 quota) shall be carried forward and added to the strike quotas of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(2) For the years 2003, 2004, 2005, 2006 and 2007, the number of bowhead whales landed shall not exceed 280. For each of these years the number of bowhead whales struck shall not exceed 67, except that any unused portion of a strike quota from any year (including 15 unused strikes from the 1998-2002 quota) shall be carried forward and added to the strike quotas of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(3) For the years 2008, 2009, 2010, 2011 and 2012, the number of bowhead whales landed shall not exceed 280. For each of these years the number of bowhead whales struck shall not exceed 67, except that any unused portion of a strike quota from any year (including 15 unused strikes from the 2003-2007 quota) shall be carried forward and added to the strike quotas of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(4) For the years 2013, 2014, 2015, 2016, 2017 and 2018, the number of bowhead whales landed shall not exceed 336. For each of these years the number of bowhead whales struck shall not exceed 67, except that any unused portion of a strike quota from any year (including 15 unused strikes from the 2008-2012 quota) shall be carried forward and added to the strike quotas of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

Table 1

B-C-B bowhead whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	55	42	2003	44	38	2008	52	40	2013	58	47
1999	48	43	2004	45	38	2009	38	31	2014	53	38
2000	48	36	2005	70	57	2010	73	47	2015	49	39
2001	76	50	2006	42	34	2011	51	38	2016	61	49
2002	53	42	2007	63	41	2012	69	55			
Total	**280**	**213**		**264**	**208**		**283**	**211**		**221**	**173**
Block limit	**335**	**280**		**335**	**280**		**335**	**280**		**402**	**336**

EASTERN NORTH PACIFIC GRAY WHALES

(1) For the years 1998, 1999, 2000, 2001 and 2002, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 620, provided that the number of gray whales taken in any one of the years 1998, 1999, 2000, 2001 or 2002 shall not exceed 140.

(2) For the years 2003, 2004, 2005, 2006 and 2007, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 620, provided that the number of gray whales taken in any one of the years 2003, 2004, 2005, 2006 and 2007 shall not exceed 140.

(3) For the years 2008, 2009, 2010, 2011 and 2012, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 620, provided that the number of gray whales taken in any one of the years 2008, 2009, 2010, 2011 and 2012 shall not exceed 140.

(4) For the years 2013, 2014, 2015, 2016, 2017 and 2018, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 744, provided that the number of gray whales taken in any one of the years 2013, 2014, 2015, 2016, 2017 and 2018 shall not exceed 140.

The numbers below include stinky whales: 2, 15, 27 and 4 in 1998-2002, 2003-07, 2008-12 and 2013-16 respectively.

The Schedule does not include any carry over.

Table 2

Eastern North Pacific gray whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	125	123	2003	128	126	2008	130	127	2013	127	125
1999	124*	122*	2004	111	110	2009	116	115	2014	124	122
2000	115	113	2005	124	115	2010	118	118	2015	125	124
2001	112	112	2006	134	129	2011	130	128	2016	120	120
2002	131	130	2007	132*	128	2012	143	139			
Total	**607**	**600**		**629**	**608**		**637**	**627**		**496**	**491**
Block limit		**620**			**620**			**620**			**744**

*Includes one from USA west coast (by Makah).

WEST GREENLAND HUMPBACK WHALES

(1) The number of humpback whales struck off West Greenland in accordance with this sub-paragraph shall not exceed 9 in each of the years 2010, 2011 and 2012, except that any unused portion of the quota for each year shall be carried forward from that year and added to the strike quota of any of the subsequent years, provided that no more than 2 strikes shall be added to the strike quota for any one year.

(2) The number of humpback whales struck off West Greenland in accordance with this sub-paragraph shall not exceed *10* in each of the years *2015, 2016, 2017* and *2018*, except that any unused portion of the quota for each year shall be carried forward from that year and added to the strike quota of any of the subsequent years, provided that no more than 2 strikes shall be added to the strike quota for any one year. This provision will be reviewed if new scientific data become available within the remaining quota period and if necessary amended on the basis of the advice of the Scientific Committee.

Table 3

West Greenland humpback whales.

Year	Strikes	Landed	Year	Strikes	Landed
2010	9	9	2013	8	7
2011	8	8	2014	7	6
2012	10	7	2015	6	6
			2016	5	5
Total	**27**	**24**		**26**	**24**
'Block limit'	**27**				

All strikes in the 2010-12 block were taken so none are carried forward.

WEST GREENLAND FIN WHALES

The number of fin whales from the West Greenland stock taken in accordance with this sub-paragraph shall not exceed the limits shown in Table 1.

(1) Table 1 lists a catch limit of 19[2] whales: [2]Available to be taken by aborigines pursuant to paragraph 13*(b)*3. Catch limit for each of the years 1998, 1999, 2000, 2001 and 2002.

(2) Table 1 lists a catch limit of 19[2] whales: [2] Available to be taken by aborigines pursuant to paragraph 13*(b)*3. Catch limit for each of the years 2003, 2004, 2005, 2006 and 2007.

At IWC/57 in Ulsan, Republic of Korea, June 2005, Denmark (Greenland) voluntarily reduced the catch limit for the West Greenland stock of fin whales from 19 to 10 for each of the years 2006 and 2007.

(3) The number of fin whales struck from the West Greenland stock in accordance with this sub-paragraph shall not exceed 19 in each of the years 2008, 2009, 2010, 2011 and 2012.

(4) The number of fin whales struck from the West Greenland stock in accordance with this sub-paragraph shall not exceed ***16*** in each of the years 2010, 2011 and 2012.§

§At IWC/62 in Agadir, Morocco, June 2010, Denmark and Greenland agreed to voluntarily reduce further the catch limit for the West Greenland stock of fin whales from 16 to 10 for each of the years 2010, 2011 and 2012.

The number of fin whales struck from the West Greenland stock in accordance with this sub-paragraph shall not exceed 19 in each of the years *2015, 2016, 2017* and *2018*.

The Schedule does not allow any carry over.

Table 4

West Greenland fin whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	11	9	2003	9	6	2008	14	11	2013	9	9
1999	9	7	2004	13	11	2009	10	8	2014	12	11
2000	7	6	2005	13	12	2010	6	5	2015	12	10
2001	8	7	2006	10	9	2011	5	5	2016	9	8
2002	13	13	2007	12	10	2012	5	4			
Total	**48**	**42**		**57**	**48**		**40**	**33**		**42**	**38**
'Block limit'*		**95**			**77**		**68**				

*Including the voluntary reductions to the catch limits agreed for 2006-7 and 2010-12..

WEST GREENLAND BOWHEAD WHALES

(1) The number of bowhead whales struck off West Greenland in accordance with this sub-paragraph shall not exceed 2 in each of the years 2008, 2009, 2010, 2011 and 2012, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 2 shall be added to the quota for any one year.

(2) The number of bowhead whales struck off West Greenland in accordance with this sub-paragraph shall not exceed 2 in each of the years 2015, 2016, 2017 and 2018, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 2 shall be added to the quota for any one year. This provision will be reviewed if new scientific data become available within the 4 year period and if necessary amended on basis of the advice of the Scientific Committee.

Table 5

West Greenland bowhead whales.

Year	Strikes	Landed	Year	Strikes	Landed
2008			2013		
2009	3	3	2014		
2010	3	3	2015	1	1
2011	1	1	2016		
2012					
Total	**7**	**7**		**1**	**1**
'Block limit'	**10**				

WEST GREENLAND MINKE WHALES

(1) The number of minke whales struck from the West Greenland stock shall not exceed 175 in each of the years 1998, 1999, 2000, 2001 and 2002, except that any unused portion of the strike quota for each year shall be carried forward from that year and added to the strike quota of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(2) The number of minke whales struck from the West Greenland stock shall not exceed 175 in each of the years 2003, 2004, 2005, 2006 and 2007, except that any unused portion of the strike quota for each year shall be carried forward from that year and added to the strike quota of any subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(3) The number of minke whales struck from the West Greenland stock shall not exceed 200 in each of the years 2008, 2009, 2010, 2011 and 2012, except that any unused portion of the quota for each year shall be carried forward from that year and added to the strike quota of any of the subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(4) The number of minke whales struck from the West Greenland stock shall not exceed 178 in each of the years 2010, 2011 and 2012, except that any unused portion of the quota for each year shall be carried forward from that year and added to the strike quota of any of the subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year.

(5) The number of minke whales struck from the West Greenland stock shall not exceed 164 in each of the years 2015, 2016, 2017 and 2018, except that any unused portion of the quota for each year shall be carried forward from that year and added to the strike quota of any of the subsequent years, provided that no more than 15 strikes shall be added to the strike quota for any one year. This provision will be reviewed if new scientific data become available within the 4 year period and if necessary amended on basis of the advice of the Scientific Committee.

Table 6

West Greenland minke whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	168	165	2003	185	178	2008	153	148	2013	175	166
1999	174	169	2004	179	175	2009	164	153	2014	146	144
2000	145	142	2005	176	173	2010	187	180	2015	133	130
2001	139	137	2006	181	175	2011	179	173	2016	148	146
2002	139	134	2007	167	161	2012	148	144			
Total	**765**	**747**		**888**	**862**		**831**	**798**		**602**	**586**
'Block limit'	**875**			**875**			**934**				

EAST GREENLAND MINKE WHALES

(1) The number of minke whales from the Central stock taken in accordance with this sub-paragraph shall not exceed 12 in each of the years 1998, 1999, 2000, 2001 and 2002, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 3 shall be added to the quota for any one year.

(2) The number of minke whales from the Central stock taken in accordance with this sub-paragraph shall not exceed 12 in each of the years 2003, 2004, 2005, 2006 and 2007, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 3 shall be added to the quota for any one year.

(3) The number of minke whales struck from the Central stock in accordance with this sub-paragraph shall not exceed 12 in each of the years 2008, 2009, 2010, 2011 and 2012, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 3 shall be added to the quota for any one year.

(4) The number of minke whales struck from the Central stock in accordance with this sub-paragraph shall not exceed 12 in each of the years 2015, 2016, 2017, and 2018, except that any unused portion of the quota for each year shall be carried forward from that year and added to the quota of any subsequent years, provided that no more than 3 shall be added to the quota for any one year.

Table 7

East Greenland minke whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	10	10	2003	14	13	2008	1	1	2013	6	4
1999	14	14	2004	11	11	2009	4	4	2014	11	11
2000	10	10	2005	4	4	2010	9	9	2015	6	6
2001	17	14	2006	3	2	2011	10	9	2016	15	15
2002	10	10	2007	2	2	2012	4	4			
Total	**61**	**58**		**34**	**32**		**28**	**27**		**38**	**36**
'Block total'		**60**			**60**		**60**				

ST VINCENT AND THE GRENADINES

(1) For the seasons 2000 to 2002 the taking of 2[1] humpback whales each season is permitted by Bequians of St Vincent and The Grenadines. [1]Each year this figure will be reviewed and if necessary amended on the basis of the advice of the Scientific Committee.

(2) For the seasons 2003-2007 the number of humpback whales to be taken by the Bequians of St. Vincent and The Grenadines shall not exceed 20.

(3) For the seasons 2008-2012 the number of humpback whales to be taken by the Bequians of St. Vincent and The Grenadines shall not exceed 20.

(4) For the seasons 2013-2018 the number of humpback whales to be taken by the Bequians of St. Vincent and The Grenadines shall not exceed 24.

Table 8

St Vincent and The Grenadines humpback whales.

Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed	Year	Strikes	Landed
1998	2	2	2003	1	1	2008	2	1	2013	4	4
1999	2	2	2004	0	0	2009	1	1	2014	2	0
2000	2	2	2005	1	1	2010	3	3	2015	1	1
2001	2	2	2006	1	1	2011	2	1	2016	0	0
2002	2	2	2007	1	1	2012	2	1	2017	1	1
									2018		
Total	**10**	**10**		**4**	**4**		**10**	**7**		**8**	**6**
Block limit					**20**			**20**			**24**

Appendix 5

SCENARIOS TESTED AND DATA USED IN GRAY WHALE *SLA* RUNS

At IWC/66 the Commission instructed the Scientific Committee to examine the following two scenarios that bracket the likely range of 'stinky' whales landed and struck and lost whales in future hunts, using the existing *Gray Whale SLA*:

(a) that from 2019, the number of killed animals in each year is increased by ten whales (to include both inedible and struck-and-lost whales); and

(b) that from 2019, the number of killed animals in each year is increased by 6% of the landed (this includes both inedible and struck-and-lost).

The numbers of whales killed (=no. of strikes) and the numbers landed, lost and 'stinky' whales are listed in Table 1.

The following three versions of the scenarios were tested, each using the two definitions of the recent averages (i) over 2013-16 and (ii) over 2008-16, as shown in Table 1.

(1) The average number landed (including 'stinky' whales) increases from 744 (=124*6) to 804 (= 134*6).

(2) The average number killed (i.e. struck) increases by 10:
   (a) from 744 .0 (=124.0*6) to 804.0 (=134.0*6); and
   (b) from 755.4 (=125.9*6) to 815.4 (=135.9*6).

(3) The average number of edible landed whales increases by 6%:
   (a) From 730.8 (=121.8*6) to 774.3; and
   (b) from 724.8 (=120.8*6) to 768.1.

Table 2 lists the estimated number of strikes for each of the scenarios. They range from 789-815 strikes over the 6-year block (or an average of 132-136 strikes per year). These strike limits are allowed by the *SLA*. Details of the catches and abundance estimates used when applying the *SLA* are listed in Tables 3 and 4.

Table 1

The numbers of whales killed (=no. of strikes) and the numbers landed, lost and 'stinky' whales taken since 2008. The column headed 'Edible Landed' excludes 'stinky' whales and struck and lost whales. The values shown for 2017 and 2018 are the assumed values used when running the *SLA*. The table also shows the average numbers over the periods 2013-16 and 2008-16.

Year	Struck and lost	'Stinky'	Total landed	Edible landed	Total killed=no. of strikes	Notes
2008	3	10	127	117	130	
2009	1	6	115	109	116	
2010		1	118	117	118	
2011	2	2	128	126	130	
2012	4	8	139	131	143	
Total 2008-12	10	27	627	600	637	
2013	2	2	125	123	127	
2014	2		122	122	124	
2015	1	1	124	123	125	
2016	0	1	120	119	120	
2017	1		127		128	Assumed
2018	1		126		127	Assumed
Estimated total 2013-18	7	4	**744**	487	751	
(i) Average 2013-16:	1.3	1.0	122.8	121.8	124.0	
(ii) Average 2008-16:	1.7	3.4	124.2	120.8	125.9	

Table 2

The estimated number of strikes for each of the scenarios (see text).

		Total landed	Edible landed	Total kill=no. of strikes
(1) Average no. landed inc. from 744 to 804	(i)	804		812.2
	(ii)	804		814.8
(2) Average no. killed increased by 10	(i)			804.0
	(ii)			815.4
(3) Edible landed increased by 6%	(i)		774.3	788.6
	(ii)		768.1	800.7

Table 3

Catches. Any lost whales have been allocated to sex in the ratio of the catches in that year. Catches in years 2017 and 2018 are estimated.

Year	All M	All F	All	Year	All M	All F	All	Year	All M	All F	All
1930	23	24	47	1960	58	98	156	1990	67	95	162
1931	5	5	10	1961	77	131	208	1991	67	102	169
1932	10	10	20	1962	59	92	151	1992	0	0	0
1933	38	37	75	1963	68	112	180	1993	0	0	0
1934	66	60	126	1964	90	129	219	1994	21	23	44
1935	71	83	154	1965	71	110	181	1995	48	44	92
1936	93	105	198	1966	95	125	220	1996	18	25	43
1937	12	12	24	1967	161	213	374	1997	48	31	79
1938	32	32	64	1968	89	112	201	1998	63	62	125
1939	19	20	39	1969	89	125	214	1999	70	54	124
1940	56	69	125	1970	71	80	151	2000	63	52	115
1941	38	39	77	1971	57	96	153	2001	62	50	112
1942	60	61	121	1972	61	121	182	2002	80	51	131
1943	59	60	119	1973	97	81	178	2003	71	57	128
1944	3	3	6	1974	94	90	184	2004	43	68	111
1945	25	33	58	1975	58	113	171	2005	49	75	124
1946	14	16	30	1976	69	96	165	2006	57	77	134
1947	11	20	31	1977	87	100	187	2007	50	82	132
1948	7	12	19	1978	94	90	184	2008	64	66	130
1949	10	16	26	1979	58	125	183	2009	59	57	116
1950	4	7	11	1980	53	129	182	2010	57	61	118
1951	6	8	14	1981	36	100	136	2011	60	70	130
1952	17	27	44	1982	57	111	168	2012	51	92	143
1953	21	27	48	1983	46	125	171	2013	41	86	127
1954	14	25	39	1984	59	110	169	2014	43	81	124
1955	22	37	59	1985	54	116	170	2015	49	76	125
1956	45	77	122	1986	46	125	171	2016	54	66	120
1957	36	60	96	1987	48	111	159	2017	48	80	128
1958	55	93	148	1988	43	108	151	2018	48	79	127
1959	74	122	196	1989	61	119	180				

Table 4

Abundance estimates.

Year	Estimate	CV	Year	Estimate	CV
1968	13,426	0.094	1986	22,921	0.081
1969	14,548	0.08	1988	26,916	0.058
1970	14,553	0.083	1993	15,762	0.067
1971	12,771	0.081	1994	20,103	0.055
1972	11,079	0.092	1996	20,944	0.061
1973	17,365	0.079	1998	21,135	0.068
1974	17,375	0.082	2001	16,369	0.061
1975	15,290	0.084	2002	16,033	0.069
1976	17,564	0.086	2007	20,750	0.06
1977	18,377	0.08	2008	17,820	0.054
1978	19,538	0.088	2010	21,210	0.046
1979	15,384	0.08	2011	20,990	0.044
1980	19,763	0.083	2015	28,790	0.13
1985	23,499	0.089	2016	26,960	0.05

Annex F

Report of the Sub-Committee on In-depth Assessments

Members: Palka (Convenor), Allison, Baba, Baker, Bell, Brownell, Burkhardt, Butterworth, Cholewiak, Cipriano, Clapham, Cooke, de la Mare, de Moor, Diallo, Donovan, Double, Enmynkau, Filatova, Findlay, Fortuna, Funahashi, Goodman, Goto, Gushcherov, Hakamada, Herr, Hughes, Iñíguez, Isoda, Ivashchenko, Jackson, Kato, Kitakado, Konan, Lang, Lundquist, Maeda, Mallette, Matsuoka, McKinlay, Miyashita, Mizroch, Morishita, Morita, H., Morita, Y., Moronuki, Nelson, Øien, Park, J., Park, K., Pastene, Punt, Redfern, Reeves, Rosenbaum, Scordino, Sirović, Skaug, Slugina, Stimmelmayr, Taguchi, Tamura, Wade, Walløe, Walters, Weinrich, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Introductory remarks and election of Chair
Palka welcomed the participants and was elected Chair for SC/67a. Herr was identified as co-Chair for this sub-committee.

1.2 Appointment of rapporteurs
Cooke, Clapham, Herr, and Palka agreed to act as rapporteurs.

1.3 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

1.4 Documents available
The documents considered by the sub-committee were SC/67a/IA02, SC/67a/SH14 and SC/67a/Rep08.

2. IN-DEPTH ASSESSMENT OF INDO-PACIFIC ANTARCTIC MINKE WHALES

2.1 Progress on summary report of completed in-depth assessment
In 2014, after 13 years, the in-depth assessment of Antarctic minke whales in the Indo-Pacific Antarctic region was completed. At that time it was suggested all of the components and results of the assessment that had been concluded over the years be brought together in one document. The intersessional Correspondence Group initially established at SC/65b was asked to prepare a document synthesising the results of the in-depth assessment of Antarctic minke whales in the Indo-Pacific region which was conducted from 2001-14. The main task of the group was to summarise the obtained results, and not to go too much into details of analyses. No new or recent analyses conducted after SC/65b were to be considered or included in the document. SC/67a/SH14 was presented to this meeting as a draft of that document. The document covered a wide variety of topics discussed over 13 years including systematics, commercial and research catches, abundance estimates, spatial distribution patterns, stock structure, biological information, population dynamics, feeding ecology and energetics, pollutants and marine debris, and species interactions. The intersessional correspondence group plans to complete the task assigned to the group during the upcoming intersessional period by finalising the document, taking into account comments received during this year's meeting, and submitting the manuscript to a peer-reviewed journal.

The sub-committee welcomed the document and acknowledged the great effort that had gone into summarising the information and results collected over a time period of so many years. After a general discussion of which issues should be included in the summary document, it was noted that the text on the discussion of trends in nutritional condition in SC/67a/SH17 was incomplete and so several additional references were identified that reflected the status of the discussion at that time (2014). Other suggestions to improve the document were the paper should include a clear description of what animals are being assessed; it should mention that even after completion of the in-depth assessment, research is continuously ongoing but this document is focusing on research results that occurred at or before the completion of in-depth assessment in 2014; the document could be shorter; and extracts of conclusions from previous Committee reports could be presented for complete and precise representation of final results.

2.2 Work plan
The sub-committee **agreed** that the intersessional correspondence group appointed last year should continue to finalise the document that summarises the in-depth assessment of the Indo-Pacific Antarctic minke whales that was completed in 2014 by integrating points raised in the discussion in preparation for submission to a peer-reviewed journal.

3. IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

3.1 Progress on intersessional work
SC/67a/IA02 documented progress with model development. The model can be run when the input data have been prepared.

Allison reported that the catch series had been completed. The Japanese *Discovery* marking data had also been coded and entered, and (with the assistance of Yoshida) all remaining questions of interpretation had been resolved, as far as is possible.

No new analyses of sightings data were presented, but an analysis of the US west coast sightings data has been published (Barlow, 2016). The specific data items for use in the assessment are discussed below.

3.2 Preparation of data for the assessment
3.2.1 Stock structure hypotheses
Issues of stock structure were discussed extensively at the 2015 and 2016 meetings. Last year, the Committee agreed to proceed on the basis of two alternative hypotheses: (i) a single stock for the entire North Pacific (Kanda *et al.*, 2015; Pastene *et al.*, 2016); and (ii) a 5-stock hypothesis presented in Mizroch *et al.* (2016). After much discussion, the Committee considered that the evidence for the 5-stock hypothesis is weak. The genetic information was consistent with a single stock in the area covered by the samples. However, it noted that all the samples had been taken from the area of just one of the stocks proposed in Mizroch *et al.* (2016), namely the North Pacific pelagic stock.

This year the sub-committee decided to proceed, as agreed last year, with assessment modelling based on two alternative hypotheses: (1) the entire North Pacific contains a single stock; and (2) there are up to 5 stocks as proposed last year. The sub-committee tentatively **agreed** to use the lines shown in Appendix 2 for compiling catch and abundance data for use in the assessment model, but **agreed** that the intersessional steering group could modify them, if necessary to facilitate the divisions of data into sub-regions. There is no implication that these lines correspond to stock boundaries.

The sub-committee noted the policy used in RMP *Implementations* of assigning relative plausibilities (high, medium, low and disputed) to different hypotheses relating to stock structure and other matters. The sub-committee **agreed** that it would not attempt to assign relative plausibilities to the alternative stock structure hypotheses at this stage. The issue of relative plausibility will be addressed next year when results of assessment modelling are available.

The sub-committee emphasised that this decision to proceed does not imply endorsement of either hypothesis at this stage. The sub-committee acknowledges that some members are of the view that there is no scientific basis for a multi-stock scenario.

3.2.2 Abundance data and trends

Last year the sub-committee classified the sources of abundance data into three groups: (i) surveys which have been analysed and from which usable abundance estimates are already available; (ii) surveys involving significant sei whale sightings for which no analysis was yet available; and (iii) surveys resulting in zero or minimal sei whale sightings, which can be used to bound the area of abundance (IWC, 2017).

No progress was made intersessionally on the analysis of surveys in group (ii). The sub-committee decided that it was no longer in a position to delay the assessment pending further analyses. It, therefore, developed a final list of abundance information that will be used in the assessment (see Appendix 3). This consists of existing estimates that are published or contained in documents to the Committee, plus data from published sources that can be used with minimal analysis.

As noted in the work plan, the sub-committee **recommended** that the intersessional steering group for the assessment be reconvened, and that its first task will be to produce a table of inputs to the assessment model. Most of the remaining work on abundance involves extracting existing estimates from papers and assigning or prorating them to sub-regions. The only dataset that may require some limited additional analysis in order to generate potential model input is the summary data from JSV (Japanese sighting vessels) and Japanese dedicated surveys. The analysis should use the published summaries by 10° square of n (number seen) and L (survey distance) by year, summer only (May-October). A simple regression analysis may be required to account for the shifting distribution of effort over time. Cooke offered to provide such an analysis of the JSV data for consideration by the intersessional group. The sub-committee **agreed** that these data would be used in the assessment model either as a purely relative abundance index or converted to absolute abundance using a plausible range for a scaling factor.

The sub-committee **agreed** that sei whales do not occur to any significant extent in the following areas: Okhotsk Sea (apart from the Kuril Islands); Sea of Japan; waters north of the Bering Strait. As listed in Appendix 3, there are some further areas of near-zero recent abundance but where catches were taken in the past (Gulf of Alaska, eastern Aleutians, and Canadian west coast).

3.2.3 Marking data

The coding of the Japanese *Discovery* marking data is now complete, but a choice needs to be made on how to handle known or presumed multiple marking of individuals, because marks believed to have been fired into different whales may be recovered in the same whale, and single marks may be recovered from whales thought to have been multiply marked. The sub-committee referred the question to the proposed intersessional group, because some (preferably simple) analysis of the data may be required to resolve it.

Mizroch reported that she is coding up some US marking data. Because it is a fairly small dataset, the sub-committee **agreed** that it can be used if it is submitted to the Secretariat in time for the assessment, but that it is not an essential input.

The sub-committee had little information on marking efficiency, mark retention, or recovery efficiency. Marking efficiency and recovery efficiency are mutually confounded in the data and should be considered a single parameter. It was **agreed** to try two alternative assumptions: (i) marking/recovery efficiency is 100%; and (ii) marking/recovery efficiency is a free parameter in the model, with values in the range of 0 to 1. Marking efficiency includes marking-caused mortality, if it is present and acts within the first year. Marks recorded with any other verdict than definite hits should either be excluded from the analysis, or allowed to have as lower marking efficiency than definite hits.

The sub-committee **agreed** to try two alternative assumptions about mark shedding: (i) no mark shedding; and (ii) parameter to be estimated from the data. For the latter case the modeller may wish to refer to published estimates of shedding rate (de la Mare, 1985) to guide the choice of a prior for the shedding rate.

3.2.4 Catch history

Allison reported that nearly all catches have either actual positions or have been assigned approximate positions that are precise enough to assign them to one of the tentative sub-regions for the assessment. The only exception is some USSR catches where a decision needs to be made where to assign them to. A proportion of catches of uncertain species (such as sei whales in the years prior to their distinction from Bryde's whales) have been assigned to sei whales by prorating from known species compositions for the given areas and seasons. Sex is unknown for some of the earlier catches, but for the purpose of implementing the model in SC/67a/IA02 the sex ratio of the catch is pro-rated according to the sex ratio from known-sex catches in the same area and year if there are any, otherwise according to the sex ratio of catches by area averaged over years.

The sub-committee requested Allison to identify any remaining adjustments to the catch series that may be necessary, and to refer them to the intersessional group for endorsement.

3.2.5 Life history parameters

The life history and exploitation-related parameters required by the assessment model are age at recruitment (or selectivity ogive), age at maturity (or maturity ogive), and the natural mortality rate. For initial runs of the assessment model, the same parameter values would be used as at the last assessment of North Pacific sei whales. The intersessional group would extract the values, because the published report of the last assessment (IWC, 1977) does not provide them in a form directly usable as input to the model.

3.3 Assessment model

The sub-committee **endorsed** the model structure described in SC/67/IA02. The model is similar to that used in multi-stock *Implementation Simulation Trials*. The time step is half-yearly, with summer defined as May to October and winter as November to April. The model can accommodate any definitions of feeding and breeding areas with any degree of mixing between them. The model utilises catches, marks and recoveries, and abundance information, which are used to calculate a likelihood function of the parameters.

Model outputs include time series of abundances by year and sub-region (and by stock where applicable). The goodness-of-fit to each data source and the residuals shall be plotted to help the sub-committee to examine the ability of the model to fit the different inputs, and potentially to draw inferences about their mutual consistency or otherwise. In principle, it may be possible to reject specific hypotheses based on (lack of) fit to the model, but it is difficult to specify explicit criteria for this in advance.

The sub-committee did not consider the mixing matrices in detail, but **agreed** that the model should allow movement between the wintering grounds and the summer feeding areas, as indicated by the mark recaptures. With regard to mixing between summer sub-regions, the sub-committee **agreed** that initial exploration of the model should include runs with: (i) no mixing; (ii) minimal mixing to achieve consistency with the mark-recapture data; and (iii) maximal mixing (no fidelity to feeding grounds). The intersessional steering group should consider alternative mixing assumptions if initial runs of the assessment model indicated that the above scenarios were not consistent with the data.

For scenarios that involve more than one breeding stock, the initial assumption should be that there is no mixing between breeding stocks.

3.4 Work plan

The sub-committee **agreed** that an intersessional steering group was needed to take forward preparation of model inputs, especially the abundance data, and that it should start its work before leaving this meeting. The sub-committee **agreed** that the first version of the group's proposals for input data for the assessment could be appended to this report, although the sub-committee had not reviewed it at this meeting.

The following tasks need to be completed in the intersessional period:

- finalise and review the data inputs for the assessment (intersessional steering group);
- conduct initial runs of the assessment using the assumptions proposed by the sub-committee (Punt);
- review results of initial runs and specify alternative assumptions if required (intersessional steering group); and
- report to next year's meeting on the final model inputs and the results.

There are no new budgetary implications, as the required funds were approved last year.

4. COMPREHENSIVE ASSESSMENT OF NORTH PACIFIC HUMPBACK WHALES

4.1 Progress on intersessional work

Donovan provided a summary of the IWC's first Workshop on the Comprehensive Assessment of North Pacific Humpback Whales. The Workshop was held from 19-21 April 2017 at the kind invitation of the Marine Mammal Laboratory in Seattle. It was convened by Phil Clapham, and Greg Donovan was elected Chair. The Workshop covered an enormous amount of material and since it was just held, it was not possible to finalise a report of the Workshop before the Committee meeting. As a result details of the Workshop's results are summarised below. It is expected the report for this meeting will be combined with the report of the upcoming 2018 intersessional Workshop that will continue the development of the Comprehensive Assessment.

The objective of the Workshop was to undertake the first steps in assessing humpback whales in the North Pacific (the Comprehensive Assessments of North Atlantic and Southern Hemisphere humpback whales were completed in 2002 and 2014, respectively). It is envisioned that this will be a 2-3 year process. The primary task was to identify and review the available information on stock structure, removals (catches, bycatches and ship strikes), abundance and trends (by stock and area), biological parameters and environmental issues. This information will ultimately be integrated using a population dynamics modelling approach. The important steps that were completed at the Workshop were to confirm available data, develop a series of plausible conceptual models for stock structure, and identify major uncertainties or knowledge gaps.

4.2 Preparation of data for assessment

4.2.1 Stock structure hypotheses

The Workshop reviewed information on stock structure from a suite of datasets including photo-identification, genetics, telemetry, acoustics, catches and sightings.

The Workshop was fortunate to be able to review and build upon the extensive SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) project. This major international collaborative project was conducted on all then-known winter breeding regions during three seasons (2004, 2005 and 2006) and all known summer feeding areas during two seasons (2004 and 2005[1]). A total of 7,971 unique individuals were catalogued and a total of 6,178 tissue samples were also collected for genetic studies of population structure, with broadly even representation of wintering and feeding areas.

Updated information, in some cases extensive, was received and reviewed from several regions and research groups including the Russian Pacific, the Bering and Chukchi Seas, Japan and Mexico. Thus, the Workshop had an abundance of data with which to develop stock structure hypotheses.

The Workshop identified the geographic 'building blocks' it would use when describing the various stock structure hypotheses. These are listed in Table 1 and shown in Fig. 1.

The hypotheses considered by the Workshop relating to wintering and feeding grounds (and movements) are summarised in Tables 2 and 3. Note that Hawaii in the central North Pacific is always considered a single wintering area.

During the sub-committee meeting Brownell provided information on work conducted on Saipan in the Marianas. The NOAA Pacific Islands Fisheries Science Center conducted small boat surveys on 6 days during 11-22 February 2017. They encountered 25 humpback whales including two mother-calf pairs. Biopsy samples were collected from 11 humpbacks including both mothers. Fluke images were collected from 19 humpbacks. The Saipan catalogue now contains 35 non-calf individuals with fluke images for 24 of them. This year there were three re-sightings from previous years. The first was a male that was photographed and biopsy sampled in 2015. The second was a female first encountered in 2016 with a calf and biopsy sampled; she did not have a calf in 2017. The third was an

[1]Although coverage in 2005 was much reduced for offshore and Aleutians.

Table 1

Geographic areas used to describe stock structure hypotheses (see Fig.1).

Area	Abbreviation	Area	Abbreviation
Philippines	PHI	Western Gulf of Alaska	wGOA
Ogasawara	OG	Central Gulf of Alaska	cGOA
Okinawa	OK	Northern Gulf of Alaska/Prince William Sound	nGOS-PWS
Hawaii	HI	Southeast Alaska-Northern British Columbia	seAK-nBC
Kuril Islands	KI	Southern British Columbia-Washington State	sBC-WA
Okhotsk Sea	OS	Northern California-Oregon	nCA-OR
Eastern Kamchatka	eKam	Southern and Central California	s&cCA
Western Aleutians	wAI	Mexico Baja	MXBJ
Central Aleutians	cAI	Mexico Mainland	MXMN
Eastern Aleutians	eAI	Mexico Islands (Revillagigedos)	MXIS
Bering Sea	BS	Southern Mexico	sMX
Arctic	Ar	Central America	cAm

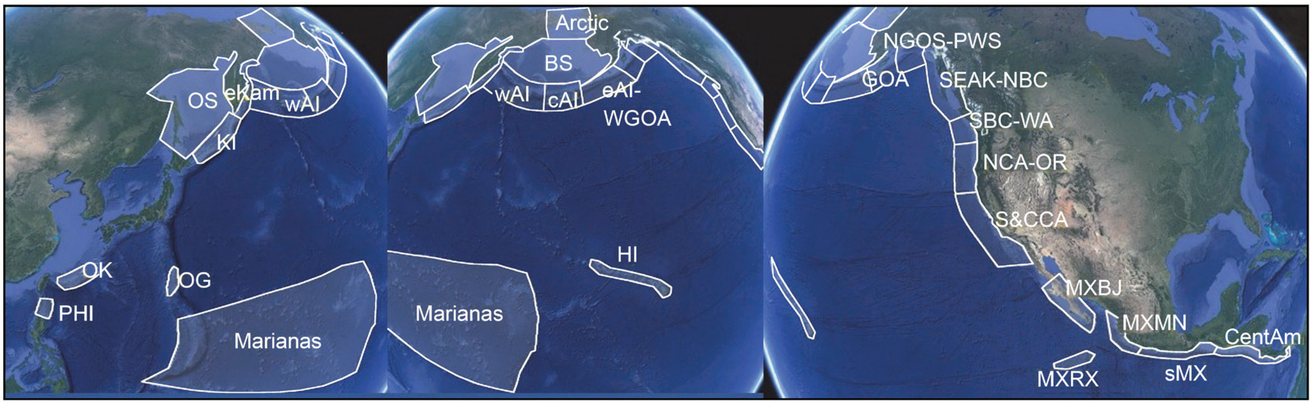


Fig. 1. The geographic 'building blocks' identified by the Workshop to use when describing the various stock structure hypotheses.

Table 2a

Summary of hypotheses under consideration with respect to wintering areas: eastern North Pacific. Y=final destination breeding ground T=Transit i.e. animals found in this area are moving through to their final destination. For areas see Table 1 and Fig.1

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>MX BJ</td><td>Y</td><td rowspan="4">Y</td><td>T</td><td rowspan="3">Y</td><td rowspan="3">Y</td><td>Y</td></tr>
<tr><td>MX IS</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>nMLMX</td><td>Y</td><td rowspan="2">Y</td><td>Y</td></tr>
<tr><td>sMLMX</td><td>T</td><td rowspan="2">Y</td><td rowspan="2">Y</td><td rowspan="2">Y</td></tr>
<tr><td>cAm</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

Table 2b

Summary of hypotheses under consideration with respect to wintering areas: western North Pacific. Legend as Table 2a.

<table>
<tr><td>Ogasawara</td><td>Y</td><td rowspan="4">Y</td><td>T</td><td rowspan="3">Y</td></tr>
<tr><td>Okinawa</td><td>Y</td><td rowspan="2">Y</td></tr>
<tr><td>Philippines</td><td>Y</td></tr>
<tr><td>Mariana+</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

individual that was encountered in 2007 during the MISTCS cruise; in 2017 it was involved in a competitive group and is assumed to be male. Comparisons of Saipan humpbacks to humpback catalogs from the Philippines, Okinawa, Russia, and Japan are underway. It was noted that genotyping has occurred for all the Saipan samples, and that one individual had been matched between Saipan and Ogasawara; given the small sample size, this suggested a strong connection between the two areas.

Kato reported that a significant number of genetic and photo-identification samples have been collected from Okinawa waters since 1991 by the Okinawa Churashima Research Center. Currently the comparison of these samples with other data sets have begun. In addition, similar data are potentially available from Ogasawara. Formerly during the late 1990's to 2010, the Ogasawara Marine Center conducted photo-identification surveys. Since the 2014/15 season the Ogasawara Whale Watching Association took over the photo-identification surveys. It is expected that the Ogansawara Whale Watching Association data sets from 2014 to 2016 will be available for future analyses. However, access to the older Ogasawara Marine Center data sets will require negotiates with the original data holder.

4.2.2 Abundance data and trends

The Workshop examined a comprehensive mark-recapture analysis (still ongoing) using data for the whole North Pacific derived from the SPLASH dataset. Several difficulties were identified, and suggestions were made to address these. In addition, the completed analysis will take into account the revised (since SPLASH) stock structure hypotheses considered at the Workshop and the need for abundance estimates for the areas relevant to these.

The Workshop compiled a list of abundance estimates (or data that could be used to generate such estimates) for the areas that would be needed for the various stock structure hypotheses. It also addressed the future work needed to complete analyses. The intersessional Steering Group will ensure that progress is made to this end.

During the sub-committee meeting a question was raised regarding whether data collected since the SPLASH project are being used to update abundance estimates. The response was additional data have become available since SPLASH, and the intent was to incorporate these new data to provide a consistent series of estimates for inclusion in the assessment.

4.2.3 Catch history and other removals

The Workshop examined the existing catch data and has agreed the series for incorporating into the assessment. This will require different allocations of catches for each

Table 3

Summary of consideration of links between areas used to describe feeding grounds (Y=separate feeding ground on its own). For areas see Table 1 and Fig.1

Area	Links with			
KI	Y	With eKam	With wAI	
OS	With KI			
eKam	With KI			
wAI	With BS, cAI and eAI	With BS and cAI		
cAI	With BS, wAI and eAI	With BS and wAI	With BS and eAI	
eAI	With BS, cAI and eAI	With BS and eAI		
Ar	With BS			
BS	With A	With wAI, cAI and eAI	With wAI and cAI	With cAI and eAI
wGOA	With aAI and cGOA	With nGOA, eAI, cGOA		
cGOA	With aAI and wGOA	With nGOA, eAI, wGOA		
nGOA-PWS	With nGOA-PWS			
seAK-nBC	T			
sBC-WA	With nCA-OR			
nCA-OR	With s&cCA	With sBC-WA		
c&cCA	Y	T		

stock structure hypothesis. It also reviewed the available information on bycatch and ship strikes. This is a more complex issue than direct catches. The Workshop noted that, as for other assessments (e.g. gray whales) there was rather limited information from some areas and that even where there are data, the numbers will likely be underestimated by an unknown (and possibly large) amount. The Workshop agreed that it will follow the approach adopted elsewhere that it will develop several scenarios reflecting both past and likely future removals; these are intended to capture the uncertainty (both in numbers and allocations for the various stock structure hypotheses) for use in the modelling work. These scenarios will be developed by an intersessional Steering Group that will also investigate whether additional data can be tracked down.

During the sub-committee it was noted in discussion that additional data on mortalities were available from various sources. It was **agreed** to request any data on mortalities be sent to Clapham, who would compile these for future inclusion into the model. Assigning cause of death (e.g. entanglement, ship-strike etc.) to mortality reports is often difficult, but this would be attempted where sufficient information are available. It was proposed that uncertainty in these data would be dealt with using an approach similar to that employed for the gray whale assessment.

4.2.4 Life history parameters

The Workshop compiled and reviewed the available information on biological parameters for humpback whales in all oceans. It was recognised that these can vary amongst populations. This information will be considered as necessary within the context of the modelling framework, particularly with respect to maximum rates of increase.

4.2.5 Environmental issues

The Workshop considered this item in the context of potentially changing carrying capacity in the North Pacific. It was agreed that whilst separating the effects of environmental changes from the traditional view of populations approaching carrying capacity is something to strive for, such data are not available. However, the Workshop noted several interesting studies linking humpback whale occurrence and density with environmental factors in parts of the North Pacific and adjacent Arctic, as well as information suggesting changes in numbers, distribution, health and reproduction of humpback whales (e.g. parts of southeast Alaska and Hawaii). Further investigations into the effects of environmental changes in the habitat of humpback whales were encouraged.

4.3 Assessment model

The Workshop reviewed an initial sex- and age-structured modelling framework that might be used as the basis for the assessments, and this proved valuable in allowing the Workshop to move forward. In the light of discussions of the available data the Workshop agreed that future modelling efforts should employ a simpler modelling framework based upon an age-aggregated model; this will allow easier use of priors for the maximum rate of increase, and allow the model to be fitted using a Bayesian estimation approach, in common with the assessments for Southern Hemisphere humpback whale populations.

4.4 Work plan

The Workshop developed several research recommendations that do not have cost implications for the IWC. These include: additional comparisons amongst catalogues; support for the existing work in Russia and expansion of this research; further information and catalogue comparisons with new Japanese data; further consideration of Korea; further information from the Mariana Islands; additional analytical genetic work including further characterisation of the Mexican regions and central California, as well as investigation of population assignment (feeding grounds to breeding units); additional biopsy sampling in particular in Marianas Islands and central Mexico; and additional work on abundance estimates.

The Workshop made considerable progress with the work to develop conceptual stock structure hypotheses and to review the available information on other factors central to completing the Comprehensive Assessment. It recommended that an intersessional Steering Group be established to:

(a) consolidate and prioritise the stock structure hypotheses developed at this Workshop from a modelling perspective and develop appropriate draft presence/absence and mixing matrices for consideration at the next Workshop;
(b) facilitate the additional work on abundance estimates; and
(c) finalise plans for the second Workshop in 2018.

The sub-committee **endorsed** this work plan and **agreed** to establish the intersessional Steering Group. It also thanked Donovan and the Workshop participants, and recognised the progress that has been made towards an assessment.

Table 4

Summary of the work plan for the In-depth Assessments (IA) sub-committee.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Document Indo-Pacific Antarctic minke whale assessment	Finalise document and submit for publication	-
In-depth assessment of North Pacific sei whales	Reconvene intersessional steering group to further data preparation and development of the assessment model	Review progress of intersessional work and continue in-depth assessment
Comprehensive assessment of North Pacific humpback whales	Reconvene intersessional steering group and convene 2nd workshop to further data preparation and development of the assessment model	Review progress of intersessional workshop and continue comprehensive assessment

Table 5

Summary of budget requests for the 2017-18 period. For explanation and details of each project see text.

Title	Relevance to which sub-committee(s)?	2018 (£)
Second Workshop on the Comprehensive Assessment of North Pacific Humpback Whales	IA	11,040
Total request		11,040

5. WORK PLAN AND BUDGET REQUESTS

The sub-committee expects progress on the three assessments intersessionally through the working and steering groups (Table 4 and Annex W). Details on the work plans are found in Items 2.2, 3.4 and 4.4. The sub-committee **recommended** a budget request for an intersessional workshop to progress the comprehensive assessment of the North Pacific humpback whales be funded to insure progress (Table 5). There was discussion as to whether to hold this as a pre-meeting or an inter-sessional workshop. It was **agreed** to decide this after the sub-committee meeting taking in account the budget and needed participants.

6. ADOPTION OF REPORT

The report was adopted at 15:36 on 17 May 2017.

REFERENCES

Barlow, J. 2016. Cetacean abundance in the California Current estimated from ship-based line-transect surveys in 1991-2014. *Southwest Fisheries Science Center Administrative Report* LJ-16-01: 67pp.

de la Mare, W.K. 1985. Some evidence for mark shedding with Discovery whale marks. *Rep. int. Whal. Commn.* 35: 477-86.

International Whaling Commission. 1977. Report of the Special Meeting of the Scientific Committee on sei and Bryde's whales, La Jolla, 3-13 December 1974. *Rep. int. Whal. Commn. (special issue)* 1:1-9.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 18:203-29.

Kanda, N., Bando, T., Matsuoka, K., Murase, H., Kishiro, T., Pastene, L.A. and Ohsumi, S. 2015. A review of the genetic and non-genetic information provides support for a hypothesis of a single stock of sei whales in the North Pacific. Paper SC/66a/IA09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

Mizroch, S.A., Conn, P.B. and Rice, D.W. 2016. REVISE OF SC/66a/IA14: The mysterious sei whale: its distribution, movements and population decline in the North Pacific revealed by whaling data and recoveries of Discovery-type marks. Paper SC/66b/IA20 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 129pp. [Paper available from the Office of this Journal].

Pastene, L.A., Goto, M. and Taguchi, M. 2016. Additional genetic analyses on stock structure in North Pacific Bryde's and sei whales. Paper SC/66b/SD01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].

Appendix 1

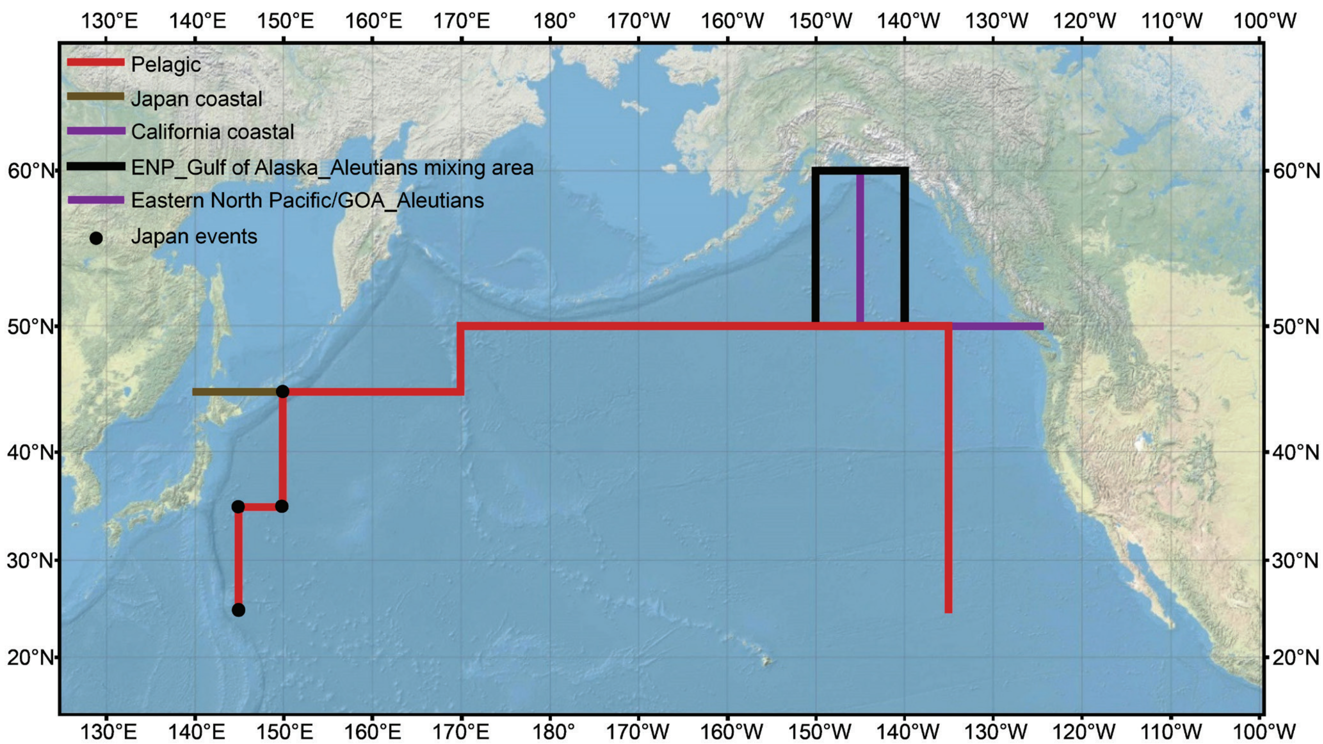
AGENDA

1. Introductory items
   1.1 Introductory remarks
   1.2 Election of Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of Agenda
   1.5 Documents available
2. In-depth assessment of Indo-Pacific Antarctic minke whales
   2.1 Progress on summary report of completed in-depth assessment
   2.2 Work plan
3. In-depth assessment of North Pacific sei whales
   3.1 Progress on intersessional work
   3.2 Preparation of data for assessment
      3.2.1 Stock structure hypotheses
      3.2.2 Abundance data and trends
      3.2.3 Marking data
      3.2.4 Catch history
      3.2.5 Life history parameters
   3.3 Assessment model
   3.4 Work plan
4. In-depth assessment of North Pacific humpback whales
   4.1 Progress on intersessional work
   4.2 Preparation of data for assessment
      4.2.1 Stock structure hypotheses
      4.2.2 Abundance data and trends
      4.2.3 Catch history
      4.2.4 Life history parameters
      4.2.5 Environmental issues
   4.3 Assessment model
   4.4 Work plan
5. Work plan and budget requests
6. Adoption of Report

Appendix 2

SCHEMATIC LINES FOR DIVIDING DATA INTO SUB-REGIONS FOR IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

These lines were tentatively agreed by the sub-committee as schematic representation of how data may be divided. They do not represent putative stock boundaries. The sub-committee agreed that the intersessional group could modify them to facilitate allocation of sightings and other data.



Appendix 3

REPORT OF THE SMALL GROUP TO DETERMINE ABUNDANCE DATA THAT WILL BE USED IN THE NORTH PACIFIC SEI WHALE IN-DEPTH ASSESSMENT

Members: Cooke, Hakamada, Kitakado, Matsuoka, Miyashita, Palka, Yoshida

The group agreed as follows.

(1) The line between the coastal and pelagic regions will be defined in the east and north by the EEZs of USA (west coast), Canada, USA (Alaska), and the Russian Federation. In the west, the data will be split at 150°E. For the 2010 POWER survey, the existing stratum boundary at 47°N can be used.

(2) Of the JARPN II research area, common minke whale sub-area 7 belongs to the sei whale western coastal region, while sub-areas 8 and 9 belong to the pelagic region. For the JARPN II data, separate estimates will be used for the periods 2002-07 and 2008-12. Within each time period and sub-region, the data will be pooled across years and months. Hakamada will provide the estimates, either using the existing estimates or a new analysis.

(3) The JARPN data (1994-1999) are unsuitable for a stratified estimate. They will only be used if a model-base estimate is produced.

(4) Cooke will conduct a multiple regression analysis of the JSV and research survey data by 10° square, to be used as relative or approximate absolute abundance. Currently, only data for 1965-2005 are held on file. Miyashita offered to supply post-2005 data summaries.

(5) The data to be used are listed in Table 1. The intersessional group will supply input data for the assessment to Punt in useable form by Jan 1, 2018. Results of analyses need to be received by the intersessional group by December 1, 2017 if they are to be used in the assessment.

Table 1

Sightings data sets to be used in North Pacific sei whale in-depth assessment.

Survey area	Programme	Years of surveys	Range of months	In IWC database	Years of estimates/ data used	Area n.mile²	Sei sightings *n*	Effort *L*nm	Estimate	CV	Extraction	Reference/paper
North Pacific E of 170°E, Aleutian and Gulf of Alaska (coast out to 47°N or 200 n.miles)	IWC-POWER cruises	2010-12	Jul.-Aug.	Yes	2010-12	574,614	4	1,983	707	0.420	Add across years by stratum	Hakamada and Matsuoka (2015), Table 10
North Pacific pelagic north of 40°N, 170°E-135°W	IWC-POWER cruises	2010-12	Jul.-Aug.	Yes	2010-12	1,463,773	254	6,340	26,490	0.236	Add across years by stratum	Hakamada and Matsuoka (2015), Table 10
North Pacific 20°-40°N, 170°E - 135°W	IWC-POWER cruises	2013-16	Jul.-Aug.	Yes	-	2,800,000	2	12,259	~200	-	Take esw from above	IWC (2017, pp.461-75); SC/67a/ASI9
North Pacific	Japanese scouting vessels (commercial and chartered) and NRIFSF surveys	1964-2015	May-Oct.	No	1965-2005	By 10° square	3,607	1,338,044	-	-	Multiple regression by 10° sq by year	Wada (1973; 1975-81); Anon. (1981-95); Kato (1996-2003); Kato and Iwasaki (1998); Kato and Miyashita (2004; 2005); Miyashita and Kato (2006)
Coast of Japan	JARPN II (coastal)	2002-16	Apr.-Oct.	Yes	2007-16	-	0	57,664	0	-	-	SC/67a/SCSP03
Coast of Japan to 150°E	JARPN	1994-99	May-Sep.	Yes	1994-99	166,306	8	-	Model-based estimate, if available in time			Matsuoka *et al.* (2000)
	JARPN II (offshore)	2002-07	May-Aug.	Yes	2002-07		To be supplied				Pool across years and months (subarea 7)	Hakamada *et al.* (2009)
	JARPN II (offshore)	2008-12	May-Aug.	Yes	2008-12							Hakamada and Matsuoka (2016)
Western North Pacific 150°-170°E, 35-50°N, excl. Russian EEZ	JARPN II (offshore)	2002-07	May-Aug.	Yes	2002-07	662,044	To be supplied				Pool across years and months by subareas (8 and 9)	Hakamada *et al.* (2009)
	JARPN II (offshore)	2008-12	May-Aug.	Yes	2008-12							Hakamada and Matsuoka (2016)
	JARPN	1994-99	May-Sep.	Yes	1994-99	662,044	135	-	Model-based estimate, if available in time			Matsuoka *et al.* (2000)
Canada west coast	-	2004-05	Summer	No	-	7,183	1	1,286	~10	-	Not necessary	Williams and Thomas (2007)
Canada west coast	DFO	2002-14	Mainly spring, summer	No	-	~50 000	0	8,705	~0	-		Ford *et al.* (2010)
SE Bering Sea	MML	1999-2011	Summer	No	-	98,361	9	13,750	<100	-		Friday *et al.* (2012; 2013)
Gulf of Alaska	GOALS	2009-15	Summer	No	-	73,424	1	4,674	~10	-		Rone *et al.* (2017)
Alaskan Peninsula, E, Aleutians	Various	2001-03	Summer	No	-	-	0	4,886	0	-		Zerbini *et al.* (2006)
US west coast EEZ	SWFSC	1991-2014	Summer and fall	No	2008, 2014	332,538	25	38,922	519	0.40	Published estimate	Barlow (2016)

REFERENCES

Anonymous. 1981. Japan. Progress report on cetacean research, June 1979-May 1980. *Rep. int. Whal. Commn.* 31: 195-200.

Anonymous. 1982. Japan. Progress report on cetacean research, June 1980 to May 1981. *Rep. int. Whal. Commn.* 32: 179-83.

Anonymous. 1983. Japan. Progress report on cetacean research, June 1981 to May 1982. *Rep. int. Whal. Commn.* 33: 213-20.

Anonymous. 1984. Japan. Progress report on cetacean research, June 1982 to May 1983. *Rep. int. Whal. Commn.* 34: 203-09.

Anonymous. 1985. Japan. Progress report on cetacean research, June 1983 to April 1984. *Rep. int. Whal. Commn.* 35: 168-71.

Anonymous. 1986. Japan. Progress report on cetacean research, May 1984 to May 1985. *Rep. int. Whal. Commn.* 36: 158-61.

Anonymous. 1987. Japan. Progress report on cetacean research, June 1985 to April 1986. *Rep. int. Whal. Commn.* 37: 172-75.

Anonymous. 1988. Japan. Progress report on cetacean research, May 1986 to May 1987. *Rep. int. Whal. Commn.* 38: 194-98.

Anonymous. 1989. Japan. Progress report on cetacean research, June 1987 to April 1988. *Rep. int. Whal. Commn.* 39: 201-04.

Anonymous. 1990. Japan. Progress report on cetacean research, May 1988 to April 1989. *Rep. int. Whal. Commn.* 40: 198-201.

Anonymous. 1991. Japan. Progress report on cetacean research, May 1989 to May 1990. *Rep. int. Whal. Commn.* 41: 239-43.

Anonymous. 1992. Japan. Progress report on cetacean research, June 1990 to March 1991. *Rep. int. Whal. Commn.* 42: 352-56.

Anonymous. 1993. Japan. Progress report on cetacean research, April 1991 to May 1992. *Rep. int. Whal. Commn.* 43: 277-84.

Anonymous. 1994. Japan. Progress report on cetacean research, June 1992 to March 1993. *Rep. int. Whal. Commn.* 44: 222-27.

Anonymous. 1995. Japan. Progress report on cetacean research, April 1993 to March 1994. *Rep. int. Whal. Commn.* 45: 239-44.

Barlow, J. 2016. Cetacean abundance in the California Current estimated from ship-based line-transect surveys in 1991-2014. *Southwest Fisheries Science Center Administrative Report* LJ-16-01: 67pp.

Ford, J.K.B., Abernethy, R.M., Phillips, A.V., Calambokidis, J., Ellis, G.M. and Nichol, L.M. 2010. Distribution and relative abundance of cetaceans in western Canadian waters from ship surveys, 2002-2008. *Can. Tech. Rep. Fish. Aquat. Sci.* 2913: 51pp. [Available from: *http://www.dfo-mpo.gc.ca/Library/343183.pdf*].

Friday, N.A., Zerbini, A.N., Waite, J.M. and Moore, S.E. 2012. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: 1999-2004. *Deep-Sea Res. II* 65-70: 260-72.

Friday, N.A., Zerbini, A.N., Waite, J.M. and Moore, S.E. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the Bering Sea shelf in June and July of 2002, 2008 and 2010. *Deep-Sea Res. II* 94: 244-56.

Hakamada, T. and Matsuoka, K. 2015. Abundance estimate for sei whales in the North Pacific based on sighting data obtained during IWC-POWER surveys in 2010-2012. Paper SC/66a/IA12 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 12pp. [Paper available from the Office of this Journal].

Hakamada, T. and Matsuoka, K. 2016. The number of the western North Pacific common minke, Bryde's and sei whales distributed in JARPNII Offshore survey area. Paper SC/F16/JR12 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Hakamada, T., Matsuoka, K. and Miyashita, T. 2009. Distribution and the number of western North Pacific common minke, Bryde's, sei and sperm whales distributed in JARPN II offshore component survey area. Paper SC/J09/JR15 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2017. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 7-9 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:459-76.

Kato, H. 1996. Japan. Progress report on cetacean research April 1995 to April 1996. *Rep. int. Whal. Commn.* 46: 255-61.

Kato, H. 1997. Japan. Progress report on cetacean research, April 1995 to April 1996. *Rep. int. Whal. Commn.* 47: 342-49.

Kato, H. 1998. Japan. Progress report on cetacean research May 1996 to April 1997. *Rep. int. Whal. Commn.* 48: 329-37.

Kato, H. 1999. Japan. Progress report on cetacean research, April 1998 to March 1999. Paper SC/51/ProgRep Japan presented to the IWC Scientific Committee, May 1999, Grenada, West Indies (unpublished). 19pp. [Paper available from the Office of this Journal].

Kato, H. 2000. Japan. Progress report on cetacean research, April 1999 to April 2000. Paper SC/52/Prog.Rep.Japan presented to the IWC Scientific Committee, June 2000, in Adelaide, Australia (unpublished). 22pp. [Paper available from the Office of this Journal].

Kato, H. 2001. Japan. Progress report on cetacean research May 2000 to May 2001. Paper SC/53/ProgRep Japan presented to the IWC Scientific Committee, July 2001, London (unpublished). 12pp. [Paper available from the Office of this Journal].

Kato, H. 2002. Japan. Progress Report on cetacean research June 2001 to April 2002. Paper SC/54/ProgRep Japan presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Kato, H. 2003. Japan. Progress report on cetacean research, May 2002 to March 2003. Paper SC/55/ProgRep Japan presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 16pp. [Paper available from the Office of this Journal].

Kato, H. and Iwasaki, T. 1998. Japan. Progress report on cetacean research May 1997 to March 1998. Paper SC/50/ProgRepJapan presented to the IWC Scientific Committee, April 1998 (unpublished). 18pp. [Paper available from the Office of this Journal].

Kato, H. and Miyashita, T. 2004. Japan. Progress report on cetacean research, April 2003 to April 2004. Paper SC/56/ProgRep Japan presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 15pp. [Paper available from the Office of this Journal].

Kato, H. and Miyashita, T. 2005. Japan. Progress report on cetacean research, May 2004 to April 2005. Paper SC/57/ProgRep Japan presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 14pp. [Paper available from the Office of this Journal].

Matsuoka, K., Hakamada, T., Fujise, Y. and Miyashita, T. 2000. Distribution pattern of minke whales based on sighting data during the JARPN 1994-1999. Paper SC/F2K/J16 presented at the JARPN Review Meeting, 7-10 February 2000 (unpublished). 17pp. [Paper available from the Office of this Journal].

Miyashita, T. and Kato, H. 2006. Japan. Progress report on cetacean research, May 2005 to April 2006, with statistical data for the calendar year 2005. Paper SC/58/ProgRep Japan presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 11pp. [Paper available from the Office of this Journal].

Rone, B., Zerbini, A., Douglas, A., Weller, D.W. and Clapham, P. 2017. Abundance and distribution of cetaceans in the Gulf of Alaska. *Mar. Biol.* 164: 1-23.

Wada, S. 1973. Index of abundance of large-sized whales in the North Pacific in 1973 whaling season. *Rep. Int. Whal. Commn.* 26: 129-65.

Wada, S. 1975. Report of the Scientific Committee, Annex L. Indices of abundance of large-sized whales in the North Pacific in 1973 whaling season. *Rep. int. Whal. Commn.* 25: 129-65.

Wada, S. 1976. Indices of abundance of large-sized whales in the North Pacific in the 1974 whaling season. *Rep. int. Whal. Commn.* 26(2): 382-91.

Wada, S. 1977. Indices of abundance of large-sized whales in the North Pacific in the 1975 whaling season. *Rep. int. Whal. Commn.* 27: 189-94.

Wada, S. 1978. Indices of abundance of large-sized whales in the North Pacific in the 1976 whaling season. *Rep. int. Whal. Commn.* 28: 319-24.

Wada, S. 1979. Indices of abundance of large sized whales in the North Pacific in the 1977 whaling season. *Rep. int. Whal. Commn.* 29: 253-64.

Wada, S. 1980. Japanese whaling and whale sighting in the North Pacific 1978 season. *Rep. int. Whal. Commn.* 30: 415-24.

Wada, S. 1981. Japanese whaling and whale sighting in the North Pacific 1979 season. *Rep. int. Whal. Commn.* 31: 783-92.

Williams, R. and Thomas, L. 2007. Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. *J. Cetacean Res. Manage.* 9(1): 15-28.

Zerbini, A.N., Waite, J.M., Laake, J.L. and Wade, P.R. 2006. Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. *Deep-Sea Res. I* 53: 1772-90.

Annex G

Report of the Sub-Committee on Northern Hemisphere Whale Stocks

Members: Brownell (Convenor), Baba, Baker, Bell, Brandão, Brownell, Burkhardt, Butterworth, Cerchio, Cholewiak, Cipriano, Clapham, Cooke, Cubaynes, de Freitas, Donovan, Double, Enmikau, Filatova, Fortuna, Fretwell, Funahashi, Givens, Goodman, Goto, Gunnlaugsson, Haug, Herr, Holm, Hubbell, Iñíguez, Isoda, Ivashchenko, Jackson, Johnson, Kato, Kim, Kitakado, Konan, Lang, Leslie, Lundquist, Mallette, Mate, Matsuoka, Mattila, Miyashita, Mizroch, Moore, Morita, H., Morita, Y., Moronuki, Murase, Nakamura, Øien, Palka, Pampoulie, Panigada, Park, Punt, Redfern, Reeves, R., Reeves, S., Robbins, Rodriguez-Fonseca, Rojas-Bracho, Rosel, Rosenbaum, Santos, Sirović, Slugina, Stimmelmayr, Taguchi, Tamura, Thomas, Urbán, Víkingsson, Wade, Walløe, Walters, Weinrich, Weller, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Brownell welcomed participants.

1.2 Election of Chairs
Brownell was elected Chair.

1.3 Appointment of Rapporteurs
Weller was appointed to act as rapporteur.

1.4 Adoption of agenda
The adopted agenda is given in Appendix 1.

1.5 Review of available documents
The documents available for discussion by the sub-committee included SC/67a/NH01-12.

2. NORTH PACIFIC BLUE WHALES

SC/67a/NH01 reports on the preliminary analysis of a year (2012) of low frequency acoustic data collected by seismometers off Hokkaido, Japan. The data were made available by Japanese colleagues. The authors of the paper identified a call type that is likely to be produced by blue whales but is different from those previously reported in the northwestern Pacific. This call is referred to as the 'Japan-type song' and occurred during the summer and in the autumn and winter. The northwestern Pacific blue whale song was also detected at the site during summer and autumn, with peak occurrence in August.

In discussion it was explained that the main differences between Japan-type song and northwestern Pacific blue whale song were in duration of units and overall complexity of song structure. Namely, the Japan-type song consisted of multiple and longer units while northwestern Pacific song consists of simple tonal structure. It was acknowledged that the spectrograms presented in the SC/67a/NH01 are not the best representatives of the song structure. It was further stated that this work was a preliminary analysis and a more comprehensive analysis of both song types is planned for the future.

It was noted that Japanese scientists examined the same acoustic dataset (Sugioka *et al.*, 2015) but they were unable to find the Japan-type blue whale song. However, Sugioka *et al.* (2015) did find the Japan-type blue whale call in the data and provided a spectrogram of a calling sequence in figure 2 of their paper. Therein, Sugioka *et al.* (2015) referred to this signal as an 'unidentified type' of fin whale signal that mimics a seasonal occurrence similar to that of the Japan-type blue whale calls. Thus, it appears that Sugioka *et al.* (2015) did not identify the Japan-type blue whale call since it was previously unpublished. The features of the Japan-type calls have a long duration and low frequency, as well as long (~1 min) inter-call intervals; all indicating this is likely to be a blue whale signal, as proposed in SC/67a/NH01, rather than a fin whale call.

SC/67a/NH02 summarises previously published information regarding the occurrence of blue whale songs across the North Pacific. The northeast Pacific song type is commonly recorded along the west coast of North America. The northwestern Pacific song type is commonly recorded in the central and western North Pacific. The two songs overlap in the Gulf of Alaska as well as lower latitude areas of the central North Pacific. In the recordings from the 1990's, the two song types co-occurred temporally at high latitudes, while recently (since 2010) there is a temporal separation between them. The northwestern Pacific song type occurs in the early summer (July) and northeastern in late summer and through the autumn (August through December).

It was noted that in the Gulf of Alaska, the northeast Pacific song type was detected more often than the northwest Pacific song type, while both were rare at lower latitude locations. Environmental conditions over the time-series that may influence this pattern have yet to be examined.

Rone *et al.* (2016) provided information on blue whales observed from sighting surveys in the Gulf of Alaska in 2009, 2013 and 2015. Blue whales were sighted only in 2013 (5 sightings of 7 animals) and 2015 (13 sightings of 13 animals). Most sightings were offshore, including in the seamount stratum of the surveys. Although the frequency of sightings was higher than in previous years, this may be explained by lack of earlier effort; alternatively, the results might indicate that this species is returning to previous habitats in the Gulf of Alaska. The surveys produced estimates of abundance for 2013 and 2015 (both approximately 60), but these estimates had low precision.

The intersessional email group (Branch [Convenor], Brownell, Donovan, Ivashchenko, Kato, Lang, Matsuoka, Mizroch, Rosenbaum, Širović, Suydam) on data available for an assessment of North Pacific blue whales had the following five priority action items: (1) obtain abundance estimates from the IWC-POWER surveys; (2) obtain abundance estimates from the JARPN and JARPNII surveys; (3) analyse and compare genetic samples from ENP, IWC-POWER, and ICR biopsy samples to determine stock structure throughout the North Pacific; (4) comparison of photo-identification catalogues between IWC-POWER, Cascadia Research Collective and other ENP catalogues and JARPN/JARPNII catalogues; and (5) review new acoustic locations and information. The following section provides updates on progress made to date on these five priority items.

(1) The IWC Pacific Ocean Whale and Ecosystem Research (IWC-POWER) surveys were designed and conducted to cover the large region from 170°E longitude to 135°W and north of 20°N over the period from 2010 to 2016 as line transect cetacean sighting survey in the Central and Eastern North Pacific. A total of 18 blue whale groups, all containing a single individual, were sighted in the research area and sightings were spread throughout the survey area. Some photo-identification photographs and nine biopsy samples were collected. Details of the results are reported as SC/67a/ASI09 for the 2016 cruise and SC/67a/Rep02 for the summary of results between 2010 and 2016. Abundance estimate of IWC-POWER surveys for blue whales is planned by the Tokyo University of Marine Science and Technology, and progress of this analysis will be reported to the SC/67b meeting.
(2) Abundance of blue whale in the western North Pacific distributed in early and late seasons in the JARPNII offshore component were estimated based on 2008-14 JARPNII dedicated sighting survey data. The estimates were 38 (in 2009) and 161 (in 2011 and 2012) in the May to June, and 958 (in 2008) in July to August for blue whales. Abundance estimates from the JARPN and JARPNII surveys were reported to the Scientific Committee in 2014. An updated estimate is expected to be ready for SC/67b.
(3) Analysis is ongoing and a report of results is expected to be ready for SC/67b. The NH sub-committee encouraged the inclusion of any recent ICR samples to the ongoing US-Japan project on stock structure.
(4) No further comparisons have been completed in the past year. The 2015 report of the IWC-POWER planning workshop provides information on the status of photo-identification catalogue comparisons completed to date and an update to this is expected to be ready for SC/67b. The NH sub-committee suggested that photo-identification images from IWC-POWER be provided to Happywhale (SC/67a/PH02) to increase the efficiency by way of automation of catalogue comparisons.
(5) The next year of blue whale song analysis will conduct quantitative analysis of the song variability found in the northeastern Pacific (Širović *et al.*, 2016) to test if we can develop an objective measure of song variability. Additionally, data from the Philippine Sea, for which there is currently no information, has been sourced and these data will be analysed for the occurrence of blue whale songs.

The sub-committee welcomed the update from this intersessional email group (appointed in 2015) and **encouraged** the group to continue its work under the leadership of Branch on the five priority items listed above.

3. NORTH ATLANTIC SEI WHALES

Cholewiak provided an update on recent passive acoustic data collected by the NOAA Northeast Fisheries Science Center that provide new insights into sei whale acoustics and distribution. Two studies were described. In the first, two high-frequency acoustic recording packages (HARPs) that were deployed along the shelf break of Georges Bank, US, were analysed for the presence of sei whale downsweeps. Preliminary results support current understanding of sei whale occurrence in spring months, but also indicate at least a low level of presence in these waters in winter. Peak detections occurred at these sites in late October and late December. These are the first data on winter occurrence for this species, and provide information on species distribution not currently captured in the visual-based surveys. The second study uses an array of marine autonomous recording units (MARUs) to localise and track sei whales in Massachusetts Bay. This study documents and characterises three types of vocalisations that have not been previously described, providing new vocalisations that may be used for passive acoustic monitoring efforts of this species.

4. NORTH ATLANTIC RIGHT WHALES

In 2016, the Scientific Committee recommended that a comprehensive update on North Atlantic right whales be submitted in 2017. It was requested that this update include recent findings from ongoing research on distribution, mortality and calving for all range states including Iceland, as well as information on mitigation measures that are occurring in both US and Canadian waters, including measures proposed to mitigate the potential effects of future geological and geophysical seismic surveys. Multiple papers published in recent years have given cause for concern regarding the status of this population. Palka reported that a workshop aimed to develop a comprehensive update on North Atlantic right whales was scheduled for March 2017 but was cancelled due to a major snow storm on the US east coast. In lieu of the comprehensive update requested in 2016, Palka reported that staff members of the Northeast Fisheries Science Center (NEFSC) had developed a Bayesian state-space implementation of a Jolly-Seber mark-recapture model which will estimate abundance and survival over the period 1990-2015 and have submitted this work for publication. It was mentioned that a usually low number of calves (n=5) were recorded in 2017. Further, of the diagnosed mortalities of right whales between 2010 and 2015, 85% were attributed to bycatch/entanglements and 15% to ship strikes (Kraus *et al.*, 2016). These numbers stand in contrast to records from 1970 to 2009 that reported 35% of diagnosed right whale mortalities were due to bycatch/entanglements and 44% due to ship strikes. While the combination of shipping lane changes and ship speed reductions appear to have significantly reduced the number of ship strikes on right whales (Laist *et al.*, 2014), modifications of fishing gear have not resulted in an observed decrease in series injuries and mortalities (Pace *et al.*, 2014). Appendix 2 provides an updated summary on North Atlantic right whales provided by the NEFSC.

In discussion of Appendix 2, the sub-committee was informed that NOAA Northeast Fisheries Science Center is analysing passive acoustic data collected along the US eastern seaboard from 2006 to present, with data collected prior to 2015 being contributed by 19 collaborators. This project is examining the occurrence and movements of North Atlantic right whales, comparing patterns prior to and post 2010. Acoustic data indicated decreased time spent in 'typical' habitats such as the Gulf of Maine post-2010 and increased presence in regions between New York and North Carolina. These analyses also examine right whale distribution with respect to distance from shore to evaluate time spent in high-risk areas.

Finally, Rosenbaum provided new information about previously unreported increases in the number of right whales in the New York Bight, as well as acoustic detections of right whale calls prior to 1 November in proximity to New York Harbor. These acoustic detections raise concern that right whales are present prior to when an annual Seasonal Management Area is in effect from 1 November-1

April at the entrance to New York Harbor. This Seasonal Management Area requires ships to slow to 10 knots in an effort to avoid striking a right whale.

Because the comprehensive update on North Atlantic right whales requested in 2016 was not submitted this year, the sub-committee **encourages** the USA to submit this update to the 2018 meeting of the Scientific Committee.

5. NORTH PACIFIC RIGHT WHALES

SC/67a/NH07 summarised sighting data on North Pacific right whales sighting in the western North Pacific collected by the Institute of Cetacean Research (ICR: 1994-2016, from April to September) and the National Research Institute of Far Seas Fisheries (NRIFSF: 1982-2011, from January to December including recent Japanese and Russian joint cruise data). About 600,000 n.miles were surveyed; maps of the Density Index (DI: individuals/100 n.miles) by 1° x 1° square are provided. North Pacific right whales were mainly distributed north of 42°N, including 10 mother-calf pairs. High density areas were observed north of 46°N in the far southeast Kamchatka region and in the Okhotsk Sea. Surface temperature in the location of the sightings ranged from 2.7 to 16.6°C.

In discussion, it was asked if the lack of sightings in the Sea of Japan was a function of effort during the right time of year. While search effort is low, no other ancillary data (strandings, bycatch) are available from the Sea of Japan. In the 1970s and 1980s search effort in the Sea of Japan was more intensive yet no right whales were encountered. However, most of the effort in the Sea of Japan has occurred at the wrong time of year to find right whales. In February 2015, a right whale was released alive from a fishing net off South Korea.

The sub-committee welcomes this report in response to its previous recommendation, encourages the authors to generate a population abundance estimate from the existing ICR and NRIFSF data, and looks forward to receiving this estimate in the near future. Further, the sub-committee **recommends** that a comparison be made as soon as feasible of the photo-identification catalogue of whales in the western North Pacific to catalogues of whales sighted off Russian, the US and Canada.

SC/67a/NH04 summarises recent sightings of western North Pacific right whales mainly in Russian coastal waters. In recent years, an increasing number of sightings have been made but it is not clear whether these can be attributed to an actual increase in the number of whales or if it is an artifact of increased search effort. A collaboration of researchers has compiled all known information on recent sightings of western North Pacific right whales and created a catalogue of individually identified whales. On the basis of these records it is hypothesised that there are coastal 'hot spots' that have a higher likelihood of encountering right whales and may therefore be regarded as potentially important parts of the feeding grounds along the Russian coast. The photo-identification catalog currently contains 17 individuals and efforts to collect additional photographs are being continued, with a proposed plan to create an online dynamic version of the database and catalogue. The catalogue of whales from Russian waters has been compared with the catalogue from the eastern North Pacific right whale catalogue (NOAA Alaska Fisheries Science Center), and no matches were found. It is crucial to consolidate international efforts to compare identified whales from different catalogues in order to get a better understanding of movements of the animals between various parts of the range. The most important step in such a collaboration would be for Russian and Japanese scientists to compare their photo-catalogues and sighting and stranding records because they complement each other by covering offshore and inshore waters of the North Pacific right whale range.

In discussion, it was mentioned that it would be of interest to examine the region off southern Kamchatka shown in Fig.1 as a function of month to look for seasonal movements/timing of whales moving from the WNP into the Okhotsk Sea. Most of the sighting effort off southern Kamchatka has occurred in July and August; more data from the May to June period would benefit this suggested analysis.

During the past 20 years, the Commander Islands has represented a stranding 'hot spot'. The Commander Islands have traditionally had high search effort which may explain the high number of strandings reported there. However, high search effort has also been conducted off eastern Kamchatka in Avacha Bay but there, only one sighting of a right whale sighting has been reported.

In summary, the sub-committee highlights the importance of cross-matching photo-identification catalogues from the Okhotsk Sea (Russia), western North Pacific (Japan) and the eastern North Pacific (US/Canada) and **recommends** that this exercise be completed as soon as feasible. It is further **recommended** that genetic samples from the aforementioned areas be compared. Lang reported that a collaboration with Pastene was underway. MtDNA sequence data published in Leduc *et al.* (2012) from the eastern North Pacific have been shared with Pastene, so that this data can be integrated with the whales sampled in the western North Pacific for a basin-wide study.

SC/67a/NH08 summarised the results of an acoustic-based study of North Pacific right whales (NPRW) in the Bering Sea. Passive acoustic recorders were deployed year-round between 2008 and 2016 at 11 locations ranging from Unimak Pass to the Bering Strait. Major results included: that NPRWs occurred in Unimak Pass; that NPRW calling occurred at consistently high levels in the southeastern Bering during ice-free months; that the summer distribution of NPRWs may range as far north as the Bering Strait; and that NPRWs may have occurred in the northern Bering Sea during winter months. The Unimak Pass finding is concerning given the pervasive vessel noise recorded throughout the study period and the assumed use of the pass as a migratory corridor into the Gulf of Alaska; a single mortality of NPRW from ship interaction would represent a major reduction to this critically endangered population. Additionally, the potential presence of NPRWs at northern locations in winter months suggests a more complicated life history strategy than previously thought for NRPWs.

In discussion, it was clarified that the Great Circle route taken by vessels traveling to and from North America and Asia transited through Unimak Pass. It was noted that some acoustic recorders have been placed in the Gulf of Alaska but that very few right whales had been detected there.

Rone *et al.* (2016) reported data from three surveys of the northwestern Gulf of Alaska in 2009, 2013 and 2015. These were conducted April (2009), June/July (2013), and August/September (2015). The two earlier surveys were conducted in an area east of Kodiak used by the US Navy for naval exercises; the 2015 survey included an area east and south of Kodiak where extensive Soviet illegal catches were made in the 1960's. The visual surveys were supplemented by acoustic monitoring using a towed array (2009 and 2013), and sonobuoys (2013 and 2015). No right whales were sighted on any of the surveys; acoustic detections were made in the Barnabas Trough area off Kodiak in 2013 and 2015, but the calling animals could not be located. The results of this work strongly support the belief that right whales are now extremely rare the Gulf of Alaska, a region in which the species was historically abundant and widely distributed.

In discussion, it was suggested that the timing of these surveys was somewhat out of phase with the May-June whaling operations in the Gulf of Alaska and that may explain the absence of right whales during the surveys. Clapham noted that this related only to the timing of the Soviet catches, and that the Townsend (1935) charts indicate a much broader temporal distribution in the Gulf, from spring into autumn, including the months in which the surveys were conducted. Finally, Brownell reported a recent sighting from April 2017 off San Diego, California. This sighting provides further evidence that the wintering area(s) of at least some North Pacific right whales are in southern waters somewhere in the eastern North Pacific.

6. NORTH PACIFIC FIN WHALES

Rone *et al.* (2016) provided information on fin whales observed from sighting surveys in the Gulf of Alaska in 2009, 2013 and 2015. Fin whales were the most frequently sighted large whale in 2009 and 2013; in all three surveys fin whales were observed in both inshore and offshore waters, but with higher concentrations inshore. Overall, the results suggest that fin whales are increasingly common within the former whaling grounds of the Gulf of Alaska; it is not clear whether the apparent shift to an inshore distribution is real, or a function of sighting effort. Abundance estimates were calculated for fin whales in 2013 and 2015.

Širović reported that NOAA Fisheries and SIO have been conducting analysis of fin whale song patterns in southern California and the Gulf of California, Mexico, from data collected since 2001, and in recordings collected at low latitudes across central and western Pacific since 2009. Complexity and variability in song patterns have been observed and results from this work are anticipated to be ready for review at SC/67b. In addition, Kato reported that research on fin whale calls in the western North Pacific are being analysed and have shown seasonal changes in occurrence, with peak call rates observed in October. A report on these results is expected to be presented at SC/67b.

Lang reported that Eric Archer at Southwest Fisheries Science Center (NOAA Fisheries) is conducting a global review of fin whale taxonomy with a focus on describing North Pacific fin whales as a separate subspecies from those in the North Atlantic. The sample set consists of mitochondrial DNA control region sequences from approximately 400 samples ranging from the Chukchi and Bering Seas, the Aleutians and Gulf of Alaska and south to Baja California. However, no samples are currently available from fin whales in the East China Sea (ECS). It is important to include this population in the analysis as previous immunogenetic studies by Fujino (1960) and morphological analysis by Ichihara (1957) indicate that ECS fin whales are significantly different from fin whales off northern Japan and the Aleutian Islands. Thus, ECS fin whales may be different enough to constitute a separate subspecies of their own but comparisons of genetic differentiation of ECS and other North Pacific fin whales is needed to complete the understanding of their taxonomic status.

7. OMURA'S WHALE

SC/67a/NH12 summarised the distribution of known reports of Omura's whales since the species was description by Wada *et al.* (2003), in an effort to establish the known range and start to assess its range-wide threats. Documentation from published papers, unpublished reports, and web-based accounts, each verified by the authors, was compiled. Verification of records conducted using methods for diagnosing the species as follows. Genetic – following Wada *et al.* (2003); skull morphology – following Wada *et al.* (2003) and Yamada's several publications; photographic (including video) – following Cerchio *et al.* (2015); acoustic – following Cerchio *et al.* (2015); visual report – through a reported description when corroborated with another verification method in the same general locale.

A total of 116 reports were compiled, some involving multiple individuals, at 58 locations plotted on a range-wide map. Our understanding of the biology of Omura's whale has progressed substantially since the publication of Wada *et al.* (2003). After the publication of a detailed species description from Madagascar, the rate of new reports increased precipitously between 2015 and 2017 resulting in a marked expansion of the species' range and it is known from all ocean basins with the exception of the eastern Pacific. The majority of records remain in the Indo-Pacific region, but most recently reports in the western Indian Ocean are steadily increasing. The presence of Omura's whales in both the North and South Atlantic has been documented through a single stranding in Mauritania and a single stranding on Brazil. However, Atlantic records remain rare; it is as yet unclear whether this is consequence of less effort to identify the species it this part of its range, or whether it is actually less abundant in the Atlantic Ocean. It is possible that further discoveries will indicate a global tropical/sub-tropical distribution. All records occur between the latitudes of 35°N and 35°S, with 79% falling within the true tropics between 23.5°N and 23.5°S.

There is a strong tendency of this species to be distributed in coastal and shallow waters. Given this distribution, the species is in particular risk of anthropogenic interactions and threats as compared to oceanic balaenopterids. Thus, we expect that Omura's whale populations have a relatively high probability of impact from entanglement and bycatch in local fisheries, ship strikes, ocean noise and coastal development and industry. The only population presently under study is the Madagascar population; all other populations are known from single examples or strandings. If the current characterisation of the species as known from the Madagascar study bears out range-wide as consisting of small, localised populations with low genetic diversity, it would make them particularly vulnerable to such anthropogenic impacts that would cause small populations to decline. The distribution of the species in typically remote and poorly surveyed regions exacerbates the problem, in that both occurrence of interactions and magnitude of impacts is difficult to impossible to document. Documented mortalities include ship strikes and fisheries bycatch, and there exist clear threats from coastal development and industry.

The sub-committee thanked Cerchio and his colleagues for their dedication in bringing forward this important new information and its related contribution to raising awareness of this poorly known species.

Cerchio reported on new findings on northwest Madagascar Omura's whales. Since publication of Cerchio *et al.* (2015) on the detailed physical description and ecology of a population of Omura's whale, substantial work has been conducted in 2015 and 2016. During November 2015 and November/December 2016, there were 83 and 119 encounters with Omura's whales, respectively, bringing the current total to 246 encounters when added to the 44 documented from 2011 to 2014. Loose aggregations of whales were encountered on many days with the largest documented involving at minimum 12 different individuals photographed over a three-hour period in an area that measured 2 x 5km. Over the course of the two seasons 10 different mother-calf pairs were identified, five in each year.

Passive acoustic monitoring from December 2015 to November 2016 using four archival recorders indicated Omura's whale song present on all recorders with some spatial and temporal heterogeneity evident. Omura's whale song was present in all but one week of the deployment between December 1, 2015 and November 10, 2016. This is strong evidence for the year-round residency of the Omura's whale population off northwestern Madagascar.

Feeding was frequently observed in both field seasons, involving both surface and subsurface lunging and sampled prey was identified morphologically as *Pseudeuphasia latifrons*, a small, diurnal species that is known from shallow coastal waters throughout the Indo-Pacific, but had not been previously identified in the SWIO. During November-December 2016, four individuals were satellite tagged and transmitted for 30, 32, 50 and 57 days into late January 2017. All individuals ranged along a 380km stretch of coast, with the majority of positions located within 100km of the tagging site. All tagged individuals generally behaved similarly, moving back and forth across this range multiple times over the course of the tag duration, typically stopping for several days in 'hotspots', before moving on. Initial Switching State Space Models indicated a strong skew toward 'Area Restricted Search' or localised movement behavior. These movement data indicate a very restricted and local range for a baleen whale, at least during these two months, and together with the acoustic monitoring data, further supports that this is a local resident population.

de Vos (2017) reported on the first documentation of an Omura's whale off Sri Lanka. A small unusually pigmented baleen whale was documented off the southern coast of Sri Lanka in February 2017 during routine field surveys. Based on five distinct morphological characteristics including jaw asymmetry, presence of a prominent central rostral ridge, blaze on right side, asymmetrical chevron on left and right sides and a strongly falcate dorsal fin the individual was positively identified as an Omura's whale. This discovery represents the first confirmed sighting of Omura's whale in Sri Lankan and therefore central Northern Indian Ocean waters.

The sub-committee **welcomed** this substantial new information from northern Madagascar and the worldwide summary of new records of this poorly known species. Additional studies are **encouraged** throughout the species distribution, particularly in areas where research similar to that being conducted off Madagascar can be conducted. The sub-committee **recognises** the significant contribution the research efforts off Madagascar have made to our growing understanding of this species and **encourages** this work to be continued and expanded into the future.

8. NORTH ATLANTIC BRYDE'S WHALES

No new information was available to the sub-committee.

9. GULF OF MEXICO BRYDE'S WHALES

Rosel reported on recent work relating to Bryde's whales in the Gulf of Mexico (Rosel *et al.*, 2016). Bryde's whales are the only baleen whale species resident to the Gulf of Mexico (GOMx) and they are restricted to a small area mainly in the northeastern GOMx in waters along the continental shelf between 100 and ~500m. The population size in 2009 was estimated to be 33 (CV=1.07), before the *Deepwater Horizon* oil spill in 2010. Historically, the distribution may have been broader across the northern and southern GOMx (e.g. Bay of Campeche, Mexico) as whaling records report sightings and some takes of 'finback' whales which were likely GOMx (Bryde's) whales (Reeves *et al.*, 2011). However, shipboard surveys in US waters of the GOMx going as far back as the early 1990s have not documented GOMx whale sightings in the north central or western GOMx (Rosel *et al.*, 2016).

The population exhibits very low levels of genetic diversity and significant genetic mitochondrial DNA divergence from other Bryde's whales worldwide (Rosel and Wilcox, 2014). The level of genetic divergence between the GOMx whales and the recognised subspecies, *B. edeni edeni* and *B. e. brydei*, is equivalent to or greater than the level of divergence between the two subspecies themselves (Rosel and Wilcox, 2014). This level of divergence indicates that the GOMx whales represent a unique evolutionary lineage and that they should receive taxonomic status equivalent to that of the two currently recognised subspecies.

The small population size, restricted range and low genetic diversity alone place these whales at significant risk of extinction. Furthermore, the northern GOMx is a highly-industrialised body of water and energy (oil and gas) exploration and production, commercial fishing, and large port cities that support a significant shipping industry pose significant threats to the population (Rosel *et al.*, 2016). The preferred habitat of the GOMx whales falls within the Eastern Gulf of Mexico Planning Area (EPA) as defined by the U.S. Bureau of Ocean Energy and Management. While the majority of the EPA is under restriction from oil and gas leasing activities until 2022 as part of the GOMx Energy Security Act of 2006, the moratorium does not apply to activities on existing leases. There are 37 active leases within in the EPA as of May 1 2017. Seismic surveys are common in the northern GOMx and seismic survey and shipping noise are dominant components of low frequency, chronically elevated, ambient noise levels in the northern GOMx (Estabrook *et al.*, 2016). Vessel support for the oil and gas platforms relies heavily on medium-sized, fast moving vessels. Oil production brings the risk of oil spills.

The 2010 *Deepwater Horizon* oil spill resulted in surface oiling over 48% of the known Bryde's whale habitat. To quantify the long-term impacts of this oil spill to cetaceans in the Gulf of Mexico, a population model was run incorporating estimates of mortality, reproductive failure and adverse health effects due to oil exposure. The output of this model predicts the largest proportional decrease in population size as compared to a model run using baseline mortality and reproductive parameters of the population had it not been exposed to oil (DEWH NRDA Trustees, 2016). The model estimated a maximum 22% decline in population size for GOMx whales (DEWH NRDA Trustees, 2016). In addition, several dead stranded animals have been found with fishing gear attached.

A recent tagging study (Soldevilla *et al.*, In press) suggested these whales feed at or near the bottom during the day and spend a majority of the night within 15m of the surface. This diurnal pattern may increase the potential for interactions, particularly at night, with a bottom longline fishery that is active within the preferred habitat of these whales in the northeastern GOMx and make them vulnerable to vessel strikes during the day. There has been one documented vessel strike of an adult female whale in the GOMx in 2009 as well as two strandings in 2012, post-*Deepwater Horizon*.

The sub-committee **welcomed** this report and commended Rosel and her colleagues for bringing this issue to the attention of the Scientific Committee. In discussion, it was clarified that the most recent abundance estimate of 33 (CV=1.07) was obtained using standard visual line-transect methods during a 2009 large-vessel survey of the U.S. waters of the Gulf of Mexico. A second estimate, obtained by incorporating visual survey data collected between 1992 and 2009 to create density habitat models (and corrected for availability bias) is 44 (CV=0.27). It was noted that both of these estimates come from surveys conducted prior to the 2010 *Deepwater Horizon* oil spill and therefore do not account for the estimated associated 22% decline in the population size as a result of the spill. The sub-committee **welcomed** the report that a new vessel-based line transect survey would be conducted by NOAA in summer 2017 and encouraged maximising data collection (acoustic, photo-identification, biopsy) on Bryde's whales to the greatest extent possible.

While all recent confirmed sightings of Bryde's whales have been in the northeastern GOMx, whaling records indicate that historically Bryde's whales had a broader distribution that included waters in the north-central and southern GOMx (Reeves *et al.*, 2011). Although Bryde's whales in the GOMx are typically found east of the majority of oil and gas exploration and production, the *Deepwater Horizon* oil footprint included 48% of the Bryde's whale habitat in the northeastern GOMx. The damage assessment of this spill incorporated data on bottlenose dolphin mortality to model impacts on other marine mammals and this work served as the basis for the estimated 22% maximum decline in Bryde's whale population size as a result of the DWH spill (DEWH NRDA Trustees, 2016).

Leslie reported on an ongoing project to clarify balaenopteroid relationships (and subsequent taxonomy) by conducting a phylogenetic analysis of representatives of all known taxa using a large nuclear DNA data set. This research includes Bryde's whales (*Balaenoptera cf. edeni*) in the GOMx and a broader geographic sample of the pantropical Bryde's whales (*B. edeni brydei*).

The available evidence clearly demonstrates that this recently identified unnamed taxon, which ranks as at least a new subspecies and possibly a species, is critically endangered. Its precarious conservation status mimics that of the eastern North Pacific right whale population estimated to be about 30 whales. Among the most significant reasons for urgent concern are the following.

- This whale appears to have an extremely limited core range centered along the continental shelf break in the north-eastern Gulf of Mexico.
- The population has extremely low genetic diversity as reflected by mtDNA haplotypes and microsatellite data; its genetic diversity is among the lowest among baleen whale populations worldwide.
- The best estimate of total abundance is 33 individuals (CV=1.07) in 2009.
- It has been estimated that population abundance declined by a maximum of 22% following the catastrophic *Deepwater Horizon* oil spill in 2010.
- Although the core habitat area of these whales is not currently subject to oil and gas exploration and development, the whales' acoustic habitat is degraded by industrial activities throughout the Gulf of Mexico, there is potential for chronic oil pollution from such activity nearby, and the constant threat of catastrophic oil spills remains.
- Intensive ship traffic contributes to chronically high levels of anthropogenic underwater sound and creates an elevated risk of ship strikes.
- Commercial fishing (e.g. a large bottom-set longline fishery for sharks, snappers, and groupers) that occurs within and around the core habitat area creates the risk of entanglement to these whales.

The sub-committee made the following recommendations.

The sub-committee **recommends** that US authorities do the following.

- Make full and immediate use of available legal and regulatory instruments to provide the greatest possible level of protection to these whales and their habitat.
- Ensure that seismic surveys and associated activities that degrade acoustic habitat are excluded from the region of the eastern Gulf of Mexico inhabited by these whales, including an appropriate geographic buffer against acoustic impacts from activities in the Central Planning Area and active leases in the Eastern Planning Area.
- Characterise the degree of overlap between the whales' currently known preferred habitat and ship traffic, and immediately implement appropriate measures to reduce the risk of ship strikes (e.g. re-routing, speed restrictions).
- Based on the known distribution of these whales and overlap with certain fisheries, improve understanding of potential for interaction with fishing gear, and expand and implement appropriate measures, such as area closures, to reduce the risk of entanglement throughout their range.
- Develop and implement restoration projects (with funds from the Deepwater Horizon oil spill settlement) for these whales and their habitat as a priority and ensure that a robust monitoring and adaptive management plan is in place to evaluate the effectiveness of all restoration efforts.
- Design and conduct research programs (sighting surveys, acoustic monitoring, genetic mark-recapture, photo-identification if feasible, satellite tagging if feasible, health studies if feasible) to further investigate these whales' distribution, movements, habitat use, health, survival and fecundity. This should include efforts to better document the whales' total geographic range and to document causes of mortality through necropsies when carcasses are reported.
- Ensure that information about core known habitat and movements in the Gulf of Mexico is transmitted to the US Coast Guard, shipping industry trade organisations, and Gulf of Mexico port authorities (e.g. in Tampa, Florida) for their consideration to mitigate ship-strike risk.

In addition, the sub-committee **recommends** that the IWC Secretariat: (a) communicate the above concerns and recommendations to range state authorities; and (b) specifically explore in collaboration with the International Maritime Organization the feasibility of providing internationally recognised forms of protection to these whales (e.g. designation of an Area to be Avoided) that would reduce the risk of ship strike and help mitigate degradation of acoustic habitat by ship noise.

The sub-committee also **encourages** US and Mexican scientists to collaborate in efforts to determine whether any of these whales occur in Mexican waters in the western GOMx (e.g. Bay of Campeche) where a major oil spill of three million barrels occurred in 1979. This should include consideration of passive acoustics as well as visual surveys focusing on areas of habitat similar to that found in the core known range in the north-eastern Gulf. It was further noted that data from the northern coast of Cuba would be beneficial.

10. NORTH ATLANTIC BLUE WHALES

Širović informed the sub-committee of her efforts to assemble data on blue whale song occurrence in the North

Atlantic. Most data available are from the east coast of North America while very few data are available from the eastern North Atlantic. There appears to be only one blue whale song type in the North Atlantic, excluding Antarctic blue whale songs reported from low latitudes (SC/67a/SH10).

11. NORTH CENTRAL AND NORTHEASTERN PACIFIC COMMON MINKE WHALES

No new information was available to the sub-committee.

12. NORTH ATLANTIC HUMPBACK WHALES

The sub-committee was referred to a discussion in the Environmental Concerns SWG regarding an Unusual Mortality Event (UME) that was declared by the US National Marine Fisheries Service on 21 April 2017. Forty-three humpback whale (*Megaptera novaeangliae*) mortalities have been documented along the United States Atlantic coast from Maine to North Carolina between 1 January 2016 and 5 May 2017. Twenty-six mortalities were reported in 2016 and 17 mortalities were reported to date in 2017.

13. NORTH ATLANTIC BOWHEAD WHALES (NOT SUBJECT TO ASW)

No new information was available to the sub-committee.

14. NORTH PACIFIC BOWHEAD WHALES (NOT SUBJECT TO ASW)

SC/67a/NH10 applied an open-population mark-recapture model to genetic samples from bowhead whales in the western Okhotsk Sea, mainly from the Ulbanskiy Bay area with additional samples from Udskaya Bay. Data from two studies conducted during 1995-2000 and 2011-16 were combined. The pattern of recaptures indicated no tendency for individual site fidelity to the two bays, and the data were pooled. The best-fitting model based on the AIC criterion yields a survival estimate of 0.88 (SE=0.03) and a recruitment rate of 0.07 (SE=0.04), which results in an estimated population decline from 643 (CV=0.66) animals in 1995 to 218 (CV=0.22) animals in 2016. However, an open population model with constant population size of 258 (CV=0.20) was not definitely rejected ($p \approx 0.03$, one sided). Therefore, the population is probably declining, but not definitely so. The sub-committee recommended that monitoring of the Okhotsk Sea bowhead whale population resumes in 2018, so that it can be confirmed whether the decline is real and ongoing.

In discussion, it was noted that the 1995 population size and the recruitment rate could not be precisely estimated. The causes of the low survival rate and consequent probable population decline were unclear, but hunting and predation by killer whales was frequently observed, and it is possible that a shortening ice-cover season may result in the whales being exposed to killer whale predation earlier in the season and for longer periods of time. Harassment by tourist boats was also noted but it was unclear how or if this plays any role in the noted population decline. Bowheads are relatively uncommon in other areas but the collection of opportunistic biopsies would be informative for this assessment. To better understand if the observed decline in the population is true, additional data are needed.

15. NORTH PACIFIC SPERM WHALES

Rone *et al.* (2016) contained information on the occurrence and distribution of sperm whales in the northwestern Gulf of Alaska (south and east of Kodiak, including offshore waters), from three joint visual/acoustic surveys conducted in 2009, 2013 and 2015. Sperm whales were not sighted in 2009. In 2013, all sperm whale sightings occurred on the continental shelf break and slope with the exception of one sighting near a seamount.

In 2015, sperm whales occurred on the continental shelf break and slope within the inshore stratum and the pelagic waters and seamounts of the offshore strata, as well as in the 'historical high catch' (HHC) area south of Kodiak. The highest numbers occurred near the fin/humpback/unidentified large whale concentrations in the southern end of the HHC stratum. The disparity in sperm whale detections between 2009 and 2013 may be attributed to differences in seasons, inclement weather (for visual), a significantly reduced survey effort (2009), and location of realised effort. Analysis of former USSR catch records and other data shows females and immatures occurring in high latitudes a far as 60°N (Ivashchenko *et al.*, 2014); therefore, it cannot be assumed that there are no females within this area given the lack of contemporary survey effort. During 2015, a large group of 11 individuals including 1 calf were documented; no mature males were observed. This 2015 sighting demonstrates that both sexes and mixed age classes can occur in the Gulf of Alaska. In 2013, acoustic estimates of abundance (n=215, D=0.001; CV=0.18) were nearly twice the visual estimates (n=129, D=0.00031; CV=0.44) (Rone *et al.*, 2014). The estimates derived from acoustic localisations were more robust than those from visual detection due to the larger sample size.

SC/67a/NH06 presented sightings of sperm whales along different coastal areas of Russia. Among a number of species of baleen whales (including humpback, fin, minke, right and bowhead), sperm whales were the most numerous along the Kuril Islands chain with a limited number of sightings around the Commander Islands. Since survey effort was mainly limited to coastal and shelf areas it is not surprising that the number of sperm whale observations was lower relative to larger numbers of humpback, minke and fin whales in the same and other areas. Despite the relatively high number of sperm whales observed around the Kurils they are still considered depleted after intensive whaling in these regions.

The intersessional correspondence group on sperm whales should be reappointed under the leadership of Brownell; members and terms of reference are provided in Annex W.

16. OTHER INFORMATION

Mate *et al.* (2016) reports on a new transdermally attached biologging device called the Advanced Dive Behavior (ADB) tag. The ADB tag contains sensors that record hydrostatic pressure, three-axis accelerometers, magnetometers, water temperature, and light level. The ADB tag also collects Fastloc GPS locations and can send dive summary data through Service Argos, while staying attached to a whale for typical periods of 3-7 weeks before releasing for recovery and subsequent data download. ADB tags were deployed on sperm whales (n=46), blue whales (n=8) and fin whales (n=5) from 2007 to 2015, resulting in attachment durations from 0 to 49.6 days. The level of detailed information on blue and fin whale foraging effort over such long durations have not previously been recorded and add useful new insights into the patchy prey distribution these whales encounter off California.

Table 1
Work plan.

Species/area	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
North Atlantic right whales	-	Comprehensive update on North Atlantic right whales (delayed from 2016 meeting) Review measures proposed to mitigate the potential effects of future geological and geophysical seismic surveys.
North Pacific right whales	-	Review new analyses from photo-id and genetics work.
North Pacific blue whale assessment	Review information to examine the feasibility of undertaking an assessment and as appropriate develop a timetable.	Review progress on the research items identified under Item 2 and the work of the intersessional group, and develop a work plan.

17. WORK PLAN AND BUDGET REQUEST

In the coming year, the work planned for North Pacific blue whales includes to review information to examine the feasibility of undertaking an assessment of North Pacific blue whales. The on-going review of new data relates mainly to the following items: abundance estimates from IWC-POWER and JARPNII surveys, stock structure from genetics, movements from photo-id and acoustics.

The primary activity planned for North Pacific right whales is to review new analyses from photo-id and genetics work.

The sub-committee will review new results expected from the NEFSC on a comprehensive update on North Atlantic right whales that would ideally include the most recent findings from ongoing research on distribution, mortality and calving for all range states including Iceland. In addition, information is needed on mitigation measure that are occurring throughout the range of this species, including measures proposed to mitigate the potential effects of future geological and geophysical seismic surveys.

This most important item for the sub-committee to revise at its 2018 meeting is any new data related to the status of Gulf of Mexico Bryde's whales, especially their abundance estimate and any new information on mitigation measures.

There were no additional budget requests.

18. ADOPTION OF REPORT

The report was adopted at 16:02 on 17 May 2017. The sub-committee thanked Brownell for his excellent Chairmanship and Weller for his duties as rapporteur.

REFERENCES

Cerchio, S., Andrianantenaina, B., Lindsay, A., Rakdahl, M., Andrianarivelao, N. and Rasoloarijao, T. 2015. Omura's whale (*Balaenoptera omurai*) in the northwest of Madagascar: a first ecological description of the species. Paper SC/66a/SH29rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 21pp. [Paper available from the Office of this Journal].

de Vos, A. 2017. First record of Omuras whale, *Balaenoptera omurai*, in Sri Lankan waters. *Mar. Biodiversity Rec.* [Manuscript: MBIR-D-17-00022].

Estabrook, B.J., Dimitri, P.W., Clark, C.W. and Rice, A.N. 2016. Widespread spatial and temporal extent of anthropogenic noise across the northeastern Gulf of Mexico shelf ecosystem. *Endang. Spec. Res.* 30: 267-82. [Available at: *https://doi.org/10.3354/esr00743*].

Fujino, K. 1960. Immunogenetic and marking approaches to identifying subpopulations of the North Pacific whales. *Sci. Rep. Whales Res. Inst., Tokyo* 15: 85-142.

Ichihara, T. 1957. An application of linear discriminant function to external measurements of fin whale. *Sci. Rep. Whales Res. Inst., Tokyo* 12: 127-89.

Ivashchenko, Y.V., Brownell, R.L.J. and Clapham, P.J. 2014. Distribution of Soviet catches of sperm whales (*Physeter macrocephalus*) in the North Pacific. *Endang. Spec. Res.* 25: 249-63.

Kraus, S., Kennedy, R., Mayo, C., McLellan, W.A., Moore, M.J. and Nowacek, D. 2016. Recent Scientific Publications Cast Doubt on North AtlanticRight Whales Future. *Front. Mar. Sci.* 3: pp137. [Available at: *DOI=10.3389/fmars.2016.00137*].

Laist, D., Knowlton, A. and Pendleton, D. 2014. Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. *Endang. Spec. Res.* 23: 133-47.

Leduc, R., Taylor, B., Martien, K., Robertson, K.M., Pitman, R.L., Salinas, J.C., Burdin, A.M., Kennedy, A.S., Wade, P.R. and Clapham, P.J. 2012. Genetic analysis of right whales in the eastern North Pacific confirms severe extirpation risk. *Endang. Spec. Res.* 18: 163-67.

Mate, B.R., Irvine, L.M. and Palacios, D.M. 2016. The development of an intermediate-duration tag to characterize the diving behaviour of large whales. *Ecol. Evol.*: 1-11. [Available at: *DOI: 10.1002/ece3.2649*].

Pace, R.M., Cole, T.V.N. and Henry, A.G. 2014. Incremental fishing gear modifications fail to significantly reduce large whale serious injury rates. *Endang. Spec. Res.* 26(115-126).

Reeves, R.R., Lund, J.N., Smith, T.D. and Josephson, E. 2011. Insights from whaling logbooks on whales, dolphins and whaling in the Gulf of Mexico. *Gulf Mex. Sci.* 29: 41-67.

Rone, B.K., Douglas, A.B., Yack, T.M., Zerbini, A.N., Norris, T.N., Ferguson, E. and Calambokidis, J. 2014. Report for the Gulf of Alaska Line-Transect Survey (GOALS) II: Marine Mammal Occurrence in the Temporary Maritime Activities Area (TMAA). Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Honolulu, Hawaii under Contract No. N62470-10-D-3011, Task Order 0022, issued to HDR Inc., San Diego, California. Prepared by Cascadia Research Collective, Olympia, Washington; Alaska Fisheries Science Center, Seattle, Washington; and Bio-Waves, Inc., Encinitas, California. April 2014. 186pp.

Rone, B.K., Zerbini, A., Douglas, A., Weller, D. and Clapham, P. 2016. Abundance and distribution of cetaceans in the Gulf of Alaska. *Mar. Biol.* 164(23). [Available at: *DOI 10.1007/s00227-016-3052-2*].

Rosel, P.E., Corkeron, P., Engleby, L., Epperson, D., Mullin, K., Soldevilla, M.S. and L., T.B. 2016. Status review of Bryde's whales (*Balaenoptera edeni*) in the Gulf of Mexico under the Endangered Species Act. *NOAA Tech. Mem.* NMFS-SEFSC-692.

Rosel, P.E. and Wilcox, L.A. 2014. Genetic evidence reveals a unique lineage of Bryde's whales in the nothern Gulf of Mexico. *Endang. Spec. Res.* 25: 19-34.

Širović, A., Oleson, E.M., Favilla, A. and Fisher-Pool, P. 2016. Blue whale song variability in the North Pacific Ocean. Paper SC/66b/IA12 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 8pp. [Paper available from the Office of this Journal].

Soldevilla, M.S., Hildebrand, J., Frasier, K., Dias, L., Martinez, A., Mullin, K. and Garrison, L. In press. Spatial distribution and dive behaviour of Gulf of Mexico Bryde's Whales: Potential risk for vessel strikes and fisheries interactions. *Endang. Spec. Res.* [Available at: *doi: 10.3354/esr00834*].

Sugioka, H., Kyo, M., Yoshida, R., Yamada, H. and Kato, H. 2015. Detection and characterization of whale signals using seafloor cabled seismic networks offshore Japan. *OCANS'15 MTS/IEEE*: 1-7. Washington, DC.

Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologica: Scientific Contributions of the New York Zoological Society* 19(1-2): 1-50+6 maps.

DEWH NRDA Trustees. 2016. Deepwater Horizon oil spill: Final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. [Available at: *http://wwwgulfspillrestorationnoaagov/restoration*].

Wada, S., Oishi, M. and Yamada, T.K. 2003. A newly discovered species of living baleen whale. *Nature* 426: 278-81.

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chairs
   1.3 Appointment of rapporteurs
   1.4 Adoption of Agenda
   1.5 Review of available documents
2. North Pacific blue whales
3. North Atlantic sei whales
4. North Atlantic right whales
5. North Pacific right whales
6. North Pacific fin whales
7. Omura's whale
8. North Atlantic Bryde's whales
9. Gulf of Mexico Bryde's whales
10. North Atlantic blue whales
11. North central and northeastern Pacific common minke whales
12. North Atlantic humpback whales
13. North Atlantic bowhead whales (not subject to ASW)
14. North Pacific bowhead whales (not subject to ASW)
15. North Pacific sperm whales
15. Other information
16. Work plan and budget request
17. Adoption of Report

Appendix 2

STATUS OF NORTH ATLANTIC RIGHT WHALES: AN UPDATE

Peter Corkeron and Richard Pace
Protected Species Branch, Northeast Fisheries Science Center, Woods Hole MA 02543, USA

The abundance of North Atlantic right whales, *Eubalaena glacialis*, estimated by a simple accounting procedure, increased gradually (~2.8%/yr) from 1990 to 2011 (Waring *et al.*, 2015). In recent years (i.e. post-2010) there have been multiple indicators that give cause for concern regarding the status of the species, reviewed recently in Kraus *et al.* (2016).

Briefly, these indicators are as follows.

- Changes in fishing gear made under the Atlantic Large Whale Take Reduction Program (ALWTRP) through 2009 was unable to detect a reduction in observed serious injuries and mortalities to large whales, including North Atlantic right whales (Pace *et al.*, 2014).
- Sub-lethal effects of drag caused by fishing gear entanglement can be substantial (Van der Hoop *et al.*, 2015) and could have population-level consequences (van der Hoop *et al.*, 2016).
- From a study of known mortalities along the east coast of North America from 1970-2009, entanglement in fishing gear was identified as the most common known cause of death (van der Hoop *et al.*, 2013).
- Entanglements have a deleterious impact on the body condition of North Atlantic right whales, with severe entanglements causing greater declines in body condition than less severe entanglements (Pettis *et al.*, 2017).
- Fishing rope has become stronger since the mid-1990s, and the severity of injuries to North Atlantic right whale caused by fishing gear has increased over the past three decades (Knowlton *et al.*, 2015).
- Survival of individual North Atlantic right whales (adults and juveniles) was reduced ~ 20% by entanglement; and health condition at the end of the entanglement is a good predictor of the likelihood that an individual whale will survive.
- Further to the point on whales' general condition - health condition of North Atlantic right whales at a population level declined 1980-2008 (Rolland *et al.*, 2016).

The trajectory of a mammal population depends on the relationship between new recruits into the population and mortality. Calf productivity relative to population size has been highly variable and for the past few years has been at or below the mean for North Atlantic right whales 2012-17[1]. Median calving interval for calving females (a crude measure of calving success) has increased from three years in 2006 to six years in 2015, and seven years in 2016[2].

Calving success in North Atlantic right whales is modeled well by a spatially and temporally resolved model of *Calanus finmarchicus* production in the Gulf of Maine (Meyer-Gutbrod *et al.*, 2015). In addition to this environmental effect on calving, anthropogenic influences may be at play. Drag-induced energetic costs associated with non-lethal entanglements can affect the likelihood that a female whale will be in condition to calve (van der Hoop *et al.*, 2016; Van der Hoop *et al.*, 2015). Rolland *et al.* (2016) established that there is a level of condition below which an individual female North Atlantic right whale will not calve. The overall condition of North Atlantic right whales has declined over the past years (Rolland *et al.*, 2016), increasing the likelihood that females will drop below the condition threshold for calving. At the same time, the likelihood of detecting individual right whales has declined in recent years[3] due to what appears to be changes in the times over which right whales occur in their primary known habitats which confounded previous methods of population estimation based upon observed minimum number alive.

In response to these concerns, staff at the Northeast Fisheries Science Center, working in collaboration with colleagues, have developed a Bayesian state-space implementation of a Jolly-Seber mark-resight model, which includes a time-varying individual covariate for likelihood

[1]See slide 28 at: *https://www.greateratlantic.fisheries.noaa.gov*.
[2]See Table 3 in the 2016 North Atlantic right whale report card, available at: *http://www.narwc.org/pdf/2016%20Report%20Card%20final.pdf.*
[3]See slide 23 at: *https://www.greateratlantic.fisheries.noaa.gov.*

of sighting, to estimate abundance and survival over the period 1990-2015. A manuscript based on this analysis is currently submitted for publication.

Preliminary results from the model have been presented to the recent meeting of the Atlantic Large Whale Take Reduction Team, and are available at *https://www.greateratlantic.fisheries.noaa.gov*. Slide 24 shows the general trends in abundance over the study period. Abundance increased gradually from 1990 to about 2010-11 (the exact year at which inflection occurs can vary with model runs) and then enters a slight decline to 2015. As annual survival of males is higher than that of females (slide 23), there are estimated to be in the order of 1.4-1.5 males for each female in the population in 2015 (slide 25).

REFERENCES

Meyer-Gutbrod, E.L., Greene, C.H., Sullivan, P.J. and Pershing, A.J. 2015. Climate-associated changes in prey availability drive reproductive dynamics of the North Atlantic right whale population. *Mar. Ecol. Prog. Ser.* 535: 243-58. [Available at: *doi: 10.3354/meps11372*].

Knowlton, A.R., Robbins, J., Landry, S., McKenna, H.A., Kraus, S.D. and Werner, T.B. 2015. Effects of fishing rope strength on the severity of large whale entanglements. *Con. Biol.* 30(2): 318-28.

Kraus, S., Kennedy, R., Mayo, C., McLellan, W.A., Moore, M.J. and Nowacek, D. 2016. Recent Scientific Publications Cast Doubt on North AtlanticRight Whales Future. *Front. Mar. Sci.* 3: pp137. [Available at: *DOI=10.3389/fmars.2016.00137*].

Pace, R.M., Cole, T.V.N. and Henry, A.G. 2014. Incremental fishing gear modifications fail to significantly reduce large whale serious injury rates. *Endang. Spec. Res.* 26(115-126).

Pettis, H.M., Rolland, R.M., Hamilton, P.K., Knowlton, A.R., Burgess, E.A. and D., K.S. 2017. Body condition changes arising from natural factors and fishing gear entanglements in North Atlantic right whales *Eubalaena glacialis*. *Endang. Species Res.* 32: 237-49.

Rolland, R.M., Schick, R.S., Pettis, H.M., Knowlton, A.R., Hamilton, P.K., Clark, J.S. and Kraus, S.D. 2016. Health of North Atlantic right whales Eubalaena glacialis over three decades: from individual health to demographic and population health trends. *Mar. Ecol. Prog. Ser.* 542: 265-82.

van der Hoop, J.M., Corkeron, P. and Moore, M. 2016. Entanglement is a costly life history stage in large whales. *Ecol. Evol.* 00: 1-15. DOI:10.1002/ece3.2615.

van der Hoop, J.M., Moore, M.J., Barco, S.G., Cole, T.V.N., Daoust, P.-Y., Henry, A.G., McAlpine, D.F., McLellan, W.A., Wimmer, T. and Solow, A.R. 2013. Assessment of management to mitigate anthropogenic effects on large whales. *Cons. Biol.* 27: 121-33. *doi: 10.1111/j.1523-1739.2012.01934.x*.

Van der Hoop, J.M., Vanderlaan, A.S.M., Cole, T.V.N., Henry, A.G., Hall, L., Mase-Guthrie, B., Wimmer, T. and Moore, M.J. 2015. Vessel strikes to large whales before and after the 2008 ship strike rule. *Cons. Lett.* 8(1): 24-32.

Waring, G.T., Josephson, E., Maze-Foley, K. and Rosel, P.E. 2015. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2016. *NOAA Tech. Mem.* NMFS-NE-238: 361pp.

Annex H

Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks

Members: Jackson (Convenor), Bell (co-Convenor), Baker, Baldwin, Belchier, Brownell, Burkhardt, Butterworth, Castro, Cerchio, Cholewiak, Clapham, Collins, Crespo, Cubaynes, de la Mare, Double, Elwen, Findlay, Fretwell, Friedlaender, Fruet, Galletti, Goto, Herr, Iñíguez, Isoda, Ivashchenko, Kato, Kaufman, Lang, Lauriano, Leaper, M. Leslie, Lundquist, Mallette, Mate, Matsuoka, Miller, Minton, Mizroch, Murase, Øien, Olson, Pastene, Redfern, Reyes, Rogers, Rosenbaum, Samaran, Širović, Slooten, Taguchi, Thomas, Torres-Florez, Vermuelen, Weinrich, Willson, Yoshida, Zerbini, Zicos.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Jackson welcomed participants.

1.2 Election of Chair
Jackson and Bell were elected Chair and Co-Chair.

1.3 Appointment of Rapporteurs
Leslie and Clapham undertook the duties of rapporteuring.

1.4 Adoption of agenda
The adopted agenda is given in Appendix 1.

1.5 Documents available
Documents identified as containing information relevant to the sub-committee were: SC/67a/SH01-13, SC/67a/PH01, SC/67a/PH03-04, SC/67a/IA01, SC/67a/WW02, SC/67a/Rep03, Thomisch *et al.* (2016), Redfern *et al.* (2017), LeDuc *et al.* (2017), Shabangu *et al.* (2017), Balcazar *et al.* (2017), Acevedo *et al.* (2017), Torres *et al.* (2016), Pastene *et al.* (2015), Weinstein *et al.* (2017) and Matsuoka and Hakamada (2014).

2. SOUTHERN OCEAN RESEARCH PARTNERSHIP

SC/67a/SH04rev1 reports on the activity of the Southern Ocean Research Partnership (IWC-SORP) since SC/66b. Progress on the five primary IWC-SORP science themes (SC/67a/SH04rev1 Annex 1-5) is summarised below:

SC/67a/SH04rev1 Annex 1 described progress on the ‘Antarctic Blue Whale Project’. The objective of this project is to improve understanding of the status of Antarctic blue whales following exploitation, to investigate the role of these whales in the Antarctic ecosystem, and to measure the circumpolar abundance of Antarctic blue whales and their rate of recovery from whaling. Over the last year, the project cooperated on a voyage to the western Antarctic Peninsula led by Argentina which generated sightings and acoustic information for several cetacean species (SC/67a/SH12).

Ongoing analyses of acoustic data from the 2015 New Zealand-Australia Antarctic Ecosystems Voyage (SC/66a/SH07) continues, in particular the development of methods to quantify the distribution and density of Antarctic blue whales encountered for comparison with the distributions of krill measured on the voyage.

Matching of new photographs of Antarctic blue whales contributed to the Antarctic Blue Whale Catalogue yielded a total of 25 new identifications, bringing the total number of photo-identified Antarctic blue whales up to 441 whales, represented by 336 left sides and 321 right sides (SC/67a/PH01). Further details can be found in the report of the *ad hoc* Photo-identification Working Group, see Annex S.

Data from research voyages are augmented with sightings information from ships of opportunity, which are contributed to the online reporting system: *http://www.marinemammals.gov.au/sorp/sightings*.

Ongoing analyses of beached blue whale bones are contributing to an assessment of genomic diversity and population differentiation of historical Antarctic blue whales (SC/67a/SH11). Further sub-committee discussion of this project is given in Item 3.2. The sub-committee recognised the great progress made within this project and the large volume of information about Antarctic blue whales generated through IWC-SORP. In response to a question about the readiness of the data for an Antarctic blue whale abundance estimate, the authors noted that it would not be possible in the short-term. Resource limitations mean that the collection of biopsy samples is slow but steady, and therefore a genetic mark-recapture study is not yet possible. They also noted that submission of photographs and resultant photo-identification of individuals, and collection of photo-identifications from IWC-SORP voyages, was relatively consistent with the needs outlined in Kelly *et al.* (2012) (approximately 50 per year). Voyages planned for the next three years, future funding and opportunities to capitalise on platforms of opportunity will likely yield more biopsy samples and photo-identifications than in recent years. The sub-committee gratefully acknowledged the in-kind contribution made toward this project by tour operators and external organisations.

SC/67a/SH04rev1 Annex 2 reported progress on the IWC-SORP theme, ‘Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean’. Analysis of the 9,720 photographs of killer whales in McMurdo Sound taken between 2002 and 2015 was undertaken and a total of 442 individual Type C killer whales have now been identified. It is thought that there may now be enough historical images dating back to 2002 to determine if a postulated decline in McMurdo killer whale population has occurred.

Three killer whale sightings surveys were conducted in 2016/17 around the Antarctic Peninsula adding to over 65,328 killer whale images that have now been collected or contributed from the Antarctic Peninsula and adjacent waters. Researchers now rarely see groups of killer whales that have not previously been encountered. A small, unmanned hexacopter was used to collect high-resolution vertical images of all three ecotypes of killer whales (Type A, B1 and B2) found in the Peninsula area. In addition to morphometric data, these images will be used to assess health and body condition of individual killer whales. Examination of photographs of both B1 and B2 killer whales in 2016 and 2017 revealed individuals in surprisingly poor body condition.

IWC-SORP also co-operated on a voyage to the western and northern Antarctic Peninsula led by Brazil which generated sightings information and led to the collection of five biopsy samples and the deployment of one LIMPET-SPLASH satellite tag on an adult male type A killer whale in the Bransfield Strait.

Building on, and set within, the long-term killer whale research at sub-Antarctic, Marion Island, the movement and foraging ecology of killer whales is ongoing. Genetic analysis of these samples, in conjunction with photo-identification association data, has shown that Marion Island killer whales form small, fairly stable social units. Over 4 years, 26 satellite tags have been deployed and these have revealed seasonal site fidelity as well as rapid, long-distance movements and deep diving over seamounts.

The sub-committee was informed that following the killer whale research conducted in 2015 in Terra Nova Bay (Lauriano) a new proposal will be submitted to the Italian National Research Program this year. The link between the IWC-SORP killer whale theme and CCAMLR was noted as being of increasing importance since the declaration of the Ross Sea marine protected area, which includes among its priority objectives the conservation of the summer feeding ground of the fish-eating killer whale ecotype (Type C).

SC/67a/SH04rev1 Annex 3 summarised progress on the project to determine 'Foraging ecology and predator-prey interactions between baleen whales and krill: a multi-scale comparative study across Antarctic regions'. Between 1 January and 30 May 2017, a constant presence and active research were maintained around the Antarctic Peninsula. Seven dive recording satellite tags and four multi-sensor, reusable video-recording suction cup tags were deployed on humpback whales. LIMPET-SPLASH tags were deployed on four Antarctic minke whales; 225 biopsies were collected from humpback whales and 10 from minke whales. Unmanned aerial systems were flown over humpback whales and photogrammetry images were obtained from over 100 individuals, the aim being to assess body condition throughout the feeding season. Regular echo sounder surveys of krill abundance were performed to allow the local abundance of whales to be related to changes in the availability of prey locally. Analyses describing the migratory behaviour and movement patterns of baleen whales from the west Antarctic Peninsula continue. Further Scientific Committee discussion of this project is given under Item 3.3 in Annex L and in papers SC/67a/EM10, SC/67a/EM11 and Weinstein *et al.* (2017). IWC-SORP sincerely thanked WWF-Australia for its generous contribution of 15,989 GBP to purchase the multi-sensor video tags deployed during the 2016/17 season.

The sub-committee **strongly commended** this work and noted the particular relevance of the preliminary feeding ground pregnancy rates currently being analysed to measure calving rates for the estimation of trends. In response to a query about whether the authors have compared their new as yet unpublished data (~42% annual pregnancy rates and 11% pregnancy rate of the population both pregnant and with a calf, i.e. annually reproducing) to those published in the catch records from the Antarctic Peninsula or elsewhere, the authors welcomed guidance and recommendations on how their new technique could be employed in this context. The authors reminded the sub-committee that humpback whale calf mortality rate remains unknown and that there is a possibility that calves may die before weaning and thus increase the instance of late season pregnancies in females that have lost calves. It was noted that these issues are not currently resolvable and impose limitations on fully understanding feeding ground pregnancy rates. Nevertheless, the sub-committee re-stressed the importance of these techniques and the data collected and **strongly encouraged** continuance of this research.

In response to a question about whether the set of analysed samples is representative of the whole population (humpback Breeding Stock G), the authors cautioned that samples sizes vary between years, although the overall sample size is relatively large n=244 summarised here, with >580 samples available. The sub-committee discussed the temporal change in annual pregnancy rate observed over the feeding season (from 8.76% to 11.6%) and the proportion of pregnant females in the samples identified as female (42% in summer and 83% in autumn). The authors noted that they believe other age (juvenile), reproductive (non-pregnant), and sex (male) classes migrate away from the area, while pregnant females remain longer to capitalise on feeding opportunities, noting that this migration pattern was reported by Chittleborough (1965) for Australian humpbacks.

The sub-committee **encouraged** the authors to present a finalised report of this information to SC/67b noting the importance of the work for understanding the population demography of humpback whales.

The interesting increase in area-restricted search across the austral autumn was noted. Given the rapid trend of warming in the Antarctic Peninsula region, the summer feeding season has been extended by approximately 80 ice-free days. If one assumes this is evenly distributed at the start and end of the season, this represents 40 additional ice-free days available for foraging. Moreover, given this warming trend, krill might be moving toward the cover of inshore areas where ice is not yet present and the whales to follow them, thereby providing for increased feeding opportunities in ice free waters with high densities of krill (Curtice *et al.*, 2015). The sub-committee was informed that the authors have an additional three years of data and will be testing these hypotheses in the near future.

SC/67a/SH04rev1 Annex 4 reported progress on the project to 'Determine the distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica'. Analyses of the data collected on the 2015 research voyage to Raoul Island continue. Thirty-nine biopsy samples were analysed for progesterone levels: 11 females were accompanied by a young-of-year calf and five (45.5%) of these females were pregnant. Seventy-eight samples, including eight replicate samples as a control, were analysed using epigenetic methods. Of the 70 individuals, the ages ranged from <1 (young-of-year) to 67 years old with most whales in the 5-35 year old range. Analysis of the satellite telemetry data has shown the occurrence of different behavioural states across the migration: 86% transit, 4% area restricted searches (resting, foraging and/or milling) and 10% uncertain. A linear mixed effect model was used to determine a mean swimming speed (±SD) of 2.4km/h (± 1.8) across all whales and tracks. All whales showed slower swimming speeds at low and high latitudes, and faster swimming speeds at mid-latitudes. Fieldwork was conducted at the Bellona and Chesterfield reef complex. Individual data were collected on nine groups of humpbacks with seven whales photo-identified by fluke and a further 11 identified by dorsal fin; 72% (n=13) were adults and 28% (n=5) were calves. Of the seven adults identified by fluke, three (2 females and 1 male) matched to the New Caledonia southern lagoon catalogue and four were newly identified individuals that will be matched to other catalogues throughout the region. Seven biopsies were collected.

These samples will be genotyped and sex-identified using standard protocols and then matched to Oceania and Australian genotype catalogues. Acoustic recordings made during the study will be analysed along with other acoustic data throughout the region as part of a long-term study on humpbacks throughout Oceania.

Humpback whale surveys were undertaken during the peak of the breeding season from 9 to 30 August, 2016. Initial efforts focused around the Whitsunday Islands (20.2°N 148.9°E) and later (23-30 August) focused off Mackay in the Percy Islands. Sixty-seven pods of humpback whales containing a total of 146 whales (including 30 calves) were observed during the survey. This number was lower than expected and the general density of pods observed was lower than that observed in the same region during previous surveys. A total of 26 genetic samples were collected during the 2016 field season (including sloughed skin and biopsy samples); 62 samples have now been collected from the region. IWC-SORP gratefully acknowledged the South Pacific Whale Research Consortium (SPWRC) for their enormous contribution to and continued collaboration on this project.

The sub-committee noted the unusually low number of sightings in the Whitsundays. It was suggested that this may be part of a broader winter-season climatic effect given the strong El Niño event which occurred in 2014-16. The sub-committee was interested to know how pregnancy rates from New Caledonia compare to those presented in SC/67a/SH04 Annex 3 (Friedlaender study) from the Antarctic Peninsula. Friedlaender noted that one of the limitations of applying hormonally detected pregnancy tests on breeding grounds is that we do not know how early after impregnation that the hormone changes associated with pregnancy are detectable in biopsy samples. It was commented that having some estimate of the detectability of pregnancy over time (i.e. how the level of hormones change over the term of a pregnancy) would greatly help in the comparability (within and between populations), and applicability, of these results (e.g. Clark *et al.*, 2016). There is also the added complication of potentially different residency times for pregnant and non-pregnant females, which could bias measurement of pregnancy rates using this method. For example the sub-committee noted the existence of telemetry data from mid-season in Madagascar showing that two females without calves, tagged whilst they were the focal animal (Nuclear Animal) of male competitive behaviour, moved rapidly off breeding grounds after they were observed engaged in this breeding behaviour (Cerchio *et al.*, 2016). The sub-committee recognised that more research into behavioural patterns could help clarify this issue.

SC/67a/SH04rev1 Annex 5 summarised progress on the project to measure ‘Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin wales in the Southern Ocean’. Those involved have continued to develop and mature a long-term acoustic research program to understand trends in Southern Ocean blue and fin whale distribution, seasonal presence, and population growth through the use of passive acoustic monitoring techniques. This international collaboration has continued to deliver: (1) analysis and interpretation of existing ad-hoc acoustic datasets in from the Southern Ocean; (2) the development and implementation of an ongoing network of long-term circumpolar underwater listening stations; and (3) development of novel and efficient methods for standardised analysis of acoustic data collected in the Antarctic and sub-Antarctic.

In 2016/17, project members deployed 23 autonomous recording devices in the Southern Ocean at 19 different recording sites, and recovered 17 previously deployed autonomous recorders from various recording sites around Antarctica. The data volume from all instruments totalled approximately 150,000 hours of underwater recordings. Group members have also deployed a number of autonomous recorders at low and mid-latitudes in the Indian, Atlantic, and Pacific oceans, and the data from these instruments are expected to value-add and supplement those from the Southern Ocean Hydrophone Network (SOHN). Strong collaborative links with other IWC-SORP projects and international programs continue to be forged. Notably, acoustic monitoring for whales during the Antarctic Circumnavigation Expedition (ACE; SC/67a/SH03rev1), the contribution of data to the workings of this Committee, and close ties with the IWC-SORP Antarctic Blue Whale Project and the South African Blue Whale Project. A meeting of the Acoustic Trends Working Group meeting was held in Bled, 4-8 May 2017, a summary of which can be found under Item 3.2. IWC-SORP sincerely thanked the International Fund for Animal Welfare (IFAW) for its generous contribution of 7,519 GBP to facilitate the research conducted during the ACE voyage.

The sub-committee thanked the authors for this important work and noted the importance of the data stemming from this IWC-SORP initiative for informing future population assessments of both Antarctic blue and fin whales.

SC/67a/SH04rev1 also provided an update on the IWC-SORP Research Fund. In 2016, £144,058 GBP were allocated to 10 projects during an open, competitive grants round. Details of these allocations and a full financial report of the IWC-SORP Research Fund can be found in SC/67a/PH02. £640,421 GBP remain unallocated and unspent in the fund. A new grants round is planned for 2017. IWC-SORP sincerely thanks all contributors to the IWC-SORP Research Fund for their voluntary contributions.

Since SC/66b, substantial vessel time has also been secured by IWC-SORP researchers for the 2018 and 2019 austral field seasons.

The sub-committee was informed that overall, IWC-SORP themes have produced 93 peer-reviewed publications to date and 103 IWC-SORP related papers have been submitted to the Scientific Committee, 16 of which will be considered by the IWC Scientific Committee this year. Moreover, a number of students and post-doctoral researchers have been directly involved in IWC-SORP projects this year and several have completed theses.

The sub-committee acknowledged the importance of data contributed to IWC-SORP by the South Georgia Heritage Trust (a charitable trust based in Scotland, see *http://www.sghtonline.gs/*), CCAMLR, and the owners and crews of ships of opportunity. The sub-committee also noted the importance of using ships of opportunity as research platforms and recognised the substantial in kind contribution of One Ocean Expeditions and National Geographic Expeditions in providing ongoing support. The sub-committee **encouraged** the continued development of these collaborations with IWC-SORP and the wider Scientific Committee.

The sub-committee **strongly commended** the researchers involved in IWC-SORP for the impressive quantity of work carried out across diverse member nations and noted that their efforts were key to the overall success of the Partnership, to the work of IWC, and to delivering a large volume of scientific information to this sub-committee. The sub-committee especially **commended** the leading-edge technology being developed and employed in this program. The sub-committee **strongly encouraged** the continuation of the program.

3. PRE-ASSESSMENT OF SOUTHERN HEMISPHERE BLUE WHALES

In SC/66a, the sub-committee began the process of identifying and summarising datasets (acoustic and genetic) relevant for assessing population structure among pygmy-type blue whales in the Southern Hemisphere (IWC, 2016). Initial results of this assessment were presented at SC/67a (IWC, 2017) and a series of further work items were progressed intersessionally (see the work plan, IWC, 2017). In this regard, the need to standardise DNA profiles across laboratories and consider sample depletion from shared genetic resources was highlighted. An intersessional group was formed to facilitate DNA profile standardisation among researchers working on both blue and fin whales.

The sub-committee acknowledged the need to be consistent in their use of vocalisation-related terminology during the blue whale acoustics discussions. Based on a larger body of knowledge from taxa outside Cetacea, the repetitive patterns of vocalisations exhibited by blue whales fit within well-described definitions of song (Catchpole and Slater, 2003; McDonald *et al.*, 2006), specifically referring to a stereotyped signal repeated in a rhythmic manner and most typically limited to males. In this context, repetitive sequences of 'Z-calls' discussed in this Annex are behaviourally classified as 'songs', but are sometimes referred to as 'Z-calls' here for consistency with the literature and submitted papers until a revised terminology is implemented.

3.1 Southern Hemisphere population structure

LeDuc *et al.* (2017) reports on tests of hypotheses of blue whale stock structure in the Eastern North Pacific Ocean, Eastern Tropical Pacific (ETP), and Southern Ocean combining mitochondrial DNA and seven microsatellite loci from previous analyses (LeDuc *et al.*, 2007; Torres-Florez *et al.*, 2014a; 2014b) and including additional samples and data. The author summary for this paper can be found in Annex I.

The Chair of SD-DNA Working Group presented a summary of the discussion of this paper by the SD-DNA Working Group (See Annex I). It was highlighted that the Indian Ocean samples were grouped together as a single unit in the analysis of population differentiation, but span an area that includes three putative pygmy blue whale populations: (1) Madagascar, (2) Sri Lanka, (3) west Australia. This was done because sample sizes from each region were small, but also makes longitudinal differentiation patterns harder to interpret.

In response to a question regarding the temporal spread of ETP samples, the authors explained that these samples were collected over several years between September and November (with the exception of one sample) and that a temporal analysis of these samples could be conducted. It was also queried whether individuals in the ETP may be admixed, suggesting gene flow between the hemispheres. Of particular note were the group of samples collected at 10°N which were assigned ~50% to the eastern North Pacific. Checking the mtDNA (maternal) lineages associated with these individuals would be useful to identify whether they are associated with the South or North Pacific blue whale populations. The authors agreed to follow up on these suggestions and provide this information to SC/67b.

In relation to the genetic differentiation between blue whales in the eastern North and South Pacific, it was noted that the genetic differentiation reported here may be more akin to population-level differentiation, rather than the level that might be expected for distinct sub-species. Further effort was **encouraged** to collect samples or DNA data from blue whales off Peru and Ecuador in order to further refine understanding of the genetic differentiation and identity of eastern South and North Pacific blue whales.

It was noted that blue whales tagged in the eastern North Pacific show area restricted search behaviour (ARS; likely to be foraging) throughout the season including during the winter in the ETP (Bailey *et al.*, 2009). Less is known about how the whales from the eastern South Pacific use the ETP region, although blue whales have been observed feeding in the vicinity of the Galapagos Islands and in the coastal waters of Ecuador during the austral winter/spring (Félix *et al.*, 2007; Palacios, 1999).

Širović provided an interim update on progress from the Intersessional Working Group on the construction of a pygmy blue whale song library. Since SC/66a the group has continued discussing the pygmy blue whale song library and pygmy blue whale song structure (IWC, 2017). Discussions have focused around the need to more qualitatively and objectively enable decision making for separation between different song type and song type variants (the latter having smaller differences between them than song types). The definitions of song and unit as defined by McDonald *et al.,* (2006) were deemed to be a good starting point, but additional definitions beyond those are needed. A first step in this process could be testing some techniques from population genetics, such as dissimilarity measures or construction of taxonomic trees based on signal features, to provide qualitative measures that will enable this separation.

Širovič also noted that the Working Group is updating the synoptic map of pygmy blue whale song occurrence produced during SC/66b (Fig 2 of Annex H, IWC, 2017) to include all blue whale songs (including Antarctic blue whale songs).

In response to a question about whether it can be assumed that rhythmic stereotyped Z-calls produced by Antarctic blue whales are only made by males, the sub-committee was informed that the non-rhythmically repetitive calls such as 'D-calls' are likely to be produced by males and females, while the repetitive Z-calls are assumed to be song made by males only. The evidence to date is from North Pacific population of blue whales where singers were genetically confirmed to be males (Oleson *et al.*, 2007), and in the Antarctic, one Antarctic blue whale male singer was genetically confirmed (identified from biopsy sample collected by Double *et al.*, 2013). Širović then summarised the components needed to answer questions about sex-specific calls: (1) more stringent quantification of units (i.e. pattern sequences *vs* one-off sound production); and (2) an examination of the D-calls – which are common worldwide and seem to be produced by both males and females, in social and foraging situations. The data and tools to analyse the latter are available, but the Working Group have no plans to do this at present due to current priorities.

The possibility of using voice recognition technology to estimate the number of individuals from call data was raised, but it was noted that blue whale calls (as Z calls) seem to be very stereotyped and there is at present no real way to tell individuals apart; Z-calls would be difficult in this respect, but this may be possible in the D-calls. The Working Group plan to start this collaborative process with the more regionally distinctive call-types (i.e. the D-calls) for studying regional variants and then move to techniques for studying individual variation and recognition.

SC/67a/PH04 provided a progress report on matching within the Southern Hemisphere Blue Whale Catalogue (SHBWC), which has been supported by funding from the sub-committee (Item 10.2.2, IWC, 2017). Since 2016, this catalogue has increased by 13% with the addition of new photo-identifications from the western Indian Ocean. New research groups from Chile and the western Indian Ocean have also joined the catalogue, and plan to upload their photographs shortly (before SC/67b). The catalogue now numbers 1131 right side and 1116 left side photo-identifications. The catalogue is divided into four 'regions', each of which has a regional coordinator: (1) Gulf of California-Eastern Tropical Pacific-South America; (2) Indonesia/Australia/New Zealand/Sri Lanka; (3) Southern Ocean; and (4) West and Central Indian Ocean. No matches have been made between regions to date. The SHBWC is in the process of migrating to the IWC Server, a task which is anticipated to complete before December 2017. Software improvements are also ongoing, to improve user accessibility and the efficiency of adding metadata alongside photographs. Terms of reference for the catalogue have recently been modified in order to ensure contributors provide date and location information on upload of their images; these must be signed by new contributors and all existing contributors are also being asked to sign up and adhere to the new terms. Matching efforts are now focused on matching photos within, rather than between, regions as a first priority, in order to progress on the goal of obtaining regional photo-identification datasets suitable for measuring abundance in a mark recapture framework. Progress on regional catalogue reconciliation is discussed in more detail under Items 3.3.1, 3.3.3 and 3.3.4.

The sub-committee thanked Galletti for her continued work on developing and maintaining this important catalogue and **encouraged** its continuance. They also supported the advice of the *Ad hoc* Working Group on Photo-identification (PH) and **recommended** the continued matching of photo-identifications within regions by the Southern Hemisphere Blue Whale Catalogue organisers as top priority for the catalogue matchers to make progress on the provision of regional datasets for mark recapture analysis.

3.2 Antarctic blue whales

3.2.1 Genetic studies

SC/67a/SH11 reports the findings of genetic species identification of bones found near former whaling stations in the South Atlantic and the Antarctic Peninsula with funding provided by the Southern Ocean Research Partnership. This is an extension of the previous initiative in 2006 and 2007 to collect bones as reported in Sremba *et al*. (2015). DNA extraction, amplification and sequencing of mtDNA have been successful for 69 of these bones (about 74% success). The species identified included humpback, fin and blue whales. The results suggest multispecies composition consistent with 'Bay' whaling (~100 years old) compared to later whaling practices, which rendered all parts of whales (i.e. no bones were left). There was some preference for blue and fin whales. Blue whale genetic diversity was high. A total of 25 blue whale samples sequenced were identified; of these 21 haplotype were found. Fourteen haplotypes were unshared with contemporary blue whale samples, showing a loss of genetic diversity. The authors note the great potential for characterising lost diversity and for looking at regional population structure. Success with DNA extraction and species identification confirmed the extensive potential for accessing this 'molecular archive' but the authors expressed concern that the bones are showing a marked deterioration. For this reason, there is some urgency in undertaking further collections and preservations of the genomic resources in these bones.

In discussion, it was noted that large numbers of blue whale bones are present at Mikkelsen Harbour (South Shetland Islands). This accumulation likely represents catches made before the mid 1920s, but the whaling operation which produced these bones is unknown (Allison, 2013). The authors explained that their intent with this collection is to investigate the regional population structuring of Antarctic blue whales and also loss of diversity through time (i.e. change in haplotype frequencies over the whaling period).

The sub-committee highlighted the importance of utilising bone collections for documenting the loss of genetic diversity and shifts in population structure, and **encourages** these and related collection efforts to continue in order to inform stock structure and assessment.

The sub-committee heard an update on intersessional work on a pilot project which commenced at SC/66a (Appendix 4, IWC, 2016) to identify the catch location and species of ~1,000 fin and blue whale baleen samples collected from Antarctic Areas IV and V by Japanese whalers and currently stored at the Smithsonian Institution. These samples have been labelled but still need to be correctly associated with the catch records in order that species ID and other biological data can be matched up with each sample. The Smithsonian is currently photographing the labels on each set of baleen plates to help associate right and left baleen labels with each other and with catch records. The timeframe for completion of this organisation and photography is summer 2017. A subset of baleen samples have been sent to NOAA Southwest Fisheries Science Center and are undergoing DNA extraction and sequencing to test the feasibility of applying next-generation sequencing on these samples. A report will be provided to SC/67b. The sub-committee was pleased to see this moving forward and looked forward to reviewing the results.

3.2.2 Cruise reports

SC/67a/ASI07 reported the findings of the 2016/2017 NEWREP-A survey, a dedicated sighting survey was conducted in Area V-West (SC/67a/ASI07) and an Antarctic minke whale sampling survey was conducted in Area III-East and Area IV (SC/67a/SP05). The total searching distance in the research area was 2,937 n.miles in a dedicated sighting survey and 3,274 n.miles in the Antarctic minke whale sampling survey. During these surveys, a total of 15 schools with 19 individuals of blue whales were sighted. Photo-identification was taken from 9 individuals. Two Antarctic blue whale biopsy samples were also collected. Details of the surveys are described in SC/67a/ASI07 and SC/67a/SP05 have been presented to the Scientific Committee in Plenary (see Item 19.2).

The authors were thanked for presenting these data to the sub-committee.

3.2.3 Acoustic studies

Samaran summarised the goals and outcomes of an IWC-SORP pre-meeting of the IWC-SORP Acoustic Trends project. The main goal of this project is to investigate trends in acoustic detections of Antarctic fin and blue whales. At this meeting the Working Group:

- conducted a brief high-level review of the work on the project completed to date;

- identified gaps in existing data collection efforts and developed a plan to expand data collection of Southern Ocean Hydrophone Network (SOHN);
- developed a new framework for standardised analysis of long-term Antarctic acoustic recordings;
- identified a need for additional coupled behavioural and acoustic studies to enable a more robust interpretation of acoustic data with a view towards development of call density and animal abundance estimates; and
- synthesised a forward-looking work plan for the next 2 years for the Acoustic Trends Project implementing the above work.

The Acoustic Trends Working Group identified the following priorities required to achieve the project goal of investigating trends in Antarctic blue and fin whale behaviour, abundance, distribution, and seasonal presence.

DATA ANALYSIS

(1) Completion of call library to provide common dataset for development, and implementation of automated call detectors. This library will also provide the basis for data to be used for case studies to demonstrate the analysis framework described in the analytical methods section.
(2) Analysis of a subset of data identified by the group, focusing on a season (summer) of data with broad spatial coverage, as well as analysis of three years of data from a single location.
(3) Apply the analysis framework to the analysed data to make robust ecological comparisons across time and space and present them as a case study in a paper outlining the approach.
(4) Enable capacity building by securing funding for and hiring post-doctoral researchers and students to conduct the analyses outlined by the framework.

SOHN DATA COLLECTION

(1) Build relationships to allow expansion of data collection efforts to areas that have not been sampled previously.
(2) Apply for funding for additional instruments to take advantage of opportunities as they arise.
(3) Continue to seek opportunities to collect auxiliary data (e.g. behavioural studies, source level measurements).

The sub-committee commended the group for this ground-breaking international initiative to develop methods for abundance estimation using acoustics, noting that such developments would be incredibly useful for future Committee work. They noted that the meeting report for this workshop will be available as an IWC report at SC/67b. In discussion it was proposed that forthcoming New Zealand research cruises could also contribute data from Area VI (120-170°W), an area which is not currently included in the acoustic dataset. The cruises are intended to be multi-year so may be able to make a steady contribution in future (although it may be too late to organise this for the next cruise). The Working Group urged sub-committee members to consider contributing ship time and analytical capacity to further assist this analytical effort.

The sub-committee commended the group for their efforts and **encouraged** the continuance of their efforts to measure population abundance and trends of Antarctic blue and fin whales.

Shabangu *et al.* (2017) reports the effects of environmental conditions on the acoustic occurrence and behaviour of Antarctic blue whales based on data collected from 586 sonobuoys deployed in the austral summers of 1997 through 2009, south of 38°S, coupled with visual observations of blue whales during the IWC SOWER line-transect surveys. Satellite-derived sea surface height, sea surface temperature, and productivity (chlorophyll-*a*) were the most important environmental predictors of blue whale vocalisation occurrence. Vocalisation rates of D-calls were strongly predicted by the location of the southern boundary of the Antarctic Circumpolar Current (SBACC), latitude, and visually detected number of whales in an area while vocalisation rates of Z-calls were predicted by the SBACC, latitude, and longitude. Satellite-derived sea surface height, wind stress, wind direction, water depth, sea surface temperatures, chlorophyll-a and wind speed were important environmental predictors of blue whale vocalisation rates in the Southern Ocean. Our results identify the response of Antarctic blue whales to inter-annual variability in environmental conditions and highlighted potential suitable habitats for this population.

In discussion it was commented that blue whale occurrence was assumed to be at the location of the acoustic instruments in the habitat model, but in fact Antarctic blue whales can be detected over long distances (Samaran *et al.*, 2010; Širović *et al.*, 2007; Stafford *et al.*, 1998), so may not be located close to the instruments. In this case detection distances are unknown, but it is not likely to have a significant effect on accuracy of the habitat modelling because available Southern Ocean environmental data are also broad in scale. The sub-committee noted that surprisingly high vocalisation rates were detected in 2007 relative to all other years. The authors explained that the year 2007/2008 was an environmental anomaly, which may explain the spike in vocalisation rates.

SC/67a/SH03 reported preliminary analyses of directional sonobouys and real time passive acoustic detection for Antarctic blue and fin whales during the Antarctic Circumnavigation Expedition (ACE), January-March 2017. Data were collected from 301 listening stations spanning 240°s of survey area. The authors reported 21,641 vocalisations from Antarctic blue whales detected at 274 listening stations, while 912 vocalisations from fin whales were detected at 34 listening stations throughout the voyage. They acknowledged that further analysis is required in order to interpret the density of the locations that were measured in real-time during the voyage. In order to correctly estimate call density in the survey area, each recording must be standardised for noise-level and recording effort. Distance sampling was suggested as a potentially appropriate method for achieving such results. Although not the focus, other whales were also detected. Future plans include examining environmental covariates with these locations. In addition to the ACE voyage, Antarctic blue whales have been visually and acoustically detected in the area south of Scott Island, Ross Sea (69°S, 179°W) over three different years: during two IWC-SORP voyages (Double *et al.*, 2015; Miller *et al.*, 2015), and one IDCR-SOWER voyage.

In discussion, it was queried whether these data can be used for identifying whale aggregation areas (i.e. higher density) across the Southern Ocean. The authors cautioned that this kind of interpretation would have to assume no temporal variation in whale habitat use over the four-month period of circumpolar data collection. They noted that while possible, conversion of call densities into animal densities is statistically very complex and requires substantial additional behavioural data (e.g. vocalisation rates of animals, what proportion of a group is vocalising). Substantial extra information would therefore be required in order for these data to be used comparably to other kinds of abundance indices.

Thomisch *et al.* (2016) reports the spatiotemporal distribution of Antarctic blue whales in the Atlantic sector of the Southern Ocean using passive acoustic recordings. Data were collected between 2008 and 2013 by 11 recorders deployed in the Weddell Sea and along the Greenwich meridian. Antarctic blue whale Z-calls were detected via spectrogram cross correlation. Additionally, a Blue Whale Index was developed to quantify the proportion of time during which acoustic energy from Antarctic blue whales exceeded background noise. Antarctic blue whales were acoustically present year-round, with most vocalisations detected between January and April. During austral summer, vocalisations peaked synchronously throughout the study area in most years, with no directed meridional displacement pattern discernable. During the austral winter, vocalisations were recorded at latitudes as high as 69°S, suggesting that some Antarctic blue whales overwinter in Antarctic waters. Our results suggest a complex and non-obligatory migratory behaviour of Antarctic blue whales, potentially involving temporally and spatially dynamic migration routes and destinations, as well as variable timing of migration to and from the feeding grounds.

The sub-committee noted that this is a commendable effort, collecting and synthesising a large data volume over large period of time. It was advised that interpretation of these data could be improved by a rigorous treatment of the impacts of noise levels (i.e., under-ice conditions) on acoustic detections, since these vary considerably with weather conditions. The authors responded that they have performed this analysis of noise levels (Menze *et al.*, 2017) and plan to integrate these data in the future.

In discussion it was commented that the year-round vocalisations indicate the Weddell Sea must be accessible to whales during winter. The authors noted that oceanographic features help maintain some ice-free areas in the Weddell Sea during the winter (Comiso and Gordon, 1998).

SC/67a/SH10 presents the first evidence for Antarctic blue whale presence in the equatorial Atlantic Ocean from a passive acoustic experiment conducted from February to December 2013 with autonomous hydrophones moored near the Equator. The analysis of the acoustic data showed the presence of Antarctic blue whales every week during this period with peak occurrence from May to July (during austral autumn and winter) for the 'chorus' (combined distant calls and song produced by whales). Clear, loud, individual Z-calls were detected only at one site and in very low densities during austral winter. These acoustic records of Antarctic blue whales represent the furthest north and the longest seasonality of vocalisations documented for this species at such a low latitude. In the Indian Ocean and the eastern tropical Pacific, Antarctic blue whale vocalisations were never recorded north of 8°S in the austral winter and in very limited numbers overall. This new observation further emphasises the complex and wide distribution of Antarctic blue whales in the Southern Hemisphere.

The sub-committee welcomed these interesting and significant results. They were informed that similar patterns are seen in the Pacific Ocean, where Antarctic blue whale vocalisations can be clearly detected as far as 5°N (Širović, pers comm). It was queried whether this extension of the known distribution for Antarctic blue whales might affect past catch allocations; however blue whale catches in this region are virtually non-existent as the whaling operation was located at higher latitudes (Fig. 1 of Branch *et al.*, 2007).

Balcazar *et al.* (2017) describes the timing of Antarctic blue whale Z-calls (i.e., song) detected at temperate and tropical locations across the junction of the south-west Pacific (SWPO) and south-east Indian (SEIO) oceans (n=6 sites). The authors found the timing of the majority of Antarctic blue whale detections in the SWPO suggest that whale movements were coincident with the use of low latitudes during the austral winter, such that detections were in the wintertime off the coast of Samoa (~15°S) and Tonga (~20°S), and from autumn to mid-spring off eastern Australia (~32°S). They also show, however, that not all SWPO Antarctic blue whales moved from high latitudes post winter. Low numbers of Z-calls were detected in the austral spring and summer off Samoa (~15°S), but as there were few detections at this time, it may suggest that remaining in the northern tropical SWPO waters, is a strategy adopted by fewer animals. Further discussion, as whales are likely to produce fewer vocalisations during the austral spring/summer, as it is outside their breeding season, this may also explain why there were fewer vocalisations detected at this time. In the SEIO, the timing of Antarctic blue whale detections in northern waters, Dampier (~19°S), were in the wintertime. While in temperate waters, Z-calls were detected over longer periods - almost year round in the Bass Strait (~38°S), although this pattern was not seen every year.

The authors were thanked for presenting this useful information from a region where Antarctic blue whales are very rarely detected. Substantial discussion was held with regard to the vocalisations described in SC/67a/SH10 and Balcazar *et al.* (2017) and what their distribution and seasonality might biologically represent; particularly whether these vocalisations should be considered song and thus can be interpreted as being associated with male breeding behaviour (see Item 3.1). Sex-specific song production would be consistent with most other baleen whale species as well as many other vertebrates. In discussion of vocalisation intent (i.e. sexual display) it was queried whether the year-round detection of song in the Southern Ocean (e.g., Thomisch *et al.*, 2016) may imply year-round breeding. However the intent of these vocalisations are not yet understood, and lower latitude catches and detections of Antarctic blue whale vocalisations occur during the austral winter, suggesting that reproduction is likely seasonal (reviewed in Branch *et al.*, 2007).

In order to better understand the behavioural context of these vocalisations, it was proposed that D-tag data could provide useful insights, because it could better link behaviour with calling activity. This would be particularly useful for investigations on accessible feeding grounds in the California Current, where preliminary analyses suggest that blue whales can switch from feeding behaviour into calling modes in close temporal proximity (Friedlaender, pers comm). It was cautioned that we still understand very little about the behavioural context of blue whale vocalisations; for example there has been a decline in Antarctic blue whale tonal and vocalisation frequencies over time, the reasons for which are unknown (Gavrilov *et al.*, 2012)2012.

The sub-committee noted that this information on lower-latitude occurrence of Antarctic blue whales provides useful context for considering potential locations of breeding grounds, although with a caution that the behavioural intent of these vocalisations is still not understood. In order to improve understanding of Antarctic blue whale structure (e.g. Attard *et al.*, 2016) they **encouraged** the collection of biopsy samples and photographs of this species at lower latitudes.

The sub-committee noted the importance of collecting data on feeding grounds to better understand the behavioural context of blue whale vocalisations. They **encouraged** the continuation of acoustic monitoring efforts to document blue whale seasonal movements, also highlighting the importance of collating data on absence as well as presence from acoustic moorings across the Southern Hemisphere to document distribution in the lead up to the blue whale population assessment.

3.2.4 Progress towards population assessment

The Chair gave a brief update on intersessional work by Kelly towards model-based abundance estimates for post-SOWER CPIII surveys. Initial results have been generated, and will be discussed and refined by the intersessional correspondence group prior to presentation at SC/67b (see the Annex H work plan, IWC, 2017).

SC/67a/PH01 reported the results of the comparison of Antarctic blue whale identification photographs from two new sources to the existing Antarctic Blue Whale Catalogue. The summary of this paper can be found in Annex S Item 3.

In discussion, the value of continuing opportunistic data collection on Antarctic blue whales was highlighted, since this species remains poorly known. However it was noted that the lack of re-sights hinders utilisation of these data for abundance estimation at this stage. The authors explained that they plan to use photos in conjunction with Discovery mark data in order to improve information about movements. It was queried whether combined use of photo-identifications and genotypes might enhance the value of the data for abundance estimation (e.g. Bonner and Holmberg, 2013; McClintock *et al.*, 2013). The authors responded that the two datasets have not yet been used in a combined analysis, and are held in different places at the moment. It was suggested that Antarctic genotype and photo-identification databases be integrated, to enable assessment of their utility for combined mark-recapture analysis, with this metadata provided in open-access format to the IWC for future analyses. This activity would have a cost implication for the sub-committee due to the personnel time required to reconcile these data and the complexities involved in conducting mark-recapture calculations using data sources with unknown levels of co-dependence (there is no 'off-the-shelf' method at present).

The sub-committee expressed appreciation for these efforts and **recommended** continuing opportunistic data collection in the Antarctic and the matching efforts as these may enable estimation of abundance.

3.3 Pygmy type blue whales

3.3.1 Southeast Pacific blue whales

3.3.1.1 REVIEW NEW INFORMATION

Redfern *et al.* (2017) reports on predicting pygmy blue whale distribution in the northern Indian Ocean (a data poor area) using extensive sighting and effort data from the California Current (CC) and Eastern Tropical Pacific (ETP). The authors used several environmental metrics (including distance to shore, wind-speed, sea surface temperature, sea surface salinity and sea surface height) as well as 377 sightings from *ca* 225,000 miles of transect effort (in the CC and the ETP) to build models to predict the distribution of blue whales in the Northern Indian Ocean. They used generalised additive models to relate the number of blue whales to habitat variables. Their predictions of blue whale habitat in the Northern Indian Ocean from the models built with combined CC and ETP data compare favorably to hypotheses about Northern Indian Ocean blue whale distributions, provide new insights into blue whale habitat, and can be used to prioritise research and monitoring efforts. These models can be used to predict blue whale distributions in other regions where blue whale ecology is expected to be similar, such as off Chile.

The sub-committee recognised the value of these types of analyses and asked if there were plans to build similar habitat models for the Chilean blue whales in the southeast Pacific. The authors responded that they had no current plans to use sighting data from Chile and Peru to do this, but could possibly use CC and ETP data to predict southeast Pacific blue whale habitat. Using the existing CC and ETP data to build such a model could be done rapidly, but it would be better to build habitat models based directly on sightings data; this would however require significant work to gather data and build new models. Both approaches may provide useful information on relative densities of whales across the region; the addition of satellite tagging data to these models could enhance their utility even further.

The sub-committee **recommended** compiling sightings data and assessing predictions made by cross-applying the CC/ETP models to assess habitat for Chilean blue whales. This would provide useful distributional information in relation to the upcoming assessment of southeast Pacific blue whales, allowing assessment of whether the regional abundance estimates are representative of the whole population. Redfern highlighted that she convenes ICG-12. The goal of this group is to build regional habitat models for the southeast Pacific and consider options for using abundance estimates to be informative about wider-scale density and abundance. In particular, this group will determine which data are appropriate to use in the analyses (e.g., all sightings, or only sightings from surveys conducted for more than one day or over some minimum spatial distance) and contribute the identified data. Preliminary predictions and assessment of predictions will then be conducted. The work conducted by this group will help address specific information needs for Chilean waters. However, it will also contribute more broadly to our understanding of how to predict blue whale distributions in data-poor marine ecosystems. If funding can be obtained, Redfern hopes to convene a workshop with the ICG members and all data contributors to review the preliminary predictions.

3.3.1.2 PROGRESS ON POPULATION ASSESSMENT

The sub-committee was informed about a workshop (SC/67a/Rep03) held on 2 December 2016 in Valparaíso, Chile, immediately following the Biennial meeting of the Society of Aquatic Mammal Experts of Latin America (SOLAMAC). The aim of the workshop was to communicate the goals and intent of the IWC population assessment process and to facilitate blue, humpback, and fin whale photo-identification standardisation and integration. A blue whale discussion group reviewed progress on catalogue sharing, data availability and data set sizes. The group recognised that the majority of photo-identification data is from Chiloe Island region, with a smaller number of more opportunistic sightings made from Isla Chañaral to the north. All groups agreed to collaborate and contribute catalogues towards a southeast Pacific assessment. The group also determined that the Gulf of Corcovado/Chiloé area during the time period 2006 to 2009 would be the focus for a catalogue inter-comparison (CCC and CBA) before the next IWC/SC meeting in May 2017.

The sub-committee welcomed this update, and acknowledged the value of the workshop for bringing the data needs and perspectives of the IWC assessment process to a regional network of researchers in order to facilitate progress on assessment goals in the region.

The sub-committee then discussed inter-sessional progress on photo-identification contributions toward the Gulf of California-Eastern Tropical-Pacific-South America portion of the SHBWC catalogue (SC/67a/PH04). No new photo-identification catalogues have yet been received from Chilean researchers, but all groups have signed the terms of reference for starting the process of uploading photographs to the catalogue. The work is slowed by the need for each group (with limited resources) to fully reconcile their blue whale photographs before contributing them to the SHBWC. The outstanding data represents a few hundred photo-identifications from the Gulf of Corcovado, and smaller datasets from Isla Chañaral region. Galletti noted that once these data are received and matched, quality control will be required to ensure the same photo-identification standards are applied across the Chilean catalogues. The temporal distribution of each catalogue is also different, and this will need to be taken into account when choosing which years are focal for matching and contributing towards a mark-recapture abundance estimate. This can only be partially assessed before the photo-identifications are reconciled and quality controlled. The contributing research groups may also need additional assistance in order to reconcile their photographs before upload.

The sub-committee **strongly encouraged** that these catalogues are reconciled intersessionally and uploaded to the SHBWC. They recognised that the process of obtaining a dataset of use for mark recapture may not be possible by SC/67b. It was noted that the previous mark-recapture abundance estimate for the region was likely to represent a regional subset of the whales using the coast of Chile (Galletti Vernazzani *et al.*, 2017) and that significant additions of photo-identifications from the Gulf of Corcovado immediately to the south may not increase the representativeness of the estimate. However in the absence of other regional data the reconciliation was still considered worth attempting, since no alternative abundance data are available at present.

In response to a query about how the Eastern Tropical Pacific (ETP) catalogue (likely a mixture of northeast and southeast Pacific blue whales) is being considered relative to the SE Pacific population assessment, it was clarified that the ETP photos were matched for inter-regional linkages only (i.e. to consider migratory connections) rather than being included as part of a mark-recapture dataset.

Last year Branch was tasked with the following data request regarding Chilean blue whale catch data from Japanese operations in the 1960s, under item 10.2.2 intersessional initiatives: '(9) The subcommittee requested that Branch contact Pastene regarding availability of the original catch data of blue whales taken off Chile in the 1960s. These data need to be checked against the IWC database.' Branch contacted Pastene in the intersessional period. The available data are catches from the Japanese company *Nitto Hogei* made in Chile while it operated in that country between 1964 and 1968.

Blue whales were not taken in every year. Between November 1964 and March 1965, 396 blue whales were caught; and between November 1965 and March 1966, 120 blue whales were caught. For the blue whale catches made in 1965-66, personnel conducted a biological survey for 60 blue whales, for which they recorded the following additional information: (1) body height; (2) blubber thickness; (3) length from the tip of snout to center of eye; (4) length from notch of flukes to anus; and (5) relative presence of spots on the body surface.

The sub-committee commended the authors for finding these data and remarked how the timing (1960s) and location (Chile) of these catches resemble those described by Aguayo (1974). It was discussed how the proportional tail length from these data will give the opportunity to test the differences between Chilean and Antarctic type blue whales. Because this was a joint operation of the Chileans and Japanese, the measurements should be comparable to other pelagic catches by the Japanese (e.g. Central Indian Ocean – late 1950, early 1960s). If the Chilean whales are intermediate in total length it will be seen in these data because the techniques should be identical.

3.3.2 Madagascar blue whales

Cerchio provided an update on recent blue whale acoustic monitoring being conducted off northwest Madagascar, western Indian Ocean (Item 10.2.2 of Annex H, IWC, 2017). Madagascar-type song had been detected on a few days in December 2015 by hydrophones recording in very shallow shelf waters. In December 2016, three archival recorders were placed just past the shelf break at 226-276m depths. The central recorder of the three (at 276m depth) was placed just offshore of the site of the shallow recorder that had detected blue whale song in 2015 past a very steep drop-off. In April 2017, all three recorders were successfully recovered after a deployment of 114 days. A rapid review of data indicated the presence of blue whale song immediately upon the deployment of the recorders on 10 December. Further analyses are ongoing. Madagascar-type blue whale song was detected on all recorders throughout December and into at least early January. Frequently multiple individuals were audible in a chorus of song. Singing was heard consistently from day to day through to late December, as opposed to being sporadic isolated events as documented by the shallow water recordings in December 2015. Unexpectedly, Sri Lanka-type blue whale song was also recorded, first heard on 11 December, the day after deployment, and was consistently detected for at least two days. These preliminary results suggest the seasonal presence of an aggregation of blue whales off the northwest coast of Madagascar, representing two different 'acoustic populations'. Continued monitoring and analysis will quantify the temporal occurrence of blue whale vocalisations over a 16 month period, and assess the accessibility of the aggregations for boat-based study (photo-identification, biopsy and tagging) from the field base on Nosy Be.

The sub-committee discussed the possible origins of these individuals, including whether this aggregation displays a Northern Hemisphere migratory cycle and whether there could be migratory links between this area and Sri Lanka, given that both 'acoustic populations' were detected off Madagascar. It was noted that the Sri Lanka-type calls have been recorded over a very large area of ocean, including the Southern Indian Ocean, Angola and Mozambique Channel. Their peak densities off Sri Lanka occur during the boreal winter and spring (Stafford *et al.*, 2011), at a similar time to the acoustic deployment off Madagascar. Cerchio posited that the aggregation off northwest Madagascar might be using a migratory corridor connecting the central-west Indian Ocean (Seychelles) with the Madagascar Plateau, or the detections may represent southern extent of a breeding area north of Madagascar. Further passive acoustic recordings will help to evaluate these hypotheses. The sub-committee noted that most of the blue whale acoustic types are recorded over very large areas of ocean (fig. 2 of Annex H, IWC, 2017), indicating the possibility of widespread movement.

The sub-committee acknowledged the importance of this report, welcomed further information at SC/67b, and reiterated that they **strongly encourage** additional data collection (e.g. acoustics, genetics and photo-identifications) and offshore surveys in order to further assess the composition of this northwest Madagascar aggregation.

3.3.3 New Zealand blue whales

SC/67a/SH02 reports on results from a recent study of blue whales around New Zealand, with an emphasis on recent vessel-based field research in the South Taranaki Bight (STB) during the austral summers of 2014, 2016 and 2017. This broad and multi-disciplinary study includes acoustics, genetics and photo-identification of New Zealand blue whales. For analysis of genetic diversity and population structure, SC/67a/SH02 reported on the collection of biopsy samples and faecal samples during each of the field seasons, as well as access to stranded (beach-cast) individuals held by the New Zealand Cetacean Tissue Archive. DNA profiling included sequencing of the mtDNA control region (410 bp), microsatellite genotyping at 15 loci and sex identification. These methods are comparable to those used in most other recent studies of population structure of blue whales (Attard *et al.*, 2015; LeDuc *et al.*, 2017; LeDuc *et al.*, 2007; Sremba *et al.*, 2012; Torres-Florez *et al.*, 2014b), allowing for direct comparisons to these 'reference databases' for other populations. To date, DNA profiling has been completed for samples collected in 2014 and 2016 and from stranding archive. Initial matching of DNA profiles revealed several within and between year replicates. One of the between-season replicates (i.e., recaptures) showed a marked deterioration in physical condition and was almost unrecognisable as the same individual by appearance. After removal of replicates, the samples represented 31 individuals (15 females, 11 males and 5 unknown sex). Based on comparison of mtDNA, the NZ population of blue whales is highly differentiated from the Antarctic blue whales and the 'pygmy' blue whales of the Southeast Pacific but not to the Australian population. However, the mtDNA diversity of the NZ samples was significantly lower than any of the other populations, perhaps reflecting a recent evolutionary history of isolation. This work presents multiple lines of evidence supporting the recognition of a resident or seasonally resident population around New Zealand. Although the population is not significantly differentiated from the population around Australia, based on mtDNA haplotypes, power to detect a difference is limited by current sample sizes. Baker also noted the importance of standardisation of molecular markers to allow comparison among regional samples. This has been straightforward for comparison with published frequencies of mtDNA haplotypes but requires more agreement in choice loci and exchange of samples for standardisation of nuclear markers.

The sub-committee commended the authors for this multi-faceted report, which clearly represents an exceptional array of work on a poorly understood population. The authors welcomed suggestions of next steps based on this report. It was suggested that focused research to categorise behaviour and potential disturbance and important foraging areas using satellite tags or behavioural suction-cup tags could add a useful dimension to this study of habitat use.

The sub-committee also recognised the importance of the planned acoustic deployments to gather data on daily acoustic occurrence and song identity of blue whales in this region. Studies recording New Zealand call types to date have been infrequent and some quite distant (i.e. to the north) from New Zealand (fig. 2 of Annex H, IWC, 2017; Kibblewhite *et al.*, 1967). The sub-committee therefore **encouraged** further, preferably long-term, acoustic monitoring at sites close to New Zealand.

The population structure implications of the paper were then discussed. The lack of genetic differentiation between Australian (south and west coast) and New Zealand pygmy blue whales was noted. However, it was also observed that each of these regions has a distinct song type (Appendix 3 of Annex H, IWC, 2017), which might imply some degree of breeding ground differentiation. Acoustic detections to date suggest the same 'Southeast Indian' song type is present along the south and west coast of Australia, including in the Tasman Sea (Balcazar *et al.*, 2015). This is consistent with westward regional movements shown by satellite tagging; blue whales feeding along the south and west coast of Australia appear to take the same migratory route along the west coast toward Indonesia (Double *et al.*, 2014), rather than travelling up the east coast. However it was also noted that the amount of acoustic deployment has been lower in southeast Australia than it has been off the west coast. The sub-committee **agreed** that having a longer time-series of acoustic data from more sites in the southwest Pacific (particularly in the Tasman Sea) would be really helpful for better understanding the overlap between these two regional call types, as well as whale movements across Australia and towards wintering grounds.

The authors were asked if they plan to conduct kinship analysis, as this could enhance the precision of mark recapture estimates of abundance from this population. The authors explained that they have sufficient genotypes to identify parent-offspring or full-sibling relationships, but would need to expand this dataset in order to conduct mark-recapture from close kin (e.g. Bravington *et al.*, 2016).

In discussion about the photo-identifications presented in SC/67a/SH02, it was noted that ~30% of the photo-identifications reported here are from opportunistic sources. It was queried whether the authors intend to submit photo-identifications to the SHBWC to assist with the IWC assessment process for pygmy blue whales. The sub-committee **recommended** that the authors do this, reiterating their recommendation from SC/66b (Item 5.3.2, IWC, 2017). The sub-committee noted the intention of the authors to conduct a mark-recapture abundance analysis for the Taranaki Bight area and **encouraged** further news on progress with this initiative.

In respect of population assessment for the New Zealand blue whales, it was noted that the substantial blue whale catches made south of New Zealand and north of the Antarctic Convergence (including the recently included Soviet data) may be informative about the southerly distribution of this population (Appendix 5 of IWC, 2017). The identity, pattern and tempo of regional pygmy blue catches are currently being investigated by Branch (Item 10.2.2, IWC, 2017) and will be reported to SC/67b. It was noted that there is no photo-identification, genetic or museum based evidence of Antarctic whales in the region (although southwest Pacific acoustic detections may suggest periodic presence, Balcazar *et al.*, 2017).

3.3.4 Indonesia/Australia blue whales

The sub-committee received an update on progress on regional matching within Australia/Indonesia/Sri Lanka from the *Ad hoc* Working Group on Photo-identification (PH). This regional catalogue is currently the largest within the SHBWC, with 525 right sides and 508 left sides submitted. However not all date and location data are yet available from regional contributors and these groups are **strongly**

recommended to submit this additional information in order to assist the assessment process. The Working Group have initiated an intersessional email group to discuss data clean-up and quality control of the blue whale photo-identification catalogue holdings from around Australia, with a view to assessing the use of the catalogue for estimating abundance and other assessment parameters before SC/67b. Details can be found in Annex S.

4. PRE-ASSESSMENT OF SOUTHERN HEMISPHERE FIN WHALES

4.1 Southern Hemisphere population structure

The sub-committee reviewed available information on population structure in Southern Hemisphere fin whales. Although fin whales are widely distributed in both hemispheres, it is generally thought that there is a hiatus in fin whale occurrence close to the equator (and therefore that populations in the two hemispheres are discrete). This likely limits the movements of fin whales between hemispheres; although acoustic recordings indicate the presence of the species in equatorial waters in the Pacific, genetic evidence suggests inter-hemispheric movement is uncommon. Fin whales are currently considered to comprise three sub-species, *B. physalus physalus* in the Northern Hemisphere, *B. physalus quoyi* and *B. physalus patachonica* in the Southern Hemisphere (Committee on Taxonomy, 2016). The latter is a pygmy-type putative subspecies, located in low to mid latitudes (Clarke, 2004).

Southern Hemisphere fin whale distribution is best known from summer feeding areas in the Southern Ocean, where they were intensively hunted during the 20th century. During the austral summer (abundance peak January/February) fin whales were sighted and caught primarily in the Southern Ocean, but also sighted and caught in all months of the year in the waters off Chile and Peru. Summer sightings elsewhere in the Southern Hemisphere are patchy; sightings have been reported from the Falkland Islands/Islas Malvinas in the southwest Atlantic, from the Bonney Upwelling in south Australia and, rarely, off South Africa. Traditionally, fin whale feeding concentrations were assumed to correspond to Antarctic Areas I to VI, although these divisions were primarily based on humpback whale catch concentrations. Inspection of Southern Ocean catch data (not including Soviet catches) corrected for catcher searching time may improve the resolution of catch densities, suggesting elevated densities at 40-65°W (roughly Area I/II), 30°W-20°E (roughly Area III), 40-70°E (roughly Area IV) and 140-160°E (roughly Area V). Including also Soviet illegal catch data (without correcting for catcher searching times) suggests that Area V fin whale concentration might span 140°E-170°W.

Winter distribution (August/September) is poorly understood. Acoustic analyses of the Southern Ocean in winter are absent of fin whale vocalisations, suggesting that they are elsewhere. Breeding is thought to occur offshore. Patchy sightings, catches and acoustic detections imply that fin whale breeding areas may be located in: (i) south-central and eastern Atlantic waters up to ~6°S and farther offshore in the south-central Atlantic; (ii) eastern Indo-Pacific waters, based on winter acoustic detections off West Australia; (iii) southwestern Pacific waters, based on winter acoustic detections off New Zealand, and in the Lau Basin between Tonga and Fiji ~20°S; and (iv) eastern Pacific waters offshore of Chile and Peru south of ~20°S. Some component of this latter population may be non-migratory and has been hypothesised to include the pygmy fin whale *B. physalus patachonica*. The range may also include the Galapágos Islands at the equator, where occasional austral winter fin whale sightings occur; austral winter sightings are more common than austral summer sightings, suggesting presence of Southern rather than Northern Hemisphere fin whales.

Global population structuring of fin whales was investigated by Archer *et al.* (2013) using whole mitochondrial genome sequences (mitogenomes). The uneven geographical spread and small number of samples from areas other than the southeast Atlantic prohibits a statistically robust assessment of Southern Hemisphere fin whale population structure. No haplotypes were shared between regions, but nearly all Southern Hemisphere mitogenomes were unique. A simple assessment of the genetic distances within and between regions using control region data from these samples shows no indication that the eastern Indo-Pacific samples are more closely related to one another than they are to samples from the southeast Atlantic. However, similar patterns of lineage mixing across the Southern Hemisphere are seen for humpback whales, which are still found to be genetically differentiated between breeding grounds and oceans based on mutational and frequency-based statistics. Acoustic data show distinct call features for fin whales in East Antarctica (~70°E) compared to those near the west Antarctic Peninsula and Scotia Sea area. Unpublished analyses of fin whale vocalisations off Juan Fernandez Island (Chile) indicates that these are also comparable to those detected off the west Antarctic Peninsula.

Two overlapping strands of investigation were proposed to understand the population structure of Southern Hemisphere fin whales. These include an in-depth investigation into the hypothesis proposed by Clarke (2004) regarding the existence of a pygmy type fin whale which feeds at slightly lower latitudes than 'Antarctic' fin whales. If *B. physalus quoyi* is in fact a mixture of two distinct forms, analyses of catch length statistics, acoustics and genetics are required to resolve this. Building on the data collated in SC/67a/SH09 (below), the longitudinal differentiation among fin whale populations should be investigated using strategic collection of skin biopsy samples for genetics and isotope analysis; in addition, satellite telemetry should be employed to discern seasonal movements, and photo-identification research should be conducted to understand site fidelity and residency patterns and linkages between high- and low-latitude grounds.

The sub-committee **recommended** further work on the strands of investigation suggested above. They were informed that hypotheses of fin whale population structure would continue to be developed intersessionally through ICG-17 for reporting at SC/67b.

In discussion, it was noted that fin whales were numerically the most exploited species in the Southern Hemisphere, with more than 726,000 taken during the 20th century. Samples from bones from whaling stations in the South Atlantic and on the Antarctic Peninsula (and elsewhere) represent a potentially valuable source of genetic data to investigate population structure. These samples come from the earlier period of whaling since, in later years, bones were converted into bone meal or in some cases were disposed of in deep water. The sub-committee was also informed of the existence of bone collections in Namibia. The sub-committee noted that acoustic data can be informative with regard to population structure; in particular, the inter-pulse intervals as well as the pattern/number of pulses in fin whale song (including presence/absence of 90Hz and 100Hz features). In this regard, telemetry studies would also provide important information concerning contemporary whale movement and exchange.

In discussion, it was noted that the acoustic data available at present are suggestive of two distinct populations of fin whales (Gedamke, 2009); the possibility of sub-species was less certain. With regard to *B. physalus patachonica*, the holotype exists in the Buenos Aires museum, and Archer has attempted to obtain permission to sample it. The sub-committee **recommended** that the Secretariat provide a letter of support to assist in this regard. Baker also commented on difficulties with importation of bone from the Antarctic Peninsula. These samples have been collected under permit from the Antarctic Conservation Act but the requirements for certification of these samples for transport across national borders is unclear. The sub-committee requested that the Secretariat also provide a letter in support of further collection and importation of these bones for scientific research.

4.2 Southern Hemisphere distribution

SC/67a/SH09 reviewed available data on Southern Hemisphere fin whales, compiled by an intersessional working group. The authors noted that large feeding aggregations have recently been repeatedly observed along the western Antarctic Peninsula together with increasing acoustic detections. Data collected on fin whales over the past few decades are scattered between research groups and no overview has been attempted of these potential sources of fin whale data. The authors of SC/67a/SH09 provided a first compilation of meta-information on available data from dedicated and opportunistic surveys, moored acoustic recorders and sonobuoy surveys, photo-identification collections, satellite tagging and biopsy sampling of Southern Hemisphere fin whales. The majority of datasets were identified from the western Antarctic Peninsula and Scotia Arc area, comprising dedicated surveys, a variety of opportunistic sightings collections, a large number of acoustic recording devices moored in the area from 2001 until today plus sonobuoy surveys, some telemetry, biopsy sampling and photo-identification collection. Other areas around Antarctica were less represented among data sets and research effort comprising fin whales comparably scattered. Apart from circumpolar IDCR/SOWER data, limited sighting effort has been conducted in IWC management Areas II, III, IV and V, and the majority of acoustic recordings in areas other than the western Antarctic Peninsula and Scotia Sea is available from Area IV/V (singular moored recorders deployed between 2004-10). Fin whale biopsy samples are available from SOWER cruises in Area III. No telemetry data from other Antarctic regions than the western Antarctic Peninsula were identified. However, telemetry data, biopsy samples, photo-identification data and effort-related sightings data are available from the coast of Chile. The authors concluded that major gaps exist with regard to understanding population structure and identity, migration patterns and movements of fin whales within the area, as well as abundance, habitat utilisation and foraging ecology. They suggested that a dedicated study was needed to gather this information with the aims of investigating the apparent increase in fin whale numbers in the western Antarctic Peninsula area and obtaining knowledge on the ecology and recovery status of Southern Hemisphere fin whales.

In response to a question concerning whether some of the data could be used to investigate trend or address other questions, it was noted that this was an exploratory data compilation phase and that the data was not exhaustive and not yet ready for detailed analysis.

The sub-committee noted that, as with the blue whale assessment, it would be helpful for researchers involved in specific fields to cooperate and attempt to standardise analytical or other methods, as much as possible (e.g., genetic markers, acoustic terminology). This work will proceed through an intersessional email group (see list in Annex W).

It was also noted that other data sources were available that had not been included in the current compilation. The sub-committee thanked the authors of SC/67a/SH09 for their work in compiling this information and requested that anyone with additional information on fin whale data sources provide this to Herr for inclusion in summaries of existing metadata; these are provided as tables in Appendix 2. An intersessional working group was established to continue to update SC/67a/SH09, convened under Herr.

SC/67a/WW02 noted that while fin whales have been documented along the coast of Chile since the early 20th century (when high numbers of catches were taken by the whaling industry) information on their ecology and movement patterns remains scarce. The seasonal distribution of catches and sightings support the traditional idea that fin whales migrate to higher latitudes for feeding. Local studies, however, have proposed foraging areas for this species during spring and summer in lower latitudes. In the spring of 2015, six transdermal implantable satellite tags were deployed on fin whales around the Marine Reserve, Isla Chañaral (29°02’S, 71°36’W) to evaluate their movements and habitat use off the coast of Chile. A switching state-space model was used to estimate the predicted track of the whales as well as behavioural modes classified as transiting and area-restricted search (ARS). Whales were tracked between 4 and 162 days (mean=68±52 days) covering an average distance of 3,225.7±2,871.6km. Five of the six whales remained at middle latitudes for prolonged periods of time, moving in a north-south pattern near the coast, and spending most of their time in ARS behaviour (72.5% of the locations). Only one individual exhibited clear southbound migratory behaviour, showing transit behaviour for most of the period it was tracked. These results suggest that some of the fin whales that are observed in Chile do follow a migration to high latitudes, whereas others remain in lower latitudes along the Chilean coast, using critical habitats as likely feeding grounds.

A question was raised regarding whether fin whale calves were observed off Chañaral; the authors responded that calves were occasionally observed in the study area. The sub-committee welcomed the information in SC/67a/WW02, and noted that it had considerable potential to inform investigations of population structure and habitat use. The authors noted that there were plans to expand the work to further investigate patterns of movement and residency. The sub-committee **recommended** that telemetry studies, photo-identification and biopsy sampling be continued in this area to understand fin whale population structure, movements and habitat use.

De la Mare outlined a method for using catch per unit effort (CPUE) data to assess broad historical whale distribution and to calculate an index of relative abundance that is reasonably related to true density (de la Mare, 2014). There are inevitably complications in using data from historical Antarctic whaling records, and consequently neither this nor any other method can transform the rudimentary available data into a fully linear index of abundance, particularly over decades. However, the tests of the methods developed in the paper demonstrate that they are at least capable of attaining the more modest aim of improving on the catch per catcher-day as a measure of relative local abundance. The intent is to apply these methods over restricted time periods to make inferences about the spatial and within season distributions of species in the Antarctic. An example for Southern Hemisphere fin whales is provided in Appendix 3. Analyses suggested that historical fin whale catch densities may have been negatively correlated with those of blue whales. The database relating to this study is available from de la Mare.

The sub-committee thanked de la Mare for this information, and **recommended** that the Soviet catch data be included in his database for analysis; Clapham volunteered to provide data on almost 6,000 fin whale records from the *Yuri Dolgorukiy* factory fleet after consultation with D. Tormosov (data holder).

It was noted that, in contrast to the negative correlation reported, contemporary surveys have observed and detected fin whales and blue whales in close proximity (Double *et al.*, 2013; 2015); the reason for this negative correlation in catches is not yet understood.

Matsuoka and Hakamada (2014) (originally SC/F14/J05) provided estimates of abundance for fin and other whales from Antarctic Areas IIIE-IV, as well as for Areas V-VIW; the data were all collected south of 60°S to the ice edge, mainly in January and February. The data were derived from JARPA and JARPA II line-transect sighting surveys conducted using consistent methods over the period 1989/90 to 2008/09. A total of 353,134 n.miles was surveyed south of 60°S and a total of 1,268 schools (5,209 animals) were sighted, including 20 calves. The observed mean school size was 4.11 individuals. Fin whales were more frequently encountered in Areas V and VIW than in Areas IIIE and IV in both northern and southern strata. High-density areas were observed in Areas IIIE (between 55°E and 65°E), VW (between 140°E and 160°E) and VE (between 163°E and 170°W). The density index of whales (DIW) of this species was 1.47 during the whole season and increased from December to March. Abundance for the Indian Ocean stock of fin whales (IIIE+IV) was estimated at 3,087 (CV=0.191) for 1995/96, and 2,610 (CV=0.285) for 2007/08 (trend=-0.145 to 0.324). Abundance for the western South Pacific stock of fin whales (V+VIW) was estimated at 1,879 (CV=0.226) for 1996/97, and 14,891 (CV=0.298) for 2008/09 (trend=0.026 to 0.215). The estimate from the latest two seasons for half of the Antarctic Areas (35°E-145°W) south of 60°S was 17,600 animals.

The sub-committee thanked the authors (Matsuoka and Hakamada, 2014), and requested that the information be included in the ongoing data compilation coordinated by Herr. It was noted that the abundance estimates reported in these papers should be referred to the ASI *ad hoc* Working Group for review at SC/67b.

4.3 Cruise reports

SC/67a/ASI07 and SC/67b/SP05 provided information on fin whales from the 2016/17 NEWREP-A sighting survey in the western sector of Area III-East (55-65°E), Area IV (70-130°E) and Area V (130-165°E); the work was based upon IWC/IDCR-SOWER survey procedures. The total searching distance in the research area was 2,937 n.miles in a dedicated sighting survey and 3,274 n.miles in an Antarctic minke whale sampling survey. During these surveys, a total of 118 schools with 350 individual fin whales were sighted.

The sub-committee thanked the authors of this paper, and requested that the information be included in the ongoing data compilation coordinated by Herr.

4.4 Acoustic studies

SC/67a/SH03 reported the results of the 2016/17 Antarctic Circumnavigation Expedition (ACE), conducted by the Swiss Polar Institute; the survey took place from 20 December 2016 to 19 March 2017 aboard the Russian icebreaker *RV Akademik Treshnikov*. Scientists from the Australian Antarctic Division conducted acoustic monitoring for marine mammals during Legs 2 and 3 of the ACE voyage, transiting from Hobart, Australia to Punta Arenas, Chile, and from Punta Arenas, Chile to Cape Town, South Africa, respectively. The main goal of this passive acoustic survey was to locate meso-scale aggregations of calling blue and fin whales. During the voyage, directional sonobuoys were used to conduct 301 listening stations along the voyage track, and these stations yielded 492 hours of acoustic recordings. Vocalisations from blue and fin whales were detected in real time during the voyage, and calibrated measurements of the bearing and intensity of these calls were obtained for each detection. In all, 21,641 calls from Antarctic blue whales were detected at 274 listening stations, while 912 calls from fin whales were detected at 34 listening stations throughout the voyage. Although not the main focus of the project, monitoring also took place for sperm whale, humpback whale, Antarctic minke whale, leopard seal, crabeater seal, and odontocete (whistle) vocalisations during each listening station. The passive acoustic data collected during this voyage will allow investigation of aspects of the distribution of Antarctic blue and fin whales and the properties of their acoustic signals including: source levels of Antarctic blue and fin whale vocalisations, environmental drivers of blue and fin whale distribution, and potential changes in the distribution of Antarctic blue and fin whales over time.

A question was raised regarding whether there was overlap between fin and blue whales, since some other work had suggested some differences in distribution between the two species. The authors responded that it was difficult to determine from their acoustic data, and while the observed fin whale distribution appeared to be rather restricted, it is important to recognise that the search effort was focussed on blue whales. They also stated that the detection range for the two species was likely comparable. The sub-committee noted that the acoustic work had the potential to inform studies of population structure and the comparative distribution of fin and blue whales, and **encouraged** further analysis to be conducted in this context.

Recent visual observations suggest that the region around Elephant Island (South Shetland Islands) may serve as an important feeding spot for fin whales, possibly during the annual migration to and from the Antarctic feeding grounds. SC/67a/SH06 reported preliminary analysis of data from a passive-acoustic recording device deployed north of Elephant Island in January 2013, to collect year-round data on fin whale acoustic presence in this region. Analysis of the recordings for the hourly presence of fin whales' 20 Hz calls over a 10-month period (January-November 2013) revealed acoustic presence of fin whales for the entire recording period with low or no presence in August and September. Acoustic presence peaked in austral autumn. Additionally, data did not reveal a clear diel pattern in hourly presence of 20Hz calls, which contrasts with the results of studies from the Gulf of California and the Bering Sea. Further analysis is ongoing and an update should be available to this sub-committee next year.

In discussion, a question was raised with regard to the increase in vocalisation rate that was apparent in autumn, specifically whether this indicated an increase in local abundance or reflected instead more vocal behaviour at this time. It was noted that a similar pattern was evident in fin whale vocalisations in February/March in previous years, and that this likely represented a behavioural change, although the function of the 20Hz calls remain unknown.

Acknowledging the existence of multiple acoustic studies and datasets, the sub-committee **encouraged**, as far as possible, sharing of data from similar studies be initiated to provide a more comprehensive view; this effort might include a literature review as well as networking among research groups.

4.5 Progress on population assessments

SC/67a/IA01 reported the results of an analysis of Japanese catches of fin whales in the Southern Hemisphere. The authors compared true Soviet length data from the *Yuri Dolgorukiy* factory fleet during 1960-75 to data for the same period reported to IWC by Japan. Length distributions between the two nations were broadly similar, although a peak in Japanese catches at 17.4m (the minimum length for this species) prior to implementation of the International Observer Scheme in 1972 suggested a degree of 'stretching' to hide some catches of under-sized animals. Overall, however, the authors concluded that (unlike for Japanese sperm whale catches in the Southern Hemisphere and the North Pacific) the Japanese Southern Hemisphere fin whale data in the IWC Catch Database are probably largely reliable.

The sub-committee welcomed this information and noted that it would be useful when compiling historical catch data to inform an assessment of Southern Hemisphere fin whales.

The Chair gave a brief update on work by Kelly towards design-based strata-level abundance estimates for fin whales using the IDCR-SOWER CPIII surveys. Initial results have been generated, and will be discussed and refined by the intersessional correspondence group prior to presentation at SC/67b (see the Annex H work plan, IWC, 2017).

4.6 Other

SC/67a/SH07 outlined a plan to coordinate future research on Southern Hemisphere fin whales, focused on the western Antarctic Peninsula intersessionally. The sub-committee thanked the authors for the opportunity to comment on the proposed research developments and **endorsed** the recommendations made. It **encouraged** interested parties to collaborate intersessionally and suggested the inclusion of fin whales under IWC-SORP be considered.

5. SOUTHERN HEMISPHERE HUMPBACK WHALES

5.1 Update on Breeding Stock D assessment

The Comprehensive Assessment of Southern Hemisphere humpback whales was concluded in 2015. In this assessment the available abundance data for BSD presented two challenges: (1) there were few data to inform a correction for surface availability; and (2) there was a potential inconsistency between observer protocols and the Distance-based approach employed to estimate abundance. See IWC (2016) for a detailed discussion of these issues.

In order to progress the Comprehensive Assessment, a preliminary minimum abundance estimate for BSD was calculated based on a strip transect analysis of the 2008 aerial survey data from Shark Bay, Western Australia (Hedley *et al.*, 2011; IWC, 2015). These results indicated a lower bound value of 4,900 [95% CI: 4,100, 7,900] for surface available whales. A correction for surface availability of this estimate was made following the approach of Hedley *et al*. (2011). Thus, a rounded estimate of the lower bound of BSD abundance of 15,000 (uniform prior of U[ln15000, ln40000]) was assumed for the BSD assessment (IWC, 2015). However, this approach also influences the assessments of BSE1 (East Australia) and BSO (Oceania), as all populations were co-analysed in a three-stock model framework, to accommodate overlaps in high latitude catch allocation (IWC, 2015). Therefore although the Comprehensive Assessment of humpback whales (IWC, 2015) remains the current best approach to assess the status of these stocks, future assessments may differ substantially if a reliable absolute abundance estimate is obtained for BSD.

Intersessionally, Kelly reviewed the data available and concluded that she could not improve on the prior work by Hedley which implies a rounded estimate of the lower bound of BSD abundance of 15,000; thus the assessment approach based on this lower bound remains the best until new data become available.

This year the sub-committee **agreed** that there was no strong case to further re-analyse past survey data for BSD because of the absence of success despite the efforts of two experienced modellers. Rather efforts should focus on designing and implementing a new 'survey' (perhaps using new approaches, as provided by drones for example). The sub-committee acknowledged that the expense of conducting a new study in what is likely to be a remote and logistically challenging location would be considerable. The sub-committee recognised that a new abundance estimate would not only improve the reliability of the Comprehensive Assessment but it would greatly improve ability to determine the status of these populations as well as substantially aid fundamental understanding of whale population dynamics.

The sub-committee was reminded that abundance and trend data for this population would continue to be available from Japanese (NEWREP-A) surveys in Antarctic Area IV.

An assessment of the feasibility of a new 'survey', and further consideration of past analyses (notably following duFresne *et al.*, 2014), are necessary before any new fieldwork could be considered. The sub-committee **recommended** that this be done, although it was not clear who was both qualified and available to undertake this work.

5.2 Review new information

5.2.1 Breeding Stock G

SC/67a/Rep03 reported on the Workshop on Southern Hemisphere blue, fin and humpback whale catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula, held on 2 December 2016 at the Centro Cultural in Valparaíso, Chile. The workshop participants agreed a strategy for combining photo-identification catalogues to support mark-resight measurement of abundance and population connectivity of humpback whale populations from the Central and Eastern South Pacific and the Antarctic Peninsula, with emphasis on the assessments conducted by the Scientific Committee. The workshop received updates from humpback whale identification catalogues and a compilation of existing photo-identification data was made as part of an existing initiative to investigate connectivity among various areas in both breeding and feeding grounds of BSG (Table 4, SC/67a/Rep03). A small group was formed to continue more targeted discussion on how to move forward toward computing new abundance estimates for BSG based on the integrated photo-identification dataset developed by the Humpback Whale Catalogue Sharing Initiative (HWCSI). All participants in the small group focusing on humpback whales agreed to collaborate on developing new population estimates of abundance for BSG humpback whales. They also agreed that a process to move forward towards computing these estimates would be led by Jorge Acevedo and Fernando Félix in consultation with all other contributors. This process would include:

(1) development of a data sharing agreement;
(2) reconciliation of regional catalogues;
(3) matching of photo-identification data (e.g. use of existing software);
(4) description of quality control procedures; and
(5) development of a framework to compute new abundance estimates.

The sub-committee thanked the participants for their involvement in the workshop and emphasised its importance for furthering collaborations and in familiarising participants with the IWC assessment process into which their photo-identification data would be contributed. It was noted that workshops such as this facilitate 'piggy backing' onto regional catalogues to assist regional researchers in achieving population assessment goals important for the IWC Scientific Committee.

SC/67a/PH03 summarised work conducted in the past year by the Antarctic Humpback Whale Catalogue (summarised in Annex S). Olson noted the development of an automated matching system by the Happywhale project (SC/67a/PH02), which is collaborating with the Antarctic catalogue, potentially represents a major advance for catalogue matching which can offer the possibility of rapid comparisons to facilitate broad investigations involving multiple catalogues across a wide area.

5.2.2 Feeding grounds

A combined summary of papers SC/67a/ASI07 and SC/67a/SP05 was presented. During the 2016/17 NEWREP-A survey, a dedicated sighting survey was conducted in Area V-West (SC/67a/ASI07) and an Antarctic minke whales sampling survey was conducted in Area III-East and Area IV (SC/67a/SP05). The total searching distance in the research area was 2,937 n.miles for the dedicated sighting survey, and 3,274 n.miles for the Antarctic minke whale sampling survey. A total of 253 groups of humpback whales were sighted (516 animals) during the dedicated sighting survey and a total of 534 schools (1,017 animals) during the Antarctic minke whales sampling survey. A total of 30 individual humpbacks were photo-identified, and 11 were biopsied (SC/67a/ASI07: 7 individuals and SC/67a/SP05: 4 individuals). It was noted that the relatively low number of biopsies obtained reflected the lower priority of this activity relative to completing the sighting survey, as well as species prioritisation, i.e., blue whales were considered the highest priority.

The sub-committee received an update about the population structure of BSA, BSB, BSC and Arabian Sea humpback whales. Results that had previously presented and reviewed by the sub-committee as part of the Comprehensive Assessment are now published in Kershaw *et al.* (2017). The paper contains some increased sample sizes and new analyses that overall reinforce previous conclusions. The sub-committee thanked Rosenbaum for bringing this paper to the sub-committee's attention and **agreed** to consider these results when the sub-committee next revisits assessments of Southern Hemisphere humpback whales.

6. SOUTHERN HEMISPHERE RIGHT WHALES NOT SUBJECT TO CMP

6.1 Review new information

6.1.1 New Zealand right whales

Torres *et al.* (2016) summarised the results of surveys of southern right whales around the sub-Antarctic Campbell Island of New Zealand in the austral winter (July/August) of 2014. Since the decimation of the southern right whales in New Zealand, research on recovery has focused on the wintering ground at the Auckland Islands and the Main Islands, neglecting known wintering habitat at Campbell Island. The 2014 surveys used a variety of methods including photo-identification, DNA profiling and stable isotope analyses of tissue samples, and visual surveys of abundance and distribution. For some analyses, e.g., photo-identification and DNA profiles (e.g. Carroll *et al.*, 2011), the records from Campbell Island were then compared to large databases available from the Auckland Island and Main Islands. The primary findings include:

(1) a lack of calves and an apparent age-class bias toward sub-adults,
(2) photo-identification matches between individuals documented elsewhere in New Zealand and 'close-kin' matches (maternity) with females from elsewhere in New Zealand,
(3) a lack of genetic differentiation with the broader New Zealand population,
(4) an apparent increase in abundance over the last 20 years, and
(5) indications based on stable isotope analyses that the whales forage within the sub-Antarctic.

In discussion it was reiterated that this was a dedicated Campbell Island survey but that comparably timed surveys of the Auckland Islands were conducted in previous years, the more recent of which focussed on the collection of photo-identification data (2010-12). The likelihood that individuals are moving back and forward between these islands was discussed. The authors hypothesised that the Campbell Island area may be a location particularly favoured by sub-adults; they attributed the surprising lack of genotypic matches between the Campbell and Auckland Islands to the fact that most of their Auckland Islands catalogue is of whales >6 years in age. However it was also noted that the number of genotyped individuals (21) is small; further collection of biopsy samples could assist with understanding the relatedness between these aggregations.

SC/67a/SH08 presented a population model based on photo-identification data spanning 2006 to 2013 from the Auckland Islands, the principal calving area of New Zealand right whales. Calving interval was estimated at 3.31 years (95% CI=3.06-3.57) and survival for juveniles and adults at 0.98 (SE 0.07). The stochastic model accounted for parameter uncertainty and year-to-year variability, and estimated population growth at 4.8% (95% CI=2.4%-6.4%). This estimate was slightly lower and more precise than the previous population growth estimate for females (95% CI = -2% to 13%; Carroll *et al.*, 2013). Sensitivity and elasticity analyses indicate that adult survival had the strongest effect on the population growth rate. New Zealand right whales are starting to re-colonise habitats where they have not been seen for many years, which may increase their exposure to human impacts such as fishing and shipping.

The sub-committee welcomed this new information. Individuals from all age classes and both sexes are observed in Port Ross, but outside its sheltered waters it is less likely that mother/calf pairs will be encountered than other age classes.

Given that three years is the accepted calving interval for southern right whales, it was suggested that calculation of the proportion of animals with a three-year calving rate could also be conducted as an alternative approach to measuring the average calving rate. The authors noted that they explored a few different calving interval measurement approaches in their paper. The sub-committee was informed that using male re-sightings (from 1995 to 2009), Carroll *et al.* (2013) estimated southern right whale population growth to be 7% (95% CI=5-9%); re-sights of males likely produce more precise trend estimates because they have higher annual availability than females.

6.1.2 Australian right whales

The sub-committee received an update on an annual series of aerial surveys conducted off the southern Australian coast between Cape Leeuwin Western Australia and Ceduna South Australia since 1993. An aerial survey was undertaken over three days in late August, 2016. Because of bad weather, and for the first time in the annual series since 1993, only 'outward' (to the east) flying legs were possible. For comparison with previous results, counts were obtained of 628 individuals including 228 calves of the year. The 2016 counts were higher than the very low count (of 97) in 2015, but still below the recent trend line. Inspection of residuals suggests some evidence for a slowdown in growth rate. From 4,305 photographic images obtained, 323 have been selected for computer-assisted 'matching' with those (some 7,000 images of over 2,000 individuals) already available in the catalogue. Regression analysis of log number against year for the period 1993-2016 gives increase rates for all animals of 0.0541 (95% CI 0.0371, 0.0710) equivalent to an increase of 5.55% (95% CI 3.78, 7.86) per annum, and for cow/calf pairs 0.0584 (0.0343, 0.0824) or 6.01% (3.49, 8.59) per annum, respectively. Current population size, estimated using the simple model adopted at the International Right Whale Workshop held in Buenos Aires, Argentina, in September 2011 (IWC, 2013), for this the 'western' Australian subpopulation, is estimated at 2,195. All but the most recent data have been incorporated into the Australasian Southern Right Whale Photo-Identification Catalogue (ARWPIC, Pirzl *et al.*, 2015) ready for a planned but not yet funded, mark-recapture analysis of life-history parameters, population connectivity and individual movements as well as population abundance and trend. They will inform an assessment of the current conservation status of Australian right whales and their recovery relative to their pre-whaling abundance.

The southern right whale population in southwestern Australia has shown strong population growth but the population estimate for southeastern Australia is 257 (Watson *et al.*, 2015) and the only area where mothers and calves are seen with regularity in southeastern Australia is at Logans Beach near Warrnambool in southwestern Victoria (SEWPAC, 2012). Recent analyses of DELWP sightings data indicate that there is an increase in numbers of whales using the southeast Australian coastline (1993-2011), but no significant increase in the number of breeding females at the Logans Beach nursery each year (Watson *et al.*, in prep). This suggests that the observed increase in number of whales using the southeastern coast is largely driven by the increase in the southwestern population. All photo-identification from southeastern Australia has been incorporated into ARWPIC.

Work conducted at the Head of the Bight (south Australia) now comprises 26 years of cliff-based counts and photo-identifications from 1991 to 2016. Data were collected in the Great Australian Bight Commonwealth Marine Reserve. Southern right whales were primarily distributed within a 15km by 2km area within 10m water depth with distribution comparable across years. Whales occupied the site between May and October with maximum abundance between late July and early August. Up to 28% of calving females were present in mid-June and up to 61% remained at the end of September. The mean residence period was 65 days (ranging between 1 and 99) for calving females and 15 days (ranging between 1 and 51) for unaccompanied adults. Over the study years, between 18 and 81 female and calf pairs were sighted per day. The estimated mean rate of increase in total SRWs sighted at Head of Bight was 5.5% (SD=2.5, 95%CI=0.03) per annum (1991-2016). The corresponding mean rate of increase for females accompanied by a calf was 4.9% (SD=1.9, 95%CI=0.03). The photo-identification database includes 1,186 non-calf individuals, including 459 reproductive females from which a total of 471 subsequent inter-annual calving intervals were recorded. The estimated mean calving interval was 3.3 years (SD=0.8, 95%CI=0.01) with high philopatry resulting in cohort-structured breeding cycles and a corresponding variation in annual abundance. The mean age at first parturition was 9.3 years. Calving dates ranged from 19 June-27 August with a mean calving date of 16 July.

It was noted that more of the western population is passing through Tasmanian and Victorian State waters but that not many whales are seen with calves in those regions. Photo-identifications collected from the Head of the Bight are going to be added to ARWPIC; mark recapture analysis with these data is then planned once sufficient funds are available to support this work. The southern right whale is listed as an endangered species in Australia and understanding the recovery and dynamics is a regional research priority.

The sub-committee **expressed concern** that southeast Australia abundance remains so low despite this area having been a significant calving ground in the 1800s (Dawbin, 1986). They were also informed that the sheltered bays that were formerly calving areas are now under threat by the development of large fish farms. It was queried whether whales off southeast Australia represent a separate management unit from the southwestern population. Genetic evidence to date suggests that it is only marginally differentiated (Carroll *et al.*, 2015); however sample sizes collected from this region to date are extremely small.

In the context of this question, it was noted that a global population structure analysis of southern right whales is going to be received at SC/67b.

SC/67a/ASI07 and SC/67a/SCSP05 summarised the results obtained from components of the 2016/17 NEWREP-A survey: a dedicated sighting survey conducted over a total of 2,937 n.miles in Area V-West (SC/67a/ASI07) and an Antarctic minke whale sampling survey conducted over a total of 3,274 n.miles in Area III-East and Area IV (SC/67a/SCSP05). During these surveys, a total of two schools with two individual southern right whales were sighted. Photo-identification and one biopsy sample were collected from one individual (SC/67a/ASI07).

The sub-committee welcomed this information about sightings outside the calving grounds and in high latitudes.

6.1.3 South African right whales

SC/67a/SH05 summarised the results from the 38th aerial survey of southern right whales conducted between 28 September and 5 October, 2016 along the coast of South Africa between Natures Valley and Muizenberg. Due to the extremely low number of southern right whale sightings in this area, the survey was extended up the west coast of South Africa to Lambert's Bay, for the first time. In total, only 55 cow-calf pairs and 9 unaccompanied whales were sighted during the entire survey. This is the lowest sighting density of the last 25 years and about 10 to 15% of the expected total based on surveys up until 2014. This marked decline in both cow-calf pairs and unaccompanied adults have been recorded in the last few years, with unaccompanied adults declining since 2010 and cow-calf pairs since 2015. The decrease in sightings during the surveys is not believed to reflect an intra-annual temporal shift. And whilst the decline of sightings was first believed to reflect a change in distribution of the whales outside the survey area, especially to the west coast, the lack of sightings during the last survey along the west coast suggests this is not the case. Furthermore, there are no reports of an increase in southern right whale sightings in other areas along the coast of South Africa, Namibia nor Mozambique. Consequently, the reason for this decline remains speculative. The results reflect field counts only and, at this stage, it is impossible to accurately speculate on any long-term changes to the population demographics. Consequently it is imperative that the survey series continue, and analyses are undertaken, so that the temporal-spatial components of the recent observed declines can be monitored and investigated.

In discussion it was noted that SC/67a/SH05 represents an annual snapshot, but that longer-term data from other parts of southern Africa reveal similar seasonal and annual trends in southern right whale numbers and calving rates. Similar two-year reductions in right whale abundance on calving grounds have also been observed in Australian right whale populations in recent years, followed by much higher counts in the third year (Bannister *et al.*, 2016). However, the documented decline is much stronger in southern Africa. It was also noted that the decrease in calving is preceded by a decline in the number of unaccompanied adults one year prior, and that this may represent a reduction in the size and number of breeding groups and, subsequently, opportunities to breed. The authors cautioned however that the role of unaccompanied adults is still unclear.

The sub-committee **recommended** that the Scientific Committee support the 2017 aerial survey of this region, in order to facilitate a better understanding of this trend. There was some discussion about where the right whales may be wintering if they are not on the coast.

Elwen presented the sub-committee with a summary of data on right whale seasonal presence off South Africa and Namibia, in order to address possible causes of the low sightings rates in recent surveys. This was collated from a number of sources including shore based scientific surveys, shore based incidental sightings, sightings from commercial whale watching operators and scientific cetacean focussed surveys from small boats. These data do not suggest any spatial shift in distribution since 2011, nor has there been a shift in the seasonality of right whale occurrence. Instead they also show a reduction in sightings rates at all locations where they have been surveyed, strongly supporting the hypothesis that the animals are likely to be remaining in offshore feeding grounds and are not returning to the coast to calve. The authors were therefore **encouraged** to investigate the potential for offshore movement of the whales during future surveys, as well as to compare their data with other right whale populations that are of similar conservation concern. The authors were invited to provide an update at SC/67b.

6.2 Progress on population assessment

The sub-committee was reminded that the population status of southern right whales was last discussed at a workshop in 2011 (IWC, 2013). Since this time, a population assessment of New Zealand southern right whales has been conducted (Jackson *et al.*, 2016) but not for any other southern right whale population, because of the difficulty of measuring pre-modern whaling catches for this species (Carroll *et al.*, 2014). The sub-committee **agreed** to form a new intersessional email group to review the latest catch history data for southern right whales and decide if any substantive new information is available to assist with assessments of stock status for this species.

7. ANTARCTIC MINKE WHALES

7.1 Review new information

SC/67a/ASI07 and SC/67a/SCSP05 together summarised findings from the 2016/2017 NEWREP-A survey. A dedicated sighting survey was conducted in Area V-West (SC/67a/ASI07) and an Antarctic minke whale sampling survey was conducted in Area III-East and Area IV (SC/67a/SCSP05). The total search distance in the research area was 2,937 n.miles during the dedicated sighting survey and 3,274 n.miles in the Antarctic minke whale sampling survey. During these surveys, a total of 481 schools with 873 individuals of Antarctic minke whales were sighted. Location data from three of the SPOT6 satellite tags deployed on Antarctic minke whales were received (see Apendix 2, SC/67a/ASI07). A feasibility study on biopsy sampling Antarctic minke whales was conducted and 15 biopsy samples were collected (see Appendix 1, SC/67a/ASI07).

The sub-committee thanked the authors for their report and welcomed this new information. Further discussion of these papers can be found in Item 19.2.

SC/67a/SH14 presents the results of a regional assessment of Antarctic minke whales. This has been discussed in Annex G.

8. OTHER

SC/67a/SH12 reported detections of sperm whales, both from visual observations and a towed array of hydrophones, 2014-17 in sub-Antarctic and Antarctic waters of the northwestern Antarctic Peninsula, during IWC-SORP research cruises. Only one individual was sighted off-effort in 2014, and two acoustic detections were positively attributed to sperm whales (classified as usual clicks and slow clicks), suggesting that the animals were probably recorded in a foraging context both near Cape Horn and to the northwest of King George Island. The study increases the knowledge of the current status of sperm whales in the Southern Ocean and emphasises the importance of acoustics to detect populations.

In response to a question about the detection of beaked whales, the authors informed the sub-committee that they had not detected beaked whales in the Bransfield nor the Gerlache Strait, but recorded beaked whales north of Elephant Island and in the Scotia Ridge (Trickey *et al.*, 2015). It was briefly discussed whether these data can be used to detect trends in sperm whale abundance over time. However it was commented that measuring trends in abundance with acoustic data is also very challenging due to problems with measuring group size when two or more individuals are vocalising (Item 6, IWC, 2016).

SC/67a/SH13 reported on the known historical and recent unpublished records of sperm whale captures (Allison, 2016), also including sightings and strandings from Oman and the United Arab Emirates (UAE). The work was undertaken in response to a paucity of other studies across the northern Indian Ocean. Historical data together with recent sightings (n=109) and stranding records (n=28) reveal a year-round presence of sperm whales off the coast of Oman and UAE. Evidence presented indicates that Arabian Sea sperm whales form a discrete population that differs from other Indian Ocean areas (Mikhalev, 2000). This population is likely to be subject to threats associated with a threefold increase in container shipping traffic between 2004 and 2014 through suspected sperm whale habitat around the periphery of the Arabian Sea (Wilson *et al.*, 2016). Dedicated cetacean vessel surveys off Oman over the last 15 years have focused on the Arabian Sea humpback whale, and due to differences in habitat preference have not co-occurred with sperm whale habitat. A project initiated by Government of Fujairah and Port of Fujairah in 2017 is the first dedicated field based study on sperm whales in the region and offers the potential to disseminate information on the negative associations of whales and ships to the 14,000 vessels that visit the port every year. It is hoped that this proactive initiative will support third party collection of sightings data. The authors plan to include sperm whales in the design of future research and conservation management initiatives for large whales in the region, and to use existing genetic samples and photo-identification data to evaluate questions related to population identity and status.

The sub-committee thanked the authors for providing valuable information about a poorly known species, in a poorly known area. In response to a question about population structure analysis, the authors reported that they are exploring collaborations for the analysis of archival tissue samples with the long-term goal of a tractable genetic assessment. The sub-committee noted that previous global analyses of sperm whale population structure have not included samples from the UAE or Oman, but that samples included from the nearest location (Sri Lanka, n=42) showed very low diversity within the Indian Ocean and the strongest genetic differentiation from other sites (Alexander *et al.*, 2016), indicating that the Northern Indian Ocean population may be relatively isolated compared to other regions. The sub-committee therefore **encouraged** the analysis of genetic samples to better assess the level of differentiation and diversity of Northern Indian Ocean sperm whales. The sub-committee was also informed that the stomach contents of two stranded sperm whales were examined, although not in detail, and squid beaks were conspicuous.

Pastene *et al.* (2015) summarised the results of genetic analysis based on mitochondrial DNA sequences to investigate the species identity and population genetic structure of South American Bryde's whales based on historical, biopsy and stranding samples from Chile (n=10) and Brazil (n=8). New data was compared to published sequences of Bryde's whales from the Indian and Pacific Oceans (including Peru, n=24). Phylogenetic results identified the Bryde's whales of South America as *Balaenoptera brydei*. No statistically significant genetic differentiation was found between Chilean and Peruvian Bryde's whales. However, striking differences were found between western South Atlantic (Brazil) and eastern South Pacific (Peru and Chile) Bryde's whales. Striking genetic differences were also found between all South American localities and those from the western North Pacific, Fiji and Java. These results suggest movement of *B. brydei* in the eastern South Pacific in the latitudinal range corresponding to Chile and Peru, but little or very limited movement of whales between the South Pacific and the South Atlantic Oceans. This is consistent with the notion that *B. brydei* is not distributed south of ~40°S on both sides of South America.

The sub-committee thanked the authors and welcomed this information, noting that these populations are poorly understood.

SC/67a/SH15 presented results from an investigation of the occurrence, migration and behaviour of Bryde's whales (*Balaenoptera edeni*) along the Ecuador, Peruvian and Panama coasts. Between 2000 and 2017, 573 marine mammal surveys were conducted. During these, 81 groups of Bryde's whales consisting of 102 individuals were recorded. Sixty-four individuals were photo-identified. Of these, three individuals were re-sighted: two in the same area and one in a different region, suggesting site fidelity within and between areas. The interval between re-sighting is indicative of migration in the southeast Pacific between Ecuador and northern Peru. The estimated distance between these two sightings was 294km.

The sub-committee welcomed this information and noted that it represents the first contribution from Bryde's whale research efforts conducted in Central and South America. The sub-committee noted that two forms of Bryde's whales may be present in this area (i.e. off Peru), and urged genetic research to see if these whales are identified as *B. edeni* and *B. brydei*. The authors note that they have samples from a few strandings and biopsies. The sub-committee noted that identifying the species is high priority and this research will fit into ongoing work described in Annex G.

The receipt of Acevedo *et al.* (2017) regarding the occurrence of sei whales (*Balaenoptera borealis*) in the Magellan Strait, Chile (2004-15), was acknowledged by the sub-committee but due to time limitations there was no discussion of this item.

9. WORK PLAN AND BUDGET CONSIDERATIONS

During SC/66b, the Scientific Committee **agreed** budget allocations for the following two years (2016/17 and 2017/18). More details can be found in IWC (2017). The intersessional work plan and e-mail groups described in Items 9.1-10.6 are listed in Tables 1 and 2 respectively. Following a prioritisation exercise regarding stocks that can be prepared for Comprehensive (or In-depth) assessment (see Appendix 4), the sub-committee **agreed** to focus on the following topics during 2016/17 and 2017/18.

(1) Gather assessment related data on the following with view to completing assessment within 2-5 years (top priority):
   - pygmy blue whales from New Zealand, Indonesia/Australia, southeast Pacific (focus on abundance and trend estimation);
   - southern right whales from southwest and southeast Australia (focus on abundance, trend and catch estimation);
   - range-wide population structure information relevant to discrimination of Southern Hemisphere blue, fin, sei, Bryde's, southern right and Antarctic minke whale stocks; and
   - humpback breeding stock D off west Australia (abundance estimation)

(2) Gather assessment related data on the following with view to assessment within 5-10 years (medium priority):
   - pygmy blue whales from Madagascar (focus on distribution, population identity, abundance and trend);

Table 1

Summary of the work plan for the Southern Hemisphere sub-committee, 2017-18.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Work plan assessment (Item 9)	Agree prioritisation scheme for future SH agenda setting.	
Southern Hemisphere blue whales (Item 3/9.1)		
Antarctic blue whales (Item 3.2)	Antarctic Blue Whale Catalogue – continue matching.	Report
	Continue analysis of Antarctic blue whale baleen plates.	
	Complete analysis of post-CPIII to measure blue whale abundance.	Report
Pygmy-type blue whales (Item 3.3)	Southern Hemisphere Blue Whale Catalogue – matching.	Report
	Analysis of blue whale catches in all regions (pelagic fleets and land stations) to delimit population, boundaries, regions.	Report
	Development of permanent blue whale song reference library to assist with standardization and analysis of call distribution and structure.	Website
Southeast Pacific blue whales (Item 3.3.1)	Analyse Chilean blue whale catch length data and compare with blue whale catches from other regions.	Report
	Reconcile Chilean photo-identification data within the SHBWC.	
	Apply habitat models developed for California Current and Eastern Tropical Pacific to construct habitat use analyses for Chilean blue whales and validate with sightings data.	Report
Southwest Indian Ocean blue whales (Item 3.3.2)	Conclude acoustic study off NW Madagascar.	Report
Australia/Indonesia blue whales (Item 3.3.3)	Complete addition of date/location metadata to Australia/Indonesia blue whale photos within the SHBWC and conduct quality control across all images.	Report
New Zealand blue whales (Item 3.3.4)	Continue reconciliation of NZ photo-identification catalogues within the Southern Hemisphere Blue Whale Catalogue.	Report
Southern Hemisphere fin whales (Item 4/9.2)		
	Complete work on design-based strata-level abundance estimates for fin whales.	Report
	Continue to compile available data and assess gaps for Southern Hemisphere fin whale assessment.	Report
	Complete review of population structuring of Southern Hemisphere fin whales.	Report
	Include newly available Soviet catches in modelling of Southern Ocean fin whale catches to estimate relative densities across the Southern Hemisphere.	Report
Southern Hemisphere humpback whales (Item 5/9.3)		
Ongoing work	Re-analysis of sightings data reported in duFresne to assess best location/approach for new sightings surveys off West Australia (BSD).	Report
	Analysis of high and low latitude stock mixing proportions in the southeastern Indian Ocean and southeast Pacific using genetic data.	Report
Southern right whales not subject to CMP (Item 6/9.4)		
Ongoing work	Update available data regarding pre-modern catches of right whales in the Southern Hemisphere.	Report
	Conduct 2017 right whale aerial survey off South Africa to collect photo-ID and count whales.	Report
IWC-SORP (Item 2)		
	Analysis of data from previous IWC-SORP voyages.	Report
	Argentine coastguard voyage (early 2018).	Cruse report
	Almirante Maximiano voyage (early 2018).	Cruise report
	Baleen whale and krill research voyages in Western Antarctic Peninsula.	Report
	Retrieval and redeployment of passive acoustic recorders.	Report
	Aerial survey for baleen whale distribution in western Antarctic Peninsula.	Report

- southern right whales from South Africa (focus on abundance, trend and catch estimation);
- Southern Hemisphere fin whales (focus on distribution, population identity, abundance, catch and trend);
- humpback whale breeding stock G (southeast Pacific) (focus on abundance); and
- humpback whales breeding in Oceania (south Pacific, breeding stocks E2, E3 and F).

(3) Low priority:
- all other Southern Hemisphere species.

The sub-committee **recognised** the potential use of historical DNA from whalebones from whaling stations (Sremba *et al.*, 2015) in helping to describe population structure of exploited whales. The sub-committee **requested** that the Secretariat provide a letter in support of further collection and importation of Antarctic whalebones for scientific research.

The sub-committee work plan is summarised in Table 1.

9.1 Blue whales

9.1.1 Antarctic blue whales

In the coming year, the work planned for Antarctic blue whales includes: (1) continuing ongoing research; (2) updating, reconciling, and matching of photographs held in the Antarctic Blue Whale Catalogue; (3) continuation of opportunistic data collection; and (4) completion of the review of the available data from the post CPIII IDCR/SOWER surveys to determine whether the data are of any use for informing on Antarctic blue whale trend or abundance.

9.1.2 Pygmy blue whales

Preparation for Southern Hemisphere pygmy blue whale assessments continues. Work will include:

(1) intra-region matching of photographs in the Antarctic Blue Whale Catalogue from regions identified as high priority (southeast Pacific, Australia and New Zealand);
(2) completion of the Antarctic Blue Whale Catalogue migration to the IWC server;

(3) quality control across all Australian, Antarctic Blue Whale Catalogue submissions and continued contribution of photo-identification data and location data to this catalogue;
(4) continued deployment of hydrophones to conduct passive acoustic monitoring in deep water habitat off the northwest coast of Madagascar, to document the presence and seasonality of pygmy blue whales and collect biopsy samples;
(5) development of a permanent blue whale song reference library;
(6) analysis of blue whale catches (pelagic fleets and land stations) using the 2016 IWC catch databases to delimit population structure, boundaries, and regions of possible overlap across the Southern Hemisphere and northern Indian Ocean;
(7) reconciliation of photo-identification catalogues within: (i) New Zealand; and (ii) Chile within the Southern Hemisphere Blue Whale Catalogue in order to enable mark recapture abundance estimation for assessment of these populations; and
(8) compilation of regional sightings data off Chile to validate habitat models constructed for the CC/ETP.

9.2 Fin whales
The work planned for fin whales includes:

(1) a review of data from the post-CPIII IDCR/SOWER surveys to determine whether the data are of any use for informing on fin whale trend or abundance;
(2) the inclusion of Soviet catches in an analysis of fin whale catches which corrects for catcher effort (de la Mare 2014);
(3) continued examination of Southern Hemisphere fin whale population structure; and
(4) continue compilation of a metadata summary for fin whales (e.g. sightings, acoustics, photo-identification) available from the Southern Hemisphere (see Appendix 2).

9.3 Humpback whales
At SC/65b the sub-committee identified key work items which were important for concluding the 2014 assessment of Australia and Oceania (BSD/BSE1/BSO). These have not been completed intersessionally. The following items remain in the work plan for SC/67b:

(1) a re-analysis of sightings data reported in duFresne *et al.* (2014) in order to determine the most appropriate survey method for measuring BSD abundance in future;
(2) evaluation of the available genetic data, assumptions and analytical approaches for establishing mixing proportions of breeding stocks in the Antarctic; and
(3) continuation of ongoing work on the Antarctic Humpback Whale Catalogue to support future assessments.

9.4 Southern Hemisphere right whales not subject to CMP
The activities planned are:

(1) a southern right whale aerial photographic survey in South Africa to continue the time series; and
(2) review of the latest catch history data for southern right whales in order to decide if any new information is available to assist with assessments of stock status for this species.

9.5 IWC-SORP
IWC-SORP activities include:

(1) analysis of data from previous IWC-SORP voyages;
(2) the planning and execution of several research voyages to the Southern Ocean; and
(3) retrieval and redeployment of passive acoustic recorders.

Budgetary implications
The sub-committee **recommended** the following requests for funding over and above the items already approved for funding in 2017/18 at SC/66b (Item 25, p 94, IWC, 2017).

(1) Support for a quality control process to be applied across all Australian submissions to the Southern Hemisphere Blue Whale Catalogue in preparation for a pygmy blue whale assessment (Galletti, Jackson and Olson, cost £2,301 GBP, see Item 3.1).
(2) Support for the 2017 right whale aerial photographic survey in South Africa to continue the time-series, which began in 1979 with a view to determining if the recent, marked decline in numbers sighted (Vermeulen and Findlay, cost £20,000 GBP, see Item 6.1.3).

10. ADOPTION OF THE REPORT
The report was adopted at 18:46 on 17 May 2017. The Chair thanked her co-Chair and rapporteurs for their hard work. The sub-committee thanked Jackson and Bell for their excellent work chairing the meeting.

REFERENCES
Acevedo, J., Aguayo-Lobo, A., González, A., Haro, D., Olave, C., Quezada, F., Martínez, F., Garthe, S. and Cáceres, B. 2017. Occurrence of Sei Whales (*Balaenoptera borealis*) in the Magellan Strait from 2004-2015, Chile. *Aquat. Mamm.* 43(1): 63-72.
Aguayo, L.A. 1974. Baleen whales off continental Chile. pp.209-17. *In*: Schevill, W.E. (eds). *The Whale Problem: A Status Report*. Harvard University Press, Cambridge, Mass. x+419pp.
Alexander, A., Steel, D., Hoekzema, K., Mesnick, S., Engelhaupt, D., Kerr, I., Payne, R. and Baker, C.S. 2016. What influences the worldwide genetic structure of sperm whales (*Physeter macrocephalus*)? *Mol. Ecol.* 25(12): 2754-72.
Allison, C. 2013. IWC individual and summary catch databases Version 5.5 (12 February 2013). Available from the International Whaling Commission, 135 Station Road, Impington, Cambridge CB24 9NP UK, 12 February 2013.
Allison, C. 2016. IWC indivdual and summary catch databases.
Archer, F.I., Morin, P.A., Hancock-Hanser, B.L., Robertson, K.M., Leslie, M.S., Bérubé, M., Panigada, S. and Taylor, B.L. 2013. Mitogenomic phylogenetics of fin whales (*Balaenoptera physalus* spp.): Genetic evidence for revision of subspecies. *PLoS One* 8(5): e63396.
Attard, C.R.M., Beheregaray, L.B., Jenner, K.C.S., Gill, P.C., Jenner, M.N.M., Morrice, M.G., Teske, P.R. and Moller, L.M. 2015. Low genetic diversity in pygmy blue whales is due to climate-induced diversification rather than anthropogenic impacts. *Biol. Lett.* 11: 20141037.
Attard, C.R.M., Beheregaray, L.B. and Möller, L.M. 2016. Towards population-level conservation in the critically endangered Antarctic blue whale: the number and distribution of their populations. *Sci. Rep.* 6: 22291.
Bailey, H., Mate, B.R., Palacios, D.M., Irvine, L., Bograd, S.J. and Costa, D.P. 2009. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. *Endang. Spec. Res.* 10: 93-106.
Balcazar, N.E., Klinck, H., Nieukirk, S.L., Mellinger, D.K., Klinck, K., Dziak, R.P. and Rogers, T.L. 2017. Using calls as an indicator for Antarctic blue whale occurrence and distribution across the southwest Pacific and southeast Indian Oceans. *Mar. Mamm. Sci.* 33(1): 172-86.
Balcazar, N.E., Tripovich, J.S., Klinck, H., Nieukirk, S.L., Mellinger, D.K., Dziak, R.P. and Rogers, T.L. 2015. Calls reveal population structure of blue whales across the southeast Indian Ocean and the southwest Pacific Ocean. *J. Mamm.* 96(6): 1184-93.
Bannister, J.L., Hammond, P.S. and Double, M.C. 2016. Population trend in right whales off southern Australia 1993-2015. Paper SC/66b/BRG09 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 14pp. [Paper available from the Office of this Journal].

Bonner, S.J. and Holmberg, J. 2013. Mark-recapture with multiple, non-invasive marks. *Biometrics* 69(3): 766-75.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.-N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell Jr, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean. *Mamm. Rev.* 37(2): 116-75.

Bravington, M.V., Skaug, H.J. and Anderson, E.C. 2016. Close-Kin Mark-recapture. *Statistical Science* 31(2): 259-74.

Carroll, E., Patenaude, N.J., Alexander, A., Steel, D., Harcourt, R., Childerhouse, S., Smith, S., Bannister, J., Constantine, R. and Baker, C.S. 2011. Population structure and individual movement of southern right whales around New Zealand and Australia. *Mar. Ecol. Prog. Ser.* 432: 257-68.

Carroll, E.L., Baker, C.S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O.E., Gröcke, D.R., Patenaude, N.J. and Harcourt, R. 2015. Migratory traditions shape the genetic structure of southern right whales around Australia and New Zealand. *Sci. Rep.* 5: 16182.

Carroll, E.L., Childerhouse, S.J., Fewster, R.M., Patenaude, N.J., Steel, D., Dunshea, G., Boren, L. and Baker, C.S. 2013. Accounting for female reproductive cycles in a superpopulation capture-recapture framework: application to southern right whales. *Ecol. Appl.* 23(7): 1677-90.

Carroll, E.L., Jackson, J.A., Paton, D. and Smith, T.D. 2014. Two Intense Decades of 19th Century Whaling Precipitated Rapid Decline of Right Whales around New Zealand and East Australia. *PLoS One* 9(4): e93789.

Catchpole, C.K. and Slater, P.J. 2003. *Bird Song: Biological Themes and Variations*. Cambridge University Press.

Cerchio, S., Trudelle, L., Zerbini, A.N., Charrassin, J.B., Geyer, Y., Mayer, F.X., Andrianrivelo, N., Jung, J.L., Adam, O. and Rosenbaum, H.C. 2016. Satellite telemetry of humpback whales off Madagascar reveals insights on breeding behavior and long-range movements within the southwest Indian Ocean. *Mar. Ecol. Prog. Ser.* 562: 193-209.

Chittleborough, R.G. 1965. Dynamics of two populations of the humpback whale, Megaptera Novaeangliae (Borowski). *Australian J. Mar. Freshw. Res.* 16: 33-128.

Clark, C.T., Fleming, A.H., Calambokidis, J., Kellar, N.M., Allen, C.D., Catelani, K.N., Robbins, M., Beaulieu, N.E., Steel, D. and Harvey, J.T. 2016. Heavy with child? Pregnancy status and stable isotope ratios as determined from skin biopsies of humpback whales. *Cons. Physiol.* 4(1): 1-13.

Clarke, R. 2004. Pygmy fin whales. *Mar. Mamm. Sci.* 20(2): 329-34.

Comiso, J.C. and Gordon, A.L. 1998. Interannual variability in summer sea ice minimum, coastal polynyas and bottom water formation in the Weddell Sea. pp.293-315. *In*: Jeffries, O. (eds). *Antarctic Sea Ice: Physical Processes, Interactions and Variability*, Washington D.C.

Committee on Taxonomy. 2016. List of marine mammal species and subspecies. Society for Marine Mammalogy, *http://www.marinemammalscience.org*, consulted on 16th May 2017.

Curtice, C., Johnston, D.W., Ducklow, H., Gales, N., Halpin, P.N. and Friedlaender, A.S. 2015. Modeling the spatial and temporal dynamics of foraging movements of humpback whales (*Megaptera novaeangliae*) in the Western Antarctic Peninsula. *Mov. Ecol.* 3(1): 13.

Dawbin, W.H. 1986. Right whales caught in waters around south eastern Australia and New Zealand during the nineteenth and early twentieth centuries. *Rep. Int. Whal. Comm. (Special Issue)* 10: 261-67.

de la Mare, W.K. 2014. Estimating relative abundance of whales from historical Antarctic whaling records. *Can. J. Fish. Aquat. Sci.* 71(106-119).

Double, M.C., Andrews-Goff, V., Jenner, K.C.S., Jenner, M.N., Laverick, S.M., Branch, T.A. and Gales, N.J. 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as revealed by satellite telemetry. *PLoS One* 9(4): e93578.

Double, M.C., Barlow, J., Miller, B.S., Olson, P., Andrews-Goff, V., Leaper, R., Ensor, P., Kelly, N., Wadley, V., Lindsay, M., Peel, D., Calderan, S., Collins, K., Davidson, M., Deacon, C., Donnelly, D., Olavarria, C., Owen, K., Rekdahl, M.L., Schmitt, N. and Gales, N. 2013. Cruise report of the 2013 Antarctic blue whale voyage of the Southern Ocean Research Partnership. Paper SC/65a/SH21 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 16pp. [Paper available from the Office of this Journal].

Double, M.C., Miller, B.S., Leaper, R., Olson, P., Cox, M.J., Miller, E., Calderan, S., Collins, K., Donnelly, D., Ensor, P., Goetz, K., Schmitt, N., Andrews-Goff, V., Bell, E. and O'Driscoll, R. 2015. Cruise report on blue whale research from the NZ/Australia Antarctic Ecosystems Voyage 2015 of the Southern Ocean Research Partnership. Paper SC/66a/SH07 presented to the IWC Scientific Committee, May 2015, San Diego, USA (unpublished). [Paper available from the Office of this Journal].

duFresne, S., Hodgson, A., Smith, J., Bennett, L., Burns, D., MacKenzie, D. and Steptoe, V. 2014. Final report: Breeding stock 'D' humpback whale pilot surveys - methods and location. Prepared for the Australian Marine Mammal Centre. 67pp.

Félix, F., Botero, N. and Falcon, J. 2007. Observation of a blue whale (*Balaenoptera musculus*) feeding in coastal waters of Ecuador. *Latin Am. J. Aquat. Mamm.* 6: 193-97.

Galletti Vernazzani, B., Jackson, J.A., Cabrera, E., Carlson, C. and Brownell Jr, R.L. 2017. Estimates of abundance and trend of Chilean blue whales of Isla de Chiloé, Chile. *PLoS One* 12(1): e0168646.

Gavrilov, A.N., McCauley, R.D. and Gedamke, J. 2012. Steady inter and intra-annual decrease in the vocalization frequency of Antarctic blue whales. *J. Acoust. Soc. Am.* 131(6): 4476-80.

Gedamke, J. 2009. Geographic variation in Southern Ocean fin whale song. Paper SC/61/SH16 presented to the IWC Scientific Committee, May 2009 (unpublished). 8pp. [Paper available from the Office of this Journal].

Hedley, S.L., Dunlop, R.A. and Bannister, J.L. 2011. Evaluation of WA Humpback surveys 1999, 2005, 2008: Where to from here? Report to the Australian Marine Mammal Centre on work done to 6th May, 2011. 28pp.

International Whaling Commission. 2013. Report of the IWC Workshop on the Assessment of Southern Right Whales. *J. Cetacean Res. Manage. (Suppl.)* 14:439-62.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 16:196-221.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 17:250-82.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

Jackson, J.A., Carroll, E.L., Smith, T.D., Zerbini, A.N., Patenaude, N. and Baker, C.S. 2016. An integrated approach to historical population assessment of the great whales: case of the New Zealand southern right whale. *Roy. Soc. Open Sci.* 3(3): 150669.

Kelly, N., Miller, B., Peel, D., Double, M., De La Mare, B. and Gales, N. 2012. Strategies to obtain a new circumpolar abundance estimate for Antarctic blue whale: survey design and sampling protocols. Paper SC/64/SH10 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 34pp. [Paper available from the Office of this Journal].

Kershaw, F., Carvalho, I., Loo, J., Pomilla, C., Best, P.B., FIndlay, K., Cerchio, S., Collins, T., Engel, M.H., Minton, G., Ersts, P., Barendse, J., Kotze, P.G.H., Razafindrakoto, Y., Ngouessono, S., Meÿer, M., Thorton, M. and Rosenbaum, H.C. 2017. Multiple processes drive genetic structure of humpback whale (*Megaptera novaeangliae*) populations across spatial scales. *Mol. Ecol.* 26(4): 977-994.

Kibblewhite, A.C., Denham, R.N. and Barnes, D.J. 1967. Unusual low-frequency signals observed in New Zealand waters. *J. Acoust. Soc. Am.* 41: 644-55.

LeDuc, R.G., Archer, E.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.R., van Waerebeek, K., Brownell Jr, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern Pacific: implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26(3): 740-51.

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S., LeDuc, C.A. and Brownell Jr., R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales and the use of assignment tests to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9(1): 73-80.

Matsuoka, K. and Hakamada, T. 2014. Estimates of abundance and abundance trend of the blue, fin and southern right whales in the Antarctic Areas IIIE-VIW, south of 60S, based on JARPA and JARPAII sighting data (1989/20-2008/09). Paper SC/F14/J05 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 27pp. [Paper available from the Office of this Journal].

McClintock, B.T., Conn, P.B., Alonso, R.S. and Crooks, K.R. 2013. Integrated modeling of bilateral photo-identification data in mark-recapture analyses. *Ecology* 94(7): 1464-71.

McDonald, M.A., Mesnick, S.L. and Hildebrand, J.A. 2006. Biogeographic characterisation of blue whale song worldwide: using song to identify populations. *J. Cetacean Res. Manage.* 8(1): 55-65.

Menze, S., Zitterbart, D.P., Opzeeland, I.V. and Boebel, O. 2017. The influence of sea ice, wind speed and marine mammals on Southern Ocean ambient sound. *Roy. Soc. Open Sci.* 4: 160370.

Mikhalev, Y.A. 2000. Whaling in the Arabian Sea by the whaling fleets *Slava* and *Sovetskaya Ukraina*. pp.141-81. *In*: Yablokov, A.V., Zemsky, V.A. and Tormosov, D.D. (eds). *Soviet Whaling Data (1949-1979)*. Centre for Russian Environmental Policy, Moscow. 408pp.

Miller, B.S., Barlow, J., Calderan, S., Collins, K., Leaper, R., Olson, P., Ensor, P., Peel, D., Donnelly, D., Andrews-Goff, V., Olavarría, C., Owen, K., Rekdahl, M., Schmitt, N., Wadley, V., Gedamke, J., Gales, N. and Double, M. 2015. Validating the reliability of passive acoustic localisation: a novel method for encountering rare and remote Antarctic blue whales. *Endang. Spec. Res.* 26: 257-69.

Oleson, E.M., Calambokidis, J., Burgess, W.C., McDonald, M.A., LeDuc, C.A. and Hildebrand, J.A. 2007. Behavioural context of call production by eastern North Pacific blue whales. *Mar. Ecol. Prog. Ser.* 330: 269-84.

Palacios, D.M. 1999. Blue whale (*Balaenoptera musculus*) occurrence off the Galápagos Islands, 1978-1995. *J. Cetacean Res. Manage.* 1: 41-51.

Pastene, L.A., Acevedo, J., Siciliano, S., Sholl, T.G.C., de Moura, J.F., Ott, P.H. and Aguayo-Lobo, A. 2015. Population genetic structure of the South American Bryde's whale. *Revista de Biologia Marina y Oceanografia* 50(3): 453-64.

Pirzl, R., Lawton, K., Townsend, A., Murdoch, G., Cusick, J. and Double, M.C. 2015. ARWPIC: a tool for collaborative assimilation and management of photo-identification datasets. Paper SC/66a/BRG13 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 7pp. [Paper available from the Office of this Journal].

Redfern, J.V., Moore, T.J., Fiedler, P.C., de Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Diversity and Distributions* 23: 394-408.

Samaran, F., Guinet, C., Adam, O., Motsch, J.F. and Cansi, Y. 2010. Source level estimation of two blue whale subspecies in southwestern Indian Ocean. *J. Acoust. Soc. Am.* 127(6): 3800-8.

Shabangu, F.W., Yemane, D., Stafford, K.M., Ensor, P. and Findlay, K.P. 2017. Modelling the effects of environmental conditions on the acoustic occurrence and behaviour of Antarctic blue whales. *PLoS One* 12(2): e0172705.

Širović, A., Hildebrand, J.A. and Wiggins, S.M. 2007. Blue and fin whale call source levels and propagation range in the Southern Ocean. *J. Acoust. Soc. Am.* 122(2): 1208-15.

Sremba, A., Martin, A.R. and Baker, C.S. 2015. Species identification and likely catch time period of whale bones from South Georgia. *Mar. Mamm. Sci.* 31(1): 122-32.

Sremba, A.L., Hancock-Hanser, B., Branch, T.A., LeDuc, R.L. and Baker, C.S. 2012. Circumpolar Diversity and Geographic Differentiation of mtDNA in the Critically Endangered Antarctic Blue Whale (*Balaenoptera musculus intermedia*). *PLoS One* 7(3): e32579.

Stafford, K.M., Chapp, E., Bohnenstiehl, D.R. and Tolstoy, M. 2011. Seasonal detection of three types of "pygmy" blue whale calls in the Indian Ocean. *Mar. Mamm. Sci.* 27(4): 828-40.

Stafford, K.M., Fox, C.G. and Clark, D.S. 1998. Long-range acoustic detection and localization of blue whale calls in the Northeast Pacific Ocean. *J. Acoust. Soc. Am.* 104: 3616-25.

Thomisch, K., Boebel, O., Clark, C.W., Hagen, W., Spiesecke, S., Zitterbart, D.P. and Van Opzeeland, I. 2016. Spatio-temporal patterns in acoustic presence and distribution of Antarctic blue whales *Balaenoptera musculus intermedia* in the Weddell Sea. *Endang. Spec. Res.* 30: 239-53.

Torres-Florez, J.P., Hucke-Gaete, R., LeDuc, R., Lang, A., Taylor, B., Pimper, L.E., Bedriñana-Romano, L. and Rosenbaum, H.C. 2014a. Blue whale population structure along the eastern South Pacific Ocean: evidence of more than one population. *Mol. Ecol.* 23(24): 5998-6010.

Torres-Florez, J.P., Hucke-Gaete, R., LeDuc, R., Lang, A., Taylor, B., Pimper, L.E., Bedrinana-Romano, L., Rosenbaum, H.C. and Figueroa, C.C. 2014b. Blue whale population structure along the eastern South Pacific Ocean: evidence of more than one population. *Mol. Ecol.* 23(24): 5998-6010.

Torres, L., Rayment, W.J., Olavarría, C., Thompson, D., Graham, B., Baker, C.S., Patenaude, N., Bury, S.J., Boren, L., Parker, G. and Carroll, E.L. 2016. Demography and ecology of southern right whales *Eubalaena australis* wintering at sub-Antarctic Campbell Island, New Zealand. *Polar Biol.* 40(1): 95-106.

Trickey, J.S., Baumann-Pickering, S., Hildebrand, J.A., Reyes Reyes, V., Melcón, M.L. and Iñiguez, M. 2015. Antarctic beaked whale echolocation signals near South Scotia Ridge. *Mar. Mamm. Sci.* 31(3): 1265-74.

Watson, M., Westhorpe, I., Bannister, J., Harcourt, R. and Hedley, S. 2015. Assessment of numbers and distribution of southern right whales in south-east Australia - Year 2. Australian Marine Mammal Centre Grants Program Final Report for Project 13/29.

Weinstein, B., Double, M., Gales, N., Johnston, D. and Friedlaender, A.S. 2017. Identifying overlap between humpback whale foraging grounds and the Antarctic krill fishery. *Biol. Cons.* 210: 184-91.

Willson, A., Kowalik, J., Godley, B.J., Baldwin, R., Struck, A., Struck, L., Nawaz, R. and Witt, M.J. 2016. Priorities for addressing whale and ship co-occurrence off the coast of Oman and the wider North Indian Ocean. Paper SC/66b/HIM10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 13pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of agenda
   1.5 Review of documents
2. IWC-Southern Ocean Research Partnership
3. Pre-assessment of Southern Hemisphere blue whales
   3.1 Southern Hemisphere population structure
   3.2 Antarctic blue whales
      3.2.1 Genetic studies
      3.2.2 Cruise reports
      3.2.3 Acoustic studies
      3.2.4 Progress toward population assessment
   3.3 Pygmy-type blue whales
      3.3.1 Southeast Pacific blue whales
         3.3.1.1 Review new information
         3.3.1.2 Progress on population assessment
      3.3.2 Madagascar blue whales
      3.3.3 Indonesia/Australia blue whales
      3.3.4 New Zealand blue whales
4. Pre-assessment of Southern Hemisphere fin whales
   4.1 Southern Hemisphere population structure
   4.2 Southern Hemisphere distribution
   4.3 Cruise reports
   4.4 Acoustic studies
   4.5 Progress on population assessment
   4.6 Other
5. Southern Hemisphere humpback whales
   5.1 Update on Breeding stock D assessment
   5.2 Review new information
      5.2.1 Breeding stock G
      5.2.2 Feeding grounds
6. Southern Hemisphere right whales not subject to CMP
   6.1 Review new information
      6.1.1 New Zealand right whales
      6.1.2 Australian right whales
      6.1.3 South Africa right whales
      6.1.4 Feeding grounds
   6.2 Progress on population assessment
7. Antarctic minke whales
   7.1 Review new information
8. Other
9. Work plan
   9.1 Blue whales
   9.2 Humpback whales
   9.3 Fin whales
   9.4 Southern right whales
   9.5 IWC-SORP
10. Adoption of the Report

Appendix 2

SOUTHERN HEMISPHERE FIN WHALE METADATA TABLES

Table 1

Meta information on identified data sets containing fin whale records from the Western Antarctic Peninsula (WAP) and Scotia Sea region from the post-whaling era.

Description	Region	Time period	Survey effort (km)	No. fin whale sightings [groups (ind)]	References, comments	Data holder, contact
DESIGN-BASED SURVEYS						
IDCR/SOWER Dedicated shipboard surveys	WAP and Scotia Sea, mostly south of 60°S, but several transit legs and dedicated fin whale research areas further north	1981/82 and 1982/83 (CPI) 1986/87 and 1989/90 (CPII) 1993/94 and 1999/00 (CPIII)	37,550 39,400 10,385 (south of 55°S)	16 (71) 24 (95) 26 (98)	Fig. 2 Fig. 3 Fig. 4	IWC
IWC/CCAMLR dedicated sighting survey (CCAMLR 2000)	Scotia Sea	Jan.-Feb 2000	-	44	Hedley *et al.* (2001)	IWC/CCAMLR
DEDICATED SURVEYS FROM PLATFORMS OF OPPORTUNITY						
Sighting survey from opportunistic platforms (*Yermolova, Orlova*), 8 return legs	Return legs between Ushuaia - WAP	Dec. 00-Feb. 01	5,147	34	Effort detailed in Williams *et al.* (2006), fin whale data, unpubl.	Rob Williams
Sighting survey from opportunistic platform (*Explorer*), 6 return legs	Return legs between Ushuaia - WAP	Dec. 01-Feb. 02	4,834	46	Effort detailed in Williams *et al.* (2006), fin whale data, unpubl.	Rob Williams
Sighting surveys during US AMLR cruises	WAP	2003-11	-	-	Santora *et al.* (2014)	NOAA, *Christian.Reiss@noaa.gov*
Helicopter survey operating from *Polarstern*	Northern WAP	Dec. 06-Jan. 07	9,000	10	Scheidat *et al.* (2011); Kock *et al.* (2010)	ITAW; Helena Herr
Helicopter survey operating from *Polarstern*	WAP	Jan. 2010	6,200	2	Unpublished	ITAW; Helena Herr
Sighting survey from opportunistic platform (*Polarstern*)	Northern WAP, Elephant Island	Mar.-Apr. 2012	tbc	155	Burkhardt and Lanfredi (2012)	AWI; Elke Burkhardt
Sighting survey from opportunistic platform (*Polarstern*)	Northern WAP	Mar.-Apr. 2012	N/A	105 (308)	Joiris and Dochy (2013)	-
Helicopter survey operating from *Polarstern*	Northern WAP	Feb.-Mar. 2013	7,250	123 (350)	Herr *et al.* (2016)	ITAW; Helena Herr
Sighting survey from opportunistic platform (*Cabo de Hornos*), CCAMLR fin fish survey	Around 60°50' to 60°83'S, 44°25' to 46°25'W and Elephant Island	Jan.-Feb. 2016	463	44 (61)	Viquerat and Herr (2017)	ITAW; Helena Herr, Sacha Viquerat
Opportunistic sighting data (dedicated observers)	Northern WAP	Feb.-Mar. 2013 Jan. 2014 Feb.-Mar. 2014 Feb. 2015 Feb. 2016 Jan. 2017	2,652 98 1,509 783 794 N/A	26 8 95 40 15 7	Reyes Reyes and Iñíguez (2013); Reyes Reyes *et al.* (2015); Reyes Reyes *et al.* (2014)	Fundación Cethus; Miguel Iñíguez, Vanesa Reyes Reyes, Marta Hevia
Sighting surveys during PROANTAR	Northern WAP	1998-2017	tbc	313	Ongoing analyses	Luciano Dalla Rosa
Sighting survey from opportunistic platform (James Clark Ross) JR15004	Around 60°50' to 60°83'S, 44°25' to 46°25'W	Jan.-Feb. 2016	tbc	182 (612)	Unpublished	BAS, Claire Waluda
OPPORTUNISTIC SIGHTINGS						
Sightings from vessels of opportunity collected by the SGWM (*www.sgmuseum.gs*)	Around 54°26'S, 36°33'W	1991-2015	N/A	>100	*www.sght.org*	SGHT
Systematic collection of oppor-tunistic sighting data from the bridge of *Polarstern* (WALOG)	Northern WAP, Drake Passage, Scotia Arc	2005-today	N/A	>225 (400)	PANGEA	AWI; Elke Burkhardt
Sightings collected from *James Clark Ross (JR47, 70 and 100)*	Around 54°26'S, 36°33'W, Scotia Sea	2000, 2002, 2004	tbc	14 (28)	-	BAS, Claire Waluda

Description	Region	Time period	Recording hours	Fin whale presence	References, comments	Data holder, contact
ACOUSTIC DATA						
HAFOS moored recorder	WAP	2013-present	tbc	Confirmed	-	AWI, Ilse van Opzeeland
7 moored HaruPhones by PMEL	Drake Passage (1), Bransfield Strait (6)	tbc	tbc	tbc	Unpublished data	PMEL
SOWER Sonobuoy Survey	Circumpolar, 50-80°S	1996-2009	2700	Few detections	-	IWC
8 moored ARPs by SIO	WAP (8)	2001-03	>35,000	Confirmed	Sirovic *et al.* (2004)	SIO
1 moored MARU by BAS	Scotia Arc (1)	tbc	tbc	tbc	Pangerc (2010)	BAS
3 moored HARUphones	Scotia Arc (3)	2006-07	˜4000	tbc	Unpublished data	PMEL
1 moored ARP	Scotia Sea (1)	2003	˜3000	Confirmed	Sirovic *et al.* (2009)	SIO
3 moored HARP	Elephant Island (2) South Shetland Islands (1)	Mar.-Jul. 2014, Feb. 2015-Jan. 2016, Feb.-Dec. 2016, present	˜20 000	Confirmed	Baumann-Pickering *et al.* (2015)	SIO and Fundación Cethus
ACE sonoboy survey	WAP	Feb.-Mar. 2017	tbc	Confirmed	-	AAD

Description	Region	Time period	Tag duration	No. tagged fin whales	References, comments	Data holder, contact
TELEMETRY						
Tracking data (MK10 PAT) by FURG	Northern WAP	2014-17	tbc	4	ongoing analyses	Luciano Dalla Rosa

Description	Region	Time period	No. samples	No. biopsied fin whales	References, comments	Data holder, contact
BIOPSIES						
Biopsy samples by FURG	Northern WAP	2013-17	tbc	26	Ongoing analyses	Luciano Dalla Rosa

Description	Region	Time period	No. photos	No. photographed fin whales	References, comments	Data holder, contact
PHOTO IDENTIFICATION						
Photo-ID photo collection	Northern WAP	2013-17	tbc	tbc	Ongoing analyses	Luciano Dalla Rosa
Photo-ID photo collection	Northern WAP and South Orkney Islands	2013-16	N/A	N/A	N/A	Fundación Cethus

N/A=not available; tbc=to be confirmed.

REFERENCES

Baumann-Pickering, S., Širović, A., Trickey, J.S., Hildebrand, J.A., Reyes Reyes, M.V., Melcón, M. and Iñíguez, M.A. 2015. Cetacean presence near Elephant Island, Antarctica, based on passive acoustic monitoring. Paper SC/66a/SH18 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Burkhardt, E. and Lanfredi, C. 2012. Fall feeding aggregrations of fin whales off Elephant Island (Antarctica). Paper SC/64/SH9 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 6pp. [Paper available from the Office of this Journal].

Hedley, S., Reilly, S., Borberg, J., Holland, R., Hewitt, R., Watkins, J., Naganobu, M. and Sushin, V. 2001. Modelling whale distribution: a preliminary analysis of data collected on the CCAMLR-IWC krill synoptic survey, 2000. Paper SC/53/E9 presented to the IWC Scientific Committee, July 2001, London (unpublished). 38pp. [Paper available from the Office of this Journal].

Herr, H., Viquerat, S., Siegel, V., Kock, K.-H., Dorschel, B., Huneke, W.G.C., Bracher, A., Schroder, M. and Gutt, J. 2016. Horizontal niche partitioning of humpback and fin whales around the West Antarctic Peninsula: evidence from a concurrent whale and krill survey. *Polar Biol.* 39: 799-818.

Joiris, C.R. and Dochy, O. 2013. A major autumn feeding ground for fin whales, southern fulmars and grey-headed albatrosses around the South Shetland Islands, Antarctica. *Polar Biology* 36(11): 649-1658.

Kock, K.-H., Herr, H., Scheidat, M., Bräger, S., Lehnert, K., Lehnert, L.S., Verdaat, H., Williams, R., Sibert, U. and Boebel, O. 2010. Sighting surveys from a ship and a helicopter in the Weddell Sea in 2006/07 and 2008/09. Paper SC/62/O15 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 32pp. [Paper available from the Office of this Journal].

Pangerc, T. 2010. Baleen whale presence around South Georgia. PhD thesis, University of East Anglia, Norwich, UK.

Reyes Reyes, M.V., Hevia, M., Jones, J., Trickey, J.S., Baumann-Pickering, S., Melcón, M.L., Hildebrand, J.A. and Iñíguez, M.A. 2015. Sightings and acoustic records of cetaceans during the SORP voyage 2015 along the western Antarctic Peninsula. Paper SC/66a/SH20 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 9pp. [Paper available from the Office of this Journal].

Reyes Reyes, M.V. and Iñíguez, M. 2013. Occurrence of cetaceans in the Scotia Sea during February-March 2013. Paper SC/65a/SH10 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 7pp. [Paper available from the Office of this Journal].

Reyes Reyes, M.V., Trickey, J.S., Baumann-Pickering, S., Melcón, M., Hildebrand, J.A. and Iñíguez, M.A. 2014. Sightings and acoustic records of cetaceans during the SORP voyage 2014. Paper SC/65b/SH16rev presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].

Santora, J.A., Schroeder, I.D. and Loeb, V.J. 2014. Spatial assessment of fin whale hotspots and their association with krill within an important Antarctic feeding and fishing ground. *Marine Biol.* 161: 2293-305.

Scheidat, M., Friedlaender, A., Kock, K.-H., Linn, L., Boebel, O., Roberts, J. and Williams, R. 2011. Cetacean surveys in the Southern Ocean using icebreaker-supported helicopters. *Polar Biol.* 34(10): 1513.

Sirovic, A., Hildebrand, J.A., Wiggins, S.M., McDonald, M.A., Moore, S.E. and Thiele, D. 2004. Seasonality of blue and fin whale calls west of the Antarctic Peninsula. *Deep-Sea Res.* II(51): 2327-44.

Sirovic, A., Hildebrand, J.A., Wiggins, S.M. and Thiele, D. 2009. Blue and fin acoustic presence around Antarctica during 2003 and 2004. *Mar. Mamm. Sci.* 25(1): 125-36.

Viquerat, S. and Herr, H. 2017. Mid-summer abundance estimates of fin whales (*Balaenoptera physalus*) around the South Orkney Islands and Elephant Island. *Endang. Species Res.* 32: 515-24.

Williams, R., Hedley, S.L. and Hammond, P.S. 2006. Modeling distribution and abundance of Antarctic baleen whales using ships of opportunity. *Ecology and Society* 11(1): [online: *http://www.ecologyandsociety.org/vol11/iss1/art1/*].

Table 2

Meta information on identified data sets containing fin whale records from areas around Antarctica other than the WAP and Scotia Sea region from the post-whaling era.

Description	Region	Time period	Survey effort (km)	No. fin whale sightings [groups (ind)]	References, comments	Data holder, contact
DESIGN-BASED SURVEYS						
IDCR/SOWER dedicated shipboard surveys	Circumpolar	1978/79-2009/10	tbc	tbc		IWC
JARPA and JARPA II dedicated shipboard sighting surveys	Areas III, IV, V, VI (south of 60°S, 35°E-145°W)	1987/88-2008/09	654,003	1,228 (5,077)*	Matsuoka and Hakamada (2014)	ICR, Koji Matsuoka
Dedicated sighting survey	Area IV (south of 60°S, 70°E-115°E)	2014/15	7,165	104 (236)*	Matsuoka *et al.* (2015)	ICR, Koji Matsuoka
NEWREP-A sampling and sighting survey	Area V (south of 60°S, 130°E-170°W)	2015/16	2,394	10 (23)*	Mogoe *et al.* (2016)	ICR, Koji Matsuoka
NEWREP-A dedicated sighting survey	Area V (south of 60°S, 130°E-165°E)	2016/17	5,439	21 (67)*	SC/67a/ASI07	ICR, Koji Matsuoka
NEWREP-A sampling and sighting survey	Area III-E (south of 60°S, 45°E-70°E)	2016/17	6,063	97 (238)*	SC/67a/SCSP05	ICR, Koji Matsuoka
DEDICATED SURVEYS FROM PLATFORMS OF OPPORTUNITY						
Sighting survey from opportunistic platform (*Polarstern*), return leg between Cape Town and Neumayer	IWC Area II (Lazarev Sea)	Dec. 08	2,000	5	Kock *et al.* (2009); Kock *et al.* (2010)	ITAW, Helena Herr
Helicopter survey operating from *Polar-stern,* return leg between Cape Town and Neumayer	IWC Area II (Lazarev Sea)	Dec. 08	13,300	16	Kock *et al.* (2009); Kock *et al.* (2010)	ITAW; Helena Herr
Sighting survey from opportunistic platform (*Polarstern*), return leg between Cape Town and Neumayer	IWC Area II (Lazarev Sea)	Dec. 14-Jan. 15	900	13	Viquerat *et al.* (2015)	ITAW, Helena Herr
SORP sighting survey	IWC Area V	Jan.-Feb. 2013	tbc	61	Blue whale voyage, fin whale data unprocessed	AAD
SORP sighting survey	IWC Area V	Jan.-.Feb 2015	tbc	4	Blue whale voyage, fin whale data unprocessed	AAD
BROKE-West (multidisciplinary voyage in CCAMLR 58.4.2)	IWC Area III and IV (30-80°E)	Jan.-Mar. 2006	tbc	26 (132); 16 (62) like-fin	Unpublished fin whale data, but survey details in Nicol (2010)	AAD
OPPORTUNISTIC SIGHTINGS						
Systematic collection of opportunistic sighting data from *Polarstern*	Weddell Sea, Amundsen Sea, Lazarev Sea	2005-today	N/A	>100	PANGEA	AWI; Elke Burkhardt

Description	Region	Time period	Recording hours	Fin whale presence	References, comments	Data holder, contact
ACOUSTIC DATA						
HAFOS moored recorder	Greenwich Meridian (1)	2008-present	tbc	Confirmed	-	AWI, Ilse van Opzeeland
AURAL 2 moored recorders *(AWI 230-6, AWI 232-9)*	Greenwich Meridian (2)	tbc	tbc	tbc	-	AWI
HAFOS moored recorder	Weddel Sea (1)	2010-present	tbc	Confirmed	-	AWI, Ilse van Opzeeland
PALAOA, Neumayer Observatory	Neumayer (Antarctic coastal region close to shelf) (2)	2006-present	tbc	Confirmed	-	AWI, Ilse van Opzeeland
7 OHASISBIO moored recorders	Southern Indian Ocean	2009-present	tbc	Confirmed	Tsang-Hin-Sun *et al.* (2015)	ENSTA, Flore Samaran LGO, JY Royer
SOWER sonobuoy survey	Circumpolar, 50-80°S	1996-2009	2,700	Few detections	N/A	IWC
Sonobuoy survey	60°W-180°E	2003-today	>100,000h	Many detections	-	SORP Acoustic Trends Project
ACE sonoboy survey	150°E-10°E	Jan.-Mar. 2017	tbc	Confirmed	-	AAD
1 moored ARP	Ross Sea	tbc	tbc	tbc	Sirovic *et al.* (2009)	SIO

Description	Region	Time period	Recording hours	Fin whale presence	References, comments	Data holder, contact
4 Curtin acoustic logger *(Curtin54S.2006, Curtin54S.2008, Curtin.Kerguelen.2009, Curtin65S. 2006)*, 1 ARP moored recorder *(ARPKerguelen05)*	IWC Area V (5) (Kerguelen)	2006-09	tbc	tbc	Gedamke *et al.* (2006); Gedamke *et al.* (2007)	AAD
2 ARP moored recorders *(ARPPrydz05, ARPCasey04)*	Prydz Bay (1), Casey (1)	2004-05	tbc	tbc	Gedamke *et al.* (2007)	AAD
1 Curtin acoustic logger *(Curtin.Casey.2010)*	Casey (1)	2010	tbc	tbc		AAD
1 ARP recorder (*EA*)	Area IV	2005	tbc	tbc	McKay 2005, Širović et al. 2009	SIO

Description	Region	Time period	No. samples	No. biopsied fin whales	References, comments	Data holder, contact
BIOPSIES						
SOWER	Area III	2005/06, 2006/07	43	tbc		IWC
JARPA and JARPAII	Areas IIIE, IV, V and VIW	1998/99-2010/11	55	55	Goto *et al.* (2014), ongoing update	ICR, Luis Pastene
Dedicated sighting survey	Area IV (70°E-115°E)	2014/15	9	9	Matsuoka *et al.* (2015)	ICR, Koji Matsuoka
Dedicated sighting survey	Area IV (115°E-130°E)	2015/16	7	7	Isoda *et al.* (2016)	ICR, Koji Matsuoka

Description	Region	Time period	No. photos	No. photographed fin whales	References, comments	Data holder, contact
PHOTO-ID						
SOWER photo-identification photo collection	Mainly Area III, also IV, V	2005-08	1,127	Several to dozens	Raw data	IWC

*A total of primary and secondary sighted number.

REFERENCES

Gedamke, J., Gales, N., Hildebrand, J. and Wiggins, S. 2006. Seasonal occurrence of low frequency whale vocalisations in waters of East Antarctica, February 2005-February 2006. Paper SC/58/O17 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 6pp. [Paper available from the Office of this Journal].

Gedamke, J., Gales, N., Hildebrande, J. and Wiggins, S. 2007. Seasonal occurrence of low frequency whale vocalizations across eastern Antarctic and southern Australian waters, February 2004 to February 2007. Paper SC/59/SH5 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Goto, M., Kanda, N. and Pastene, L.A. 2014. Genetic analysis on stock structure of fin whales in the Antarctic based on mitochondrial and microsatellite DNA. Paper SC/F14/J32 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 9pp. [Paper available from the Office of this Journal].

Isoda, T., Kawabe, S., Ohkoshi, C., Mogoe, T. and Matsuoka, K. 2016. Results of the NEWREP-A dedicated sighting survey in Area IV during the 2015/16 austral summer season. Paper SC/66b/IA05 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 26pp. [Paper available from the Office of this Journal].

Kock, K.-H., Herr, H., Scheidat, M., Bräger, S., Lehnert, K., Lehnert, L.S., Verdaat, H., Williams, R., Sibert, U. and Boebel, O. 2010. Sighting surveys from a ship and a helicopter in the Weddell Sea in 2006/07 and 2008/09. Paper SC/62/O15 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 32pp. [Paper available from the Office of this Journal].

Kock, K.H., Scheidat, M., Boebel, O., Bräger, S., Herr, H., Lehnert, K., Lehnert, L.S., Verdaat, H. and Williams, R. 2009. The occurrence of cetaceans along two transects from 57°S to Atka Bay (70°29.6'S/07°57.6'W). Paper SC/61/IA11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 19pp. [Paper available from the Office of this Journal].

Matsuoka, K. and Hakamada, T. 2014. Distribution pattern of whale species sighted in the Antarctic based on JARPA and JARPAII sighting surveys (1987/88 to 2008/09). Paper SC/F14/J17 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 15pp. [Paper available from the Office of this Journal].

Matsuoka, K., Tsunekawa, M., Yamaguchi, F., Honma, H., Ohkoshi, C. and Abe, N. 2015. Cruise report of the 2014/15 Japanese dedicated whale sighting survey in the Antarctic in Area IV. Paper SC/66a/IA07 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 22pp. [Paper available from the Office of this Journal].

Mogoe, T., Matsuoka, K., Nakai, K., Sato, H., Sato, T., Tsunekawa, M., Yoshimura, I., Yamazaki, M., Fujii, K., Yoshida, T., Eguchi, H. and Tamura, T. 2016. Results of biological sampling of Antarctic minke whale during the first field survey of NEWREP-A in Area V during the 2015/16 austral summer season. Paper SC/66b/SP07 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 23pp. [Paper available from the Office of this Journal].

Nicol, S. 2010. BROKE-West, a large ecosystem survey of the South West Indian Ocean sector of the Southern Ocean, 30°E-80°E (CCAMLR Division 58.4.2). *Deep Sea Res. II: Topical Studies in Oceanography* 57: 693-700.

Sirovic, A., Hildebrand, J.A., Wiggins, S.M. and Thiele, D. 2009. Blue and fin acoustic presence around Antarctica during 2003 and 2004. *Mar. Mamm. Sci.* 25(1): 125-36.

Tsang-Hin-Sun, E., Royer, J.Y. and Leroy, E.C. 2015. Low-frequency sound level in the Southern Indian Ocean. *J. Acoust. Soc. Am.* 138(6): 3439-46.

Viquerat, S., Herr, H. and Siebert, U. 2015. Report on the German cetacean distance sampling survey on board PS89 (ANT XXX-2), December 2014-January 2015, between Cape Town and Neumayer Station III. Paper SC/66a/SH12 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Table 3

Meta information on identified data sets containing fin whale records from the Southern Hemisphere, elsewhere than the Southern Ocean.

Description	Region	Time period	Survey effort (km)	No. fin whale sightings [groups (ind)]	References, comments	Data holder, contact
DEDICATED SURVEYS FROM PLATFORMS OF OPPORTUNITY						
Sighting surveys from small fishing boats	Central Chile	2004-16	tbc	81	-	EUTROPIA, M.J. Pérez Alvarez

Description	Region	Time period	Survey effort (km)	No. fin whale sightings	References, comments	Data holder, contact
OPPORTUNISTIC SIGHTINGS						
Systematic collection of opportunistic sighting data from *Polarstern*	South Atlantic	2005-today	N/A	8 (20)	PANGEA	AWI; Elke Burkhardt

Description	Region	Time period	Tag duration	No. tagged fin whales	References, comments	Data holder, contact
TELEMETRY						
6 ARGOS, 4 TDR	Coast of Chile	Dec. 15-May 16	tbc	6	Partly processed, unpublished	Maritza Sepulveda

Description	Region	Time period	No. samples	No. biopsied fin whales	References, comments	Data holder, contact
BIOPSIES						
-	Coast of central Chile	2008-16	tbc	21	Partially processed, unpublished	EUTROPIA, M.J. Pérez Alvarez

Description	Region	Time period	No. photos	No. photographed fin whales	References, comments	Data holder, contact
PHOTO-IDENTIFICATION						
Photo ID data collection	Central Chile	2004-16	tbc	81	Partially processed, unpublished	EUTROPIA, M.J. Pérez Alvarez

Appendix 3

SOME EXAMPLE RESULTS FROM ESTIMATING INDICES OF RELATIVE ABUNDANCE FOR ANTARCTIC FIN WHALES

W. de la Mare

There are many complications in the real operations that cannot be accounted for by purely statistical modelling based on crude catch statistics. These include:

- whaling preferences for the larger and more profitable whales will change the apparent abundance of the different species over time;
- searching speed and efficiency increases over time;
- inaccurate reporting;
- change in the frequency of failed chases;
- different species will have different handling times;
- cooperative catching - groups of whales will be reported to other catchers;
- use of scouting vessels; and
- changes in production priorities that influence catch periods.

Consequently, it is highly unlikely that any method exists that would transform the rudimentary available data into a fully linear index of abundance, particularly over decades. However, the tests of the methods developed by De La Mare (2014) demonstrate that they are at least capable of attaining the more modest aim of improving on the catch per catcher-day as a measure of relative local abundance.

These methods can be applied over restricted time periods to make inferences about the spatial and within-season distributions of species in the Antarctic.

REFERENCE

De la Mare, W.K. 2014. Estimating relative abundance of whales from historical Antarctic whaling records. *Can. J. Fish. Aquat. Sci.* 71: 106-119.

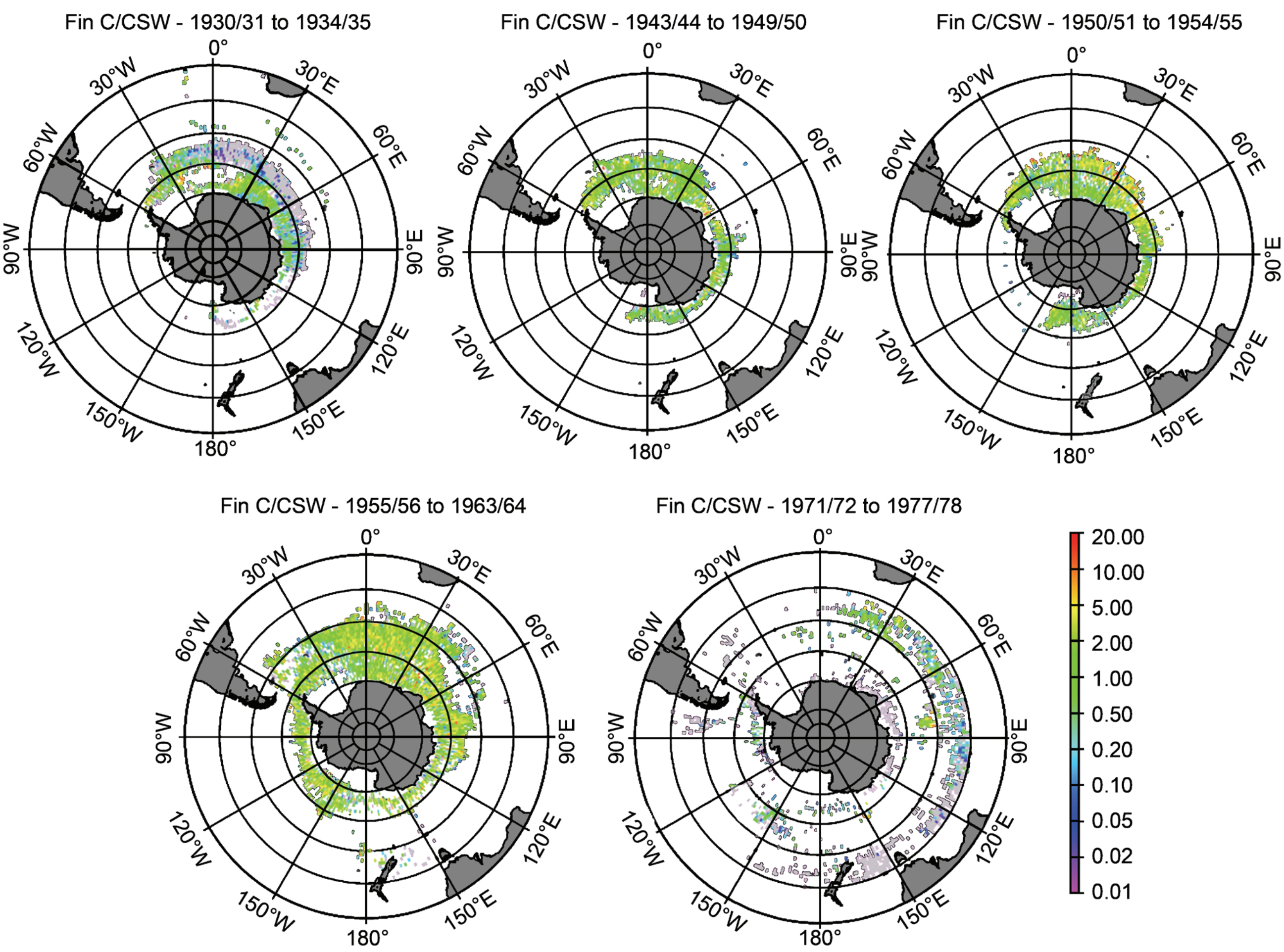


Fig.1. Apparent densities of fin whales by groups of years, from left to right: (1) 1930-35; (2) 1943-50; (3) 1950-55; (4) 1955-64; and (5) 1971-78.

Appendix 4

PRIORITISATION TABLE FOR CONSIDERING SOUTHERN HEMISPHERE SUB-COMMITTEE WORK PRIORITIES OVER THE NEXT TEN YEARS

Stock	Has this been assessed before?	Biggest obstacles to assessment	IUCN status (proxy for conservation concern)	Estimated pre-assessment data gathering (years)	Timeframe for next 10 years? (see text)
Humpback whale	Yes	Abundance/trend	LC		Evaluate in 10 years
Brazil (BSA)	Yes	None	LC	Data available	Evaluate in 10 years
Gabon (BSB1)	Yes	Abundance/trend, population structure	LC	Five years	Evaluate in 10 years
Mozambique (BSC1)		Abundance/trend, population structure	LC	Five years	Evaluate in 10 years
Madagascar (BSC3)	Yes	Abundance/trend	LC	Five years	Evaluate in 10 years
West Australia (BSD)	Yes[a]	Abundance	LC	Limited by survey feasibility. Unknown	Medium term
East Australia (BSE1)	Yes[a]	None	LC	Data available	Evaluate in 10 years
Oceania	Yes[a]	Abundance/trend, population structure	E	Five years	Medium term
Southeast Pacific (BSG)	Yes[b]	Abundance/trend	LC	Depends on feasibility of abundance estimate from re-sight data. 3 years if so.	Receive information
Northern Indian Ocean	No	Reliable estimate of population removals/range	E	Three years	Short term
Antarctic blue whale	Yes	Abundance/trend estimate	CE	Depends on feasibility of abundance estimate from resight data.	Medium term
Pygmy blue whale	No	Abundance/trend and catch series[c]	DD	-	-
Southeast Pacific	No	Abundance and catch series[c]	DD	Depends on feasibility of abundance estimate from re-sight data. Two years if so. Otherwise 5 yrs.	Short term
Indonesia/Australia	No	Abundance/trend, population structure and catch series[c]	DD	Depends on feasibility of abundance estimate from re-sight data. Two years if so. Otherwise 5 yrs.	Short term
New Zealand	No	Abundance/trend, population structure and catch series[c]	DD	Depends on feasibility of abundance estimate from re-sight data. Two years if so. Otherwise 5 yrs.	Short term
Madagascar	No	Distribution, abundance/ trend, population structure and catch series[c]	DD	Unknown. No surveys and distribution unknown. Review in 10 years.	Long term
Southern right whale					
Southwest Atlantic[d]	No	Catch series	LC	Depends on catch record analysis. Four years if so.	Medium term
Southeast Pacific[d]	No	Abundance/trend, population structure and catch series	CE	? Depends on feasibility of surveys, and catch record analysis.	Long term
Southeast Atlantic	No	Catch series	LC	Depends on catch record analysis. Four years if so.	Medium term
Southwest Australia	No	Catch series	LC	Possible in three years.	Short term
Southeast Australia	No	Catch series, population identity	LC	Could be evaluated within three years.	Short term
New Zealand	Yes	Abundance	LC	-	Evaluate in 10 years
Antarctic minke whale	Yes	Abundance	DD	Limited by survey feasibility. Unknown	Evaluate in 10 years
Dwarf minke whale	No	Abundance/trend	LC	Limited by survey feasibility. Unknown	Evaluate in 10 years
Southern Hemisphere fin whale	No	Population identification, structuring, abundance /trend, catch allocation	E	Recommend data collection over ten years, to understand structure, partition catches, gather data useful for abundance.	Long term
Southern Hemisphere sei whale	No	Population identification, structuring, abundance/ trend, catch allocation	E	Recommend data collection over ten years, to understand structure, partition catches, gather data useful for abundance.	Long term
Southern Hemisphere Bryde's whales	No	Population identification, structuring, abundance/ trend, catch allocation	DD	Recommend data collection over ten years, to understand structure, partition catches, gather data useful for abundance.	Long term
Southern Hemisphere sperm whales	No	Abundance, population structuring and limits, trend	V	Scale of data collection unknown due to complex population structure. Limited by survey feasibility. Unknown	Evaluate in 10 years

[a]Abundance estimate for BSD was not agreed: 'minimum' abundance value was used in three-stock assessment of west Australia, (BSD) east Australia (BSE1) and Oceania. Status outcomes for all three stocks may change with a revised abundance estimate for BSD. [b]Initial abundance assessment only from small part of known breeding area, with no trend data available. [c]To be provided by Branch at SC/67b. [d]These stocks are considered in CMP but are included in prioritization matrix for completeness and discussion with CMP. 'Short term'=immediate activity towards assessment. Receive all relevant documents. 'Medium term'=expect assessment in 5-10 years, with **biennial** updates on progress. Biennially, receive summary documents on metrics relevant to future assessment (population structure, abundance, trend, migratory linkages, distribution where the information is novel). 'Long-term'=expect assessment in 10+ years. Encourage work on these stocks. Receive relevant summary documents every four years (outside budget cycle).

Annex I

Report of the Working Group on Stock Definition and DNA Testing

Members: Lang, Tiedemann (co-Convenors), Arguedas, Baird, Baker, Bickham, Bravington, Burkhardt, Butterworth, Cipriano, Cooke, Cunn, de Moor, DeWoody, Elwen, Filatova, Fruet, Funahashi Goodman, Goto, Gunnlaugsson, Herr, Hjort, Hoelzel, Hall, Isoda, Jackson, Kumakiri, Leslie, Litovka, Mallette, Mate, Maeda, Miller, Mizroch, Morishita, H. Morita, Y. Morita, Nakamura, Pampoulie, Park, Pastene, Paudel, Reeves, Rosenbaum, Scordino, Širović, Skaug, Solvang, Suydam, Taguchi, Tamura, Torres-Florez, Tsuno, Walters, Wade, Walløe, Weller, Yoshida, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Lang and Tiedemann welcomed participants.

1.2 Election of Chair and appointment of rapporteurs
Lang and Tiedemann were elected as co-Chairs, and Cipriano acted as rapporteur.

1.3 Adoption of Agenda
The adopted agenda is given in Appendix 1.

Items 4.1, 4.3, and 4.4 of the Agenda are in response to requirements placed on the Scientific Committee by IWC Resolution 1999-8 IWC (2000), which called for annual reports on progress in the following areas:

(1) genetic methods for species, stocks and individual identification;
(2) collection and archiving of tissue samples from catches and bycatch; and
(3) status of and conditions for access to reference databases of DNA sequences or microsatellite profiles derived from directed catches, bycatch, frozen stockpiles and products impounded or seized because of suspected infractions.

1.4 Review of documents
The documents identified as containing information relevant to the Stock Definition and DNA Testing Working Group (hereafter, the Working Group) were: SC/67a/SDDNA01-05; SC/67a/NP01; SC/67a/SH11; SC/67a/Rep07; Malde *et al.* (2017); Baker *et al.* (2017); Bravington *et al.* (2016b), Leduc *et al.* (2017); Lah *et al.* (2016), Pastene *et al.* (2012), Hamner *et al.* (In press) and Taguchi *et al.* (2017).

2. SCIENTIFIC ADVICE ON STOCK STRUCTURE PROVIDED TO OTHER GROUPS

The Stock Definition and DNA Testing Working Group (hereafter, the Working Group) has the task of discussing high-priority stock related papers from other sub-committees and working groups, and then providing stock structure related feedback and recommendations to those sub-committees and working groups. These discussions often refer to the genetic analysis guidelines and genetic data quality documents.

2.1 Northern and Southern Hemisphere blue whales
Leduc *et al.* (2017) builds on previous studies of population structure in Southern Hemisphere blue whales (LeDuc *et al.*, 2007; Torres-Florez *et al.*, 2014) by incorporating additional samples collected in the eastern North Pacific (ENP) and eastern Tropical Pacific (ETP). Using mtDNA control region sequences and genotype data derived from seven microsatellite loci, significant nuclear and mitochondrial differentiation was identified between blue whales sampled in the Indian Ocean (IO), eastern South Pacific (ESP), Antarctic (ANT), ENP, and ETP. Within the Southern Hemisphere, these results are consistent with those of previous studies, which have shown that the pygmy-type blue whales in the IO are as different from the pygmy-type blue whales in the ESP as they are from the ANT whales. The magnitude of mtDNA differentiation identified between the ENP and ESP strata, however, was markedly lower than that found among the SH strata. When the ETP stratum was subdivided into northern (nETP) and southern (sETP) regions, no significant differences were identified in the nuclear comparisons of the nETP with the ENP or of the sETP with the ESP. Similar results were observed in the genetic assignment test, where samples from the nETP were generally assigned to the ENP while samples from the sETP were assigned to the ESP. These results suggest that, at least during the months in which the ETP was sampled (September to November), the sETP was being primarily visited by whales moving up from Chilean waters or other parts of the ESP, with the nETP being primarily used by whales from the ENP. However, temporal and spatial segregation of blue whales in the ETP is likely to be more complex than shown by the general trend, as the pattern of assignment for some individuals was equivocal (i.e. close to parity). As with previous studies, the pattern of genetic variation identified in the Southern Hemisphere is compatible with the recently proposed subspecies status of Chilean blue whales. However, the low degree of differentiation between ESP and ENP whales indicates additional study is needed to better elucidate the range of the Chilean subspecies and its relationship to the ENP.

In discussion, it was noted that including the Indian Ocean blue whales as a single stratum, as was done in Leduc *et al.* (2017), is problematic, given that blue whales in the southwestern IO off Madagascar, those in the Northern Indian Ocean, and the Indonesia-Australia blue whales are acoustically differentiated and likely to comprise separate genetic stocks. While the limited number of samples available from the southwestern and northern portions of the Indian Ocean preclude making genetic comparisons with those areas, future comparisons should consider the Indonesia-Australia stratum separately from samples collected in other regions of the IO.

In discussion of the genetic assignment test results, Lang clarified that while the results supported a general tendency for whales sampled in the sETP to assign to the ESP and whales sampled in the nETP to assign to the ENP, the assignment probabilities of many individuals were equivocal (near 0.5), which could be interpreted as evidence that some of the whales using this area are admixed individuals. The Working Group suggested that examining the mtDNA haplotype identities of potentially admixed individuals could provide insight into how the assignment probabilities should be interpreted, although the utility of this approach could be limited in this case given the high proportion of haplotypes shared between the ESP and the ENP. The Working Group further questioned if the ambiguity in the results of the assignment tests could reflect sampling of ETP whales that utilise unknown and/or unsampled feeding areas in the ENP. Photo-identification effort conducted off Costa Rica Dome (Chandler *et al.*, 1999; Douglas *et al.*, 2015) found that only a small proportion of the photographed whales could be matched to photo-identification catalogues in the ENP. These unmatched whales could be whales from the ESP or whales that utilise less well-studied regions of the ENP during summer and fall. Lang confirmed that most of the ENP biopsy samples were collected within the region of high photo-id effort but noted that the potential effect of an unsampled feeding ground on the results of the ETP assignment test has not been explored.

It was further asked if any temporal patterns in the proportion of individuals assigning more strongly to the ENP or ESP had been observed. Such a pattern might be expected given that the sampling period roughly corresponded to the start of the ENP wintering season and the end of the ESP wintering season. Lang noted that, while not shown in the paper, some efforts had been made to explore this possibility, but a clear pattern in the probability of assignments to each area over time was not detected. Given that the level of differentiation between the ENP and ESP is lower than that seen between the other strata in the study, the use of a relatively small number of microsatellite loci used in the study may have limited the power of the analyses to detect such patterns if they exist. Lang reported that most of the samples utilised in Leduc *et al.* (2017) have been incorporated in an ongoing project focused on using full mitogenome sequences and SNP genotypes at ~300 loci to better understand the stock structure and subspecies taxonomy of blue whales. This work will be presented at SC/67b.

It was noted that the initial proposal that ESP whales represent a separate subspecies of blue whale was based on analysis of total lengths from whaling catch data, which showed that the whales caught off Chile were intermediate in length between the IO pygmy-type blue whales and Antarctic blue whales (Branch *et al.*, 2007). Length data derived from aerial photogrammetric studies, however, show a somewhat different pattern, with the lengths of blue whales in the ENP, ESP, ETP, and IO being similar (Durban *et al.*, 2016; Gilpatrick and Perryman, 2008). This discrepancy could be associated with differences in the biases associated with each dataset. In addition, temporal biases may also be present within the catch data, either due to differences in incentives (e.g. whalers being compensated based on the length of the whale) and/or differences in how whale lengths were estimated. With respect to the ESP, ETP, and ENP, the genetic results presented in Leduc *et al.* (2017) are consistent with the morphological data from photogrammetry, although differences between the IO pygmy blue whales and the ESP blue whales continue to be supported with the additional data. Branch is currently re-analysing the catch data to further assess the reported size distributions, which may provide insight into the source of some biases inherent in this dataset.

Pastene noted that historical blue whale catch information collected over two years by technicians aboard Japanese whaling ships off the coast of Chile has recently been uncovered. The data associated with a subset of these catches includes measurements that are relevant to comparisons of body proportions, which have been shown to differ between pygmy and Antarctic blue whales (Ichihara, 1966). This data will be analysed in collaboration with Branch.

2.2 Western North Pacific common minke whales

Genetic analyses on the stock structure of North Pacific common minke whales have been conducted by Japanese scientists following specific recommendations made at the Expert Workshop to Review the ongoing JARPNII Programme held 26-30 January 2009 in Yokohama, Japan (IWC, 2010). Results of these analyses were reviewed at the Expert Panel of the Final Review of the Western North Pacific Japanese Special Permit Programme (JARPNII) held 22-26 February 2016 in Tokyo, Japan (IWC, 2017a) and at the subsequent IWC Scientific Committee meeting in 2016 (IWC, 2017b). At SC/67a, the Working Group reviewed new results addressing these recommendations (SC/67a/SDDNA01) as well as a summary of previously conducted work (SC/67a/SDDNA05).

SC/67a/SDDNA01 presents the results of using a dataset of complete genotypes at 16 microsatellite loci, accompanied with mtDNA and biological information, in 4,554 North Pacific common minke whales to infer Parent-Offspring (P-O) relationships, using a Maximum-Likelihood approach. The relationship between False Discovery Rate (FDR) and Power (P) was evaluated by simulation. Of 145 inferred P-O pairs at an estimated FDR of 0.1, 141 were further evaluated by typing 10 additional microsatellite loci. 75 were confirmed (among them 26 mother-foetus pairs), 66 pairs were ranked 'False Positives', yielding an overall observed FDR of 0.468. FDR_O was substantially reduced when J and O stock were analysed separately. While observed and estimated values for Power were in the same range of magnitude, observed FDR was always substantially higher than estimated FDR. This was attributed to the fact that FDR_E was estimated via simulation, implicitly assuming a single panmictic population, an assumption clearly not met in the present data set. This interpretation is corroborated by the reduced FDR_O when stocks were analysed separately. The dataset with 26 microsatellites clearly outperformed the 16 microsatellite data sets. At FDR_E=0.001, Power was at or close to 100% (P_E=0.989 and P_O=1.000) and the observed False Discovery Rate was FDR_O=0.128. Among the validated P-O pairs, O stock pairs were significantly overrepresented, while pairs between J and O stock individuals were absent. Specimens neither assigned to J nor O stock ('unassigned') exhibited a stronger affinity to the O stock. The J stock seems to appear on both sides of Japan closer to the coast, while the O stock occurs mostly east of Japan, both close to the coast and far offshore. This analysis provides no evidence for further stock structure in the area covered by this data set.

This study demonstrates that a modest increase in the number of loci investigated (here, from 16 to 26 microsatellite loci) may already substantially improve kinship inference under Maximum Likelihood. It further addresses recommendations made at both the JARPNII final review and the 2016 IWC Scientific Committee meeting regarding kinship analysis in North Pacific common minke whales.

In discussion, concern was expressed about the lack of independence that is incurred when the same dataset (the 16-locus genotype data) is used to assign individuals to stocks (Pastene *et al.*, 2016), estimate the likelihood of possible POP relationships within those stocks, and then make inferences about the plausibility of stock structure hypotheses based on these findings. Alternative stratification schemes, such as using geography or a second set of independent microsatellite loci to stratify the samples into genetic clusters, would circumvent this concern. It was noted that the lack of independence does not invalidate the inferred POPs, but could bias the estimates of FDR. This bias is expected to result in additional FPs, as individuals assigned to stocks in this way would be genetically more similar to each other than to the broader sample set. This pattern can be seen in the separate analysis of the J stock minke whales, in which no FPs were identified. The two known J-Stock POPs (i.e. mother-foetus pairs) were not detected, neither in the complete dataset nor when the J stock minke whales were analysed separately.

As part of the analysis, two LOD scores were reported; one based on the genotypes of all samples at 16 microsatellite loci and a second that included genotypes at 26 microsatellite loci, but was calculated based on only those samples identified in putative POPs using the original 16-loci dataset. It was noted that for some pairs, the LOD scores changed markedly between the two calculations, while for other pairs the LOD scores remained similar. It was explained that this pattern suggests that when only the 16 loci genotypes were used, it is possible for some pairs to be assigned a high LOD score by chance. However, when the additional 10 loci are added, that possibility is greatly reduced, and identifying mismatching genotypes at even a single locus for a pair previously suggested to represent a POP can potentially decrease the LOD score markedly.

It was noted that, rather than calculating LOD scores based on a simulated randomly mating population, a permutation test performed on the individuals in the data set itself would better address the influence of stock structure. One issue with this approach is that if actual individuals are used for permutation, then some circularity is introduced, given that these individuals are treated as unrelated, despite sharing a PO relationship. Given the relatively small number of POPs, the effect of this bias may be small. It was further noted that while this suggestion should be evaluated, it is not known what the impact of using this approach would be in terms of decreasing deviations between estimated and observed FDR.

Among inferred O-stock POPs, many included one individual sampled near the coast and one sampled in offshore waters. It was asked whether the biological data associated with these individuals suggested a pattern of offspring being found close to shore and the parent being found offshore. It was confirmed that this general pattern was present, and it included not only mother-offspring pairs, but also father-offspring pairs. It was further referred to SC/67a/SDDNA05 for information on this issue.

It was queried if the sex ratio was close to parity within sampled whales assigned to the J and O stocks and used in the kinship inference. Tiedemann noted that in the assigned O-stock whales, the number of sampled males is markedly larger than the number of sampled females. This data is provided in Appendix 2.

In concluding the discussion of the technical aspects of this paper, the Working Group commented that this work provides a good example of the value of increasing the number of loci in analysis of kinship, as was also highlighted in the discussion of Bravington *et al.* (2016b). Furthermore, the Working Group noted the value of having biological data associated with the individuals used in kinship-based analyses and encouraged the inclusion of such data when available. The plausibility of the POPs identified in the 16-locus analysis was verified by examining the biological data associated with each pair; pairs that were not biologically compatible with sharing a PO relationship were then flagged and not used in subsequent analysis. Only three of the pairs identified in the 16-locus analysis and also verified by biological data were not supported when the additional ten loci were genotyped.

The Working Group thanked Tiedemann and his co-authors for this presentation and for the work done to address the recommendations of the JARPN II panel review and final report. Discussion of how these results fit in with the stock structure hypotheses under consideration was delayed until after the presentation of SC/67a/SDDNA05.

SC/67a/SDDNA05 presented a brief summary of the updated analyses on the stock structure of western North Pacific common minke whales conducted following recommendations from the Scientific Committee. The refined analyses on hypothesis testing (including evaluation of the statistical power), morphometric, STRUCTURE, DAPC, catch-at-age and kinship, provided strong support to stock structure Hypothesis A (proposing only J and O stocks), with a single O stock exhibiting a pattern of sexual and age segregation during migration. The authors consider that Hypothesis C (proposing two J stocks and two O stocks) is contradicted by the data, and consequently such hypothesis should now be rejected.

The Working Group thanked Pastene and Taguchi for presenting this summary. The technical discussion of SC/67a/SDDNA05 focused on how samples were selected for inclusion in the exercise evaluating how genotyping additional microsatellite loci affected the proportion of individuals that could not, using the 16-loci dataset, be assigned to either the J or O stock with confidence (Tamura *et al.*, 2017). Individuals selected for this exercise were chosen at random from the subset of samples collected in subareas 6 and 7, with the intent of generating a dataset that would include a relatively equal proportion of J and O stock whales. The Working Group noted that this dataset was representative of only a portion of the region being considered, while other areas, such as the Sea of Japan and the Yellow Sea, were not included. This could result in a bias in the assignment probabilities generated by STRUCTURE. The Working Group suggested that an analysis in which the additional loci were genotyped in samples collected from a broader region would be a more appropriate test. However, the Working Group, while also recognising the logistical difficulties inherent in genotyping additional samples, welcomed the typing of additional loci.

The Working Group then discussed the implications of the results presented in SC/67a/SDDNA01, as well as those summarised from past discussions in SC/67a/SDDNA05, in evaluating the plausibility of the stock structure hypotheses included in the *IST*s for Western North Pacific minke whales.

In general, the Working Group noted that several gaps in understanding persist for western North Pacific common minkes; in particular, the breeding areas for these animals remain unknown, and current hypotheses only partially consider the potential for mixing of whales on migratory routes or wintering grounds. It was further noted that the results presented in SD5 do not contribute to an understanding of the heterogeneity that has been identified in some previous studies within the O-type whales (Wade and Baker, 2012).

The Working Group further noted that, while the table illustrating the location and number of inferred POPs within and between regions suggests connectivity between areas, it does not provide information on how those numbers compare to the numbers of sampled animals in each region for which no POP relationships were inferred. Including such information would provide insight into the relative magnitude of connectivity between areas.

Although questions about the stock structure of minke whales in the western North Pacific may not be fully resolved, particularly in the absence of knowledge about the location of breeding grounds, the Working Group noted the importance of evaluating the evidence at hand with respect to the stock structure hypotheses under consideration. As such, the Working Group agreed that the results of the kinship analysis are inconsistent with the mixing matrices associated with Hypothesis C as currently implemented in the RMP trials among sub-areas 7CS, 7CN, 8 and 9.

2.3 North Pacific Bryde's whales

Taguchi *et al.* (2017) presented the results of a Discriminant Analysis of Principal Components (DAPC) to examine the stock structure of the Bryde's whales in the North Pacific. A total of 1,019 whales collected in sub-areas 1W, 1E and 2 till 2014 was examined using seventeen microsatellite DNA loci. Bryde's whales from the eastern South Pacific off Peru, western South Pacific off Fiji and eastern Indian Ocean off Java were used for comparative purposes. The DAPC analyses revealed no structure within the North Pacific however, it showed that Bryde's whales from the North Pacific, eastern and western South Pacific and eastern Indian Ocean belong to four distinct stocks. The negative results of DAPC analysis for the North Pacific were explained by the low F_{ST} estimates among the three sub-areas (1W, 1E and 2), and these results were consistent with the previous STRUCTURE results. A previous heterogeneity test showed no differences within sub-area 1, but significant differences between sub-areas 1 and 2, for both mitochondrial and microsatellite DNA. Therefore the combined results suggest the occurrence of two stocks in the sub-areas, which are weakly differentiated.

SC/67a/Rep07 utilises the genetic information presented by Taguchi *et al.* (2017) for a further analysis of spatial genetic structure. Specifically, the area was divided longitudinally into slices of 5° longitude each. Using a moving average approach over 10° longitude (i.e. two slices), mean values were calculated for microsatellite heterozygosity (H_E and H_O) and mitochondrial haplotype diversity. Further, mean values of the first two principal components (PCs) of the DAPC value were analysed according to the same scheme. Patterns of spatial heterogeneity were revealed in the mitochondrial haplotype diversity and both PCs of the DAPC, but not in the microsatellite heterozygosity.

It was noted that the initial DAPC analyses were not informative about stock structure. The additional spatially explicit analyses, however, provided information relevant to stock-structure which was used in conjunction with biological information for stock structure inference [summarised in table 4 of SC/67a/Rep07]. It was further noted that spatially explicit analysis of information captured in single principal components (PCs) in a DAPC or other Principal Component Analyses (PCAs) may unravel stock-structure patterns not as easily detected in representations combining several PCs and/or geographic regions in a single visualisation. A further example of this approach can be found in Lah *et al.* (2016).

2.4 Other

The Working Group also provided stock structure related feedback and recommendations on South American Bryde's whales (Pastene *et al.*, 2012), North Pacific gray whales (SC/67a/NH11), Māui dolphins (Baker *et al.*, 2017), and Hector's dolphins (Hamner *et al.*, In press). The latter two papers were focused on the use of genotype-based estimates of abundance and effective population size, and were thus discussed as part of a joint session with the ASI and SM sub-committees. A summary of the discussion of those papers is included in Annex Q.

Pastene *et al.* (2012) presented the results of a genetic analysis based on mitochondrial DNA control region sequences to investigate both species identity and populations genetic structure of South American Bryde's whales. The genetic analysis was based on historical, biopsy and stranding samples from Chile (n=10) and Brazil (n=8). For comparative purposes published sequences of the Bryde's whales from different localities of the Indian and Pacific Oceans (including Peru, n=24) were incorporated into the analysis. Results of the phylogenetic analysis identified the Bryde's whales of South America as *Balaenoptera brydei*[1]. No statistically significant genetic differentiation was found between Chilean and Peruvian Bryde's whales. However, striking differences were found between western South Atlantic (Brazil) and eastern South Pacific (Peru and Chile) animals. In addition, striking genetic differences were found between all South American localities and those from the western North Pacific, Fiji and Java. These results suggest movement of *B. brydei* in the eastern South Pacific in the latitudinal range corresponding to Chile and Peru. These results also suggest no or very limited movement of whales between the South Pacific and the South Atlantic Oceans. This is consistent with the notion that *B. brydei* is not distributed further south of approximately 40°S on both sides of South America.

The Working Group thanked Pastene for presenting this work. Discussion focused on how to interpret these results in the context of studies of regional variation in Bryde's whales in other areas. While in other areas, such as New Zealand and Brazil, Bryde's whales exhibit some degree of residency within coastal areas (Lodi *et al.*, 2015; Wiseman *et al.*, 2011), the whales off Chile appear to be make south-north movements from southern Chile (~38 degrees) to the waters off Peru (Pastene *et al.*, 2012).

The Working Group was tasked with reviewing the aspects of SC/67a/NH11 that relate to stock structure. This paper, which is summarised in Annex Q, describes the results of a population assessment of the gray whales feeding off Sakhalin Island (SI) and the southern coast of Kamchatka, Russia. This assessment is an update of that presented in Cooke *et al.* (2016) and contains new data from multiple sources, including the photo-identification data collected from gray whales off Kamchatka (Yakovlev *et al.*, 2013; 2014). In addition, the output of the population model underlying the assessment was, for the first time, compared to the results of a genetic paternity test (Lang, 2010) aimed at identifying putative fathers for calves brought to the SI feeding ground by their mothers. This comparison indicated that the Sakhalin feeding aggregation is probably not genetically closed but that the SI and Kamchatka feeding aggregations, taken together, may be genetically closed. Of note, however, genetic data from Kamchatka would be required to confirm this.

The Working Group thanked Cooke for presenting this paper. In discussion, Cooke clarified that the hypothesis testing scheme utilised in SC/67a/NH11 assumed random

[1]Following the taxonomic ranking proposed by Wada *et al.* (2003).

mating between all whales in a specified group and then compared the number of paternities detected in the model output for that region with the observed number of paternities derived from the empirical data. For this exercise, the defined group was initially restricted to only those whales that utilise the Sakhalin feeding ground and was then extended to include whales using either or both the Sakhalin and southern Kamchatka (hereafter referred to as SKNK for consistency with the current stock structure hypotheses, SC/67a/Rep04) feeding grounds. When the model assumed that all fathers were part of the Sakhalin group, the predicted number of detected paternities was significantly higher, albeit by a small number, than that observed in the empirical study. However, when the model assumed that all fathers were present within the combined SI and SKNK regions, the predicted number of detected paternities was less than the observed number. It was concluded that Sakhalin whales mate preferentially, but not exclusively, with each other, but that it is possible that Sakhalin and Kamchatka whales, taken together, mate only within the combined group. However, it was noted that the population model does not specify where such mating is occurring, i.e. it cannot distinguish between a scenario in which Sakhalin and southern Kamchatka whales breed with each other on the wintering grounds or a scenario in which those animals breed with each other while migrating or on the feeding ground.

With respect to the stock structure hypotheses under consideration, the results of SC/67a/NH11 may have implications on two fronts. First, an estimate of the number of whales utilising the combined SI and SKNK regions is provided. This estimate provides data that could be used to assess the plausibility of hypotheses, such as hypotheses 3b and 4b, which assume connectivity between the SKNK and SI feeding grounds but demographic independence of this combined area from the larger feeding ground in the Northern Bering-Southern Chukchi region. Secondly, the results of SC/67a/NH11 are consistent with a scenario in which whales feeding off SI and SKNK are mating with each other preferentially. Such a scenario is represented in hypothesis 4b, although in terms of the modelling framework hypotheses 4b and 3b are represented in the same way.

The Working Group noted that the results of SC/67a/NH11 highlight the need for additional data to be collected off southern Kamchatka. Although a small number of biopsy samples have been collected from this area (see Table 1, SC/67a/Rep04), no biopsy efforts are known to have been made in more recent years (after 2011). While the model in SC/67a/NH11 is useful in evaluating whether hypotheses, such as preferential mating between SI and SKNK whales, are consistent with the model output, paternity analysis based on samples from both areas are necessary to determine if such mating occurs.

Finally, the Working Group noted that genetic analysis of historical specimens collected from western North Pacific migratory routes and/or wintering grounds are needed to evaluate the relationship between the historic western breeding stock (i.e. the stock that was subjected to past commercial whaling in the western North Pacific) and the whales that currently utilise SI and/or those represented in contemporary records of gray whales in Japanese and Chinese waters. Lang noted that mtDNA control region haplotype data had been obtained from the baleen of one such specimen (AMNH M-34260). This baleen was collected in Ulsan, South Korea, by R.C. Andrews in 1912. However, the mtDNA haplotype identified from this baleen is common among contemporary samples collected from gray whales in both the eastern and western North Pacific, which, in the absence of additional sequence data from this or other historic specimens, is not informative with respect to evaluating such relationships.

3. DNA TESTING

3.1 Genetic methods for species, stock and individual identification

The Working Group first discussed four papers (SC/67a/SDDNA02-03, (Lah *et al.*, 2016; Malde *et al.*, 2017) that utilise Single Nucleotide Polymorphisms (SNPs) to look at population or species-level questions.

SC/67a/SDDNA02 presents an update on a paper (DeWoody *et al.*, 2016) presented in 2016 that reported the results of the genome sequences of two western gray whales from Sakhalin Island and one eastern gray whale from northern Alaska, and the development and validation of a SNP panel for gray whales. A modified version of that paper has been accepted for publication in the journal *Biological Bulletin*. The genome sequences are now available through NCBI and the SNP data will be archived by the journal.

The gray whale genome sequences and SNP panel and the ongoing collection of a larger dataset of SNPs from western and eastern gray whales will help to resolve issues regarding gray whale stock structure currently being considered under the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales. Other useful applications include genetic fingerprinting for the identification of individual whales from their biopsies, estimates of relatedness and other population genetics parameters that inform of structure, genetic diversity, and aspects of behavior and reproduction. The SNP panel will provide a useful platform for future studies of gray whales because the results are directly comparable from lab to lab and study to study.

The Working Group thanked Bickham for the presentation and expressed their appreciation for this work, noting that having a publicly available gray whale genome sequence will be a valuable resource for future studies.

In discussion, it was noted that biopsies were collected from the gray whales off Sakhalin Island, Russia, by the Russian Gray Whale Project (formerly the Russia-US research program), between 1995 and 2007 (Lang *et al.*, 2010), while the samples analysed in SC/67a/SDDNA02, as well as those which will be sampled in the future, were collected in 2011 and later. Given that this time span covers over two decades, the Working Group noted that it would be useful to compare the genetic composition of whales sampled early in the study with those sampled in more recent years to determine if any shifts in the genetic composition of the whales feeding off Sakhalin had occurred during this time period. The value of using a SNP panel, such as the one designed in SC/67a/SDDNA02, to conduct such analyses was also highlighted, as SNP data can be compared among studies and over time without the need for the cross-study calibration that is necessary with microsatellites (Morin *et al.*, 2004).

Bickham noted that future plans included using the SNP panel described in SC/67a/SDDNA02 to genotype samples that will be collected from gray whales in the three primary wintering lagoons in Baja California, Mexico. It was noted that, should analysis of additional samples be warranted, genetic samples are available from US and Canadian waters that encompass much of the migratory range of gray whales in the eastern North Pacific as well as the feeding grounds in the Bering and Chukchi Seas and the Pacific Northwest (see Table 1, SC/67a/Rep04).

SC/67a/SDDNA03 summarises progress made on the bowhead genetics program with respect to building a mtDNA database and developing a new panel of 96 SNPs. For mtDNA, 3 parts were sequenced (HVR1, ND1, and cytb). The mtDNA database now has 435 samples sequenced for all 3 parts. From these samples, 72 unique haplotypes were identified. The B-C-B stock shares haplotypes with both the Okhotsk and Eastern Canadian Arctic stocks, whereas the Okhotsk and Canadian stocks do not have any shared haplotypes. All 3 stocks contain private haplotypes. Regarding the SNP data, SC/67a/SDDNA03 updates a panel of SNPs presented in Baird *et al.* (2016). 53 SNP loci were carried over from the earlier panel, and newly developed SNPs were derived from protein-coding sequences from Greenland bowhead genome sequences to increase the SNP panel to 96 loci. 475 bowhead samples were genotyped using the Fluidigm method, including 411 from B-C-B, 34 from Canada, and 30 from Okhotsk stocks. Quality control methods included genotyping duplicate samples, using mother/foetus pairs, and samples from earlier studies. There was low genotyping error rate for this method, calculated to be 0.7%. The authors note that the benefit of using non-anonymous loci is that the data are replicable across labs and methods. Additionally, the error rate of the Fluidigm method described here is low. These data will be used in future studies to examine F_{ST} and migration among stocks, relatedness, and historical demography.

In discussion, it was asked whether this panel of SNPs has been used for population genetic inference. Baird noted that such analyses were in progress and the results would be presented at SC/67b.

The Working Group thanked Baird for her presentation and looks forward to hearing more about this work during the bowhead whale *Implementation Review* that begins next year.

Malde *et al.* (2017) presented an array of SNP markers displaying fixed or nearly fixed allele frequency differences among the minke whale species. Five panels of putatively diagnostic markers were established on a genotyping platform for validation of allele frequencies; two panels (26 and 24 SNPs) separating the two species of minke whale, and three panels (22, 23, and 24 SNPs) differentiating the three subspecies of common minke whale. Two statistical methods for inferring the degree of back-crossing in hybrid individuals had been developed. The SNP panels were validated against a set of reference samples, demonstrating the ability to accurately identify back-crossed individuals up to three generations.

The Working Group thanked Skaug for presenting this work. In discussion, it was noted that the panel of SNPs used in Malde *et al.* (2017) was designed specifically for the detection of hybrid and back-crossed individuals across species and would not be appropriate, given the number of markers and the panel design, for examining population structure or kinship-based questions within species. However, a similar approach could be used to design a SNP panel appropriate for addressing population-level questions.

Lah *et al.* (2016) presents information on the population structure of a highly mobile marine mammal, the harbor porpoise (*Phocoena phocoena*). In the Atlantic shelf waters, the population structure of this species follows a pattern of significant isolation-by-distance. The population structure of harbor porpoises from the Baltic Sea, which is connected with the North Sea through a series of basins separated by shallow underwater ridges, however, is more complex. Here, the population differentiation of harbor porpoises in European Seas was investigated with a special focus on the Baltic Sea and adjacent waters, using a population genomics approach. 2,872 single nucleotide polymorphisms (SNPs) were used, derived from double digest restriction-site associated DNA sequencing (ddRAD-seq), as well as 13 microsatellite loci and mitochondrial haplotypes for the same set of individuals. Spatial principal components analysis (sPCA), and Bayesian clustering on a subset of SNPs suggest three main groupings at the level of all studied regions: the Black Sea, the North Atlantic, and the Baltic Sea. Furthermore, a distinct separation was observed between the North Sea harbor porpoises and the Baltic Sea populations, as well as a split between porpoise populations within the Baltic Sea. A notable distinction was observed between the Belt Sea and the Inner Baltic Sea sub-regions. Improved delineation of harbor porpoise population assignments for the Baltic based on genomic evidence is important for conservation management of this endangered cetacean in threatened habitats, particularly in the Baltic Sea proper. In addition, SNPs outperformed microsatellite markers – in particular in the assignment of individual specimens to genetic clusters. The paper demonstrates the utility of RAD-tags from a relatively small, opportunistically sampled cetacean sample set for population diversity and divergence analysis. It can further serve as basis for the development of a panel of informative SNP loci used in population genetic and kinship analyses of Harbour porpoises in European waters.

The Working Group thanked Tiedemann for presenting this work. In discussion, it was noted that this study demonstrated the utility of opportunistically sampled specimens (e.g. strandings) in genomic analyses, which typically rely on obtaining high quality DNA which is not always present in degraded samples.

The paper also identified similar divergence patterns when the large SNP panel and the smaller number of microsatellites were used. However, individual-level distinctions were better revealed using SNPs.

The Working Group noted that including multiple SNPs within loci and inferring haplotypes has been shown to have increased power when compared to unlinked SNPs (Morin *et al.*, 2009). This increased power would also be expected to result when using SNPs linked to microsatellite loci, e.g. 'SNPSTRs' (Mountain *et al.*, 2002). Tiedemann noted that only unlinked loci were used in the study, but that exploring the use of linked loci could be beneficial.

In reviewing these papers, it is important to evaluate whether the approach used is suitable for the question being addressed. The first three studies (SC/67a/SDDNA02, SC/67a/SDDNA03, and Malde *et al.* (2017) utilised SNP panels designed from whole genome sequences. The number of SNPs used to identify interspecies hybridisation was low, but the SNPs chosen have high diagnostic power. Both SC/67a/SDDNA03-04 utilised a moderate number of SNPs, many or all of which were chosen from genes known to be under selection. The utility of this approach (choosing SNPs potentially under selection) could be limited in population genetic analyses that assume neutrality. When genome data is available, it is however straightforward to design additional panels for use in specific analyses.

The fourth study (Lah *et al.*, 2016) utilised a ddRAD approach, in which SNP discovery and genotyping is simultaneously conducted. While this approach can identify thousands of loci, the number of loci shared among samples decreases when additional sample libraries are sequenced as the SNPs produced are essentially randomly selected from across the genome. However, the ddRAD sequence data produced could be used to design a SNP panel for use with an amplicon-based approach, which would provide higher consistency in genotyping success across specimens.

Discussion then focused on the importance of understanding if loci used are under selection. Expectations for such loci vary with the type of selection; while positive selection may result in divergence between groups, little variation would be expected in loci under purifying selection. In addition, some analysis (e.g. unbiased population inference) may assume that loci are neutral and thus may not be appropriate to use with data from loci under selection. Finally, it should be noted that SNPs derived from coding regions are not necessarily under selection themselves; in many studies, little evidence of strong selection has been detected even when SNPs are derived from coding regions.

The final paper (SC/67a/SH11) discussed under this agenda item focused on species identification from bone fragments. The author's summary for this paper is included in Annex H.

In discussion, it was questioned whether there had been any attempt to collect a specific type of bone (e.g. the left jaw) to maximise the number of individuals and minimise duplicates. Baker noted that while it would be ideal to focus on collecting a specific bone, permit and availability issues constrained such efforts. However, over 70,000 whales were taken on South Georgia, and thus the chance of collecting bone fragments from the same individual were low. Samples sharing the same mitogenome sequence can also be flagged as potential duplicates.

The mitogenome sequences were produced using a shotgun sequencing approach. The Working Group suggested that using a hybrid capture approach could be useful with historic and particularly with ancient samples. Such an approach could integrate nuclear SNPs as well.

Elwen noted that approximately 100 skulls are available from the northern coast of Namibia, although given the hot and wet environment, degradation may be an issue. The Working Group noted that degradation from weathering should mainly effect the surface area, and new extraction approaches (Damgaard *et al.*, 2015; Korlević *et al.*, 2015) are available that have been successful with, for example, the South Georgia whale bones.

A summary of the discussion of this paper in the Southern Hemisphere sub-committee is included in Annex H.

3.2 'Amendments' of sequences deposited in *GenBank*

In previous years, Cipriano has corresponded with *GenBank* to attempt to identify a mechanism by which inconsistencies identified in the metadata (e.g. taxonomic status, geographic location, locus misassignment) of some entries could be corrected. Unfortunately, Cipriano's contact person at the NCBI (National Center for Biotechnology Information) passed away this year, and no further progress on this work was made on this front.

It was noted by the Working Group that *GenBank* is essentially an uncurated database, and that there is value in retaining the 'raw data' that it represents. Although experienced users may be aware that additional sequence validation may be needed when using *GenBank* sequences, the concern is that less experienced users will be unaware of the associated caveats and may inadvertently worsen the problem by utilising sequences that have been erroneously assigned to a locus or a taxon.

Cipriano agreed to continue efforts to work with *GenBank* staff to find a mechanism for dealing with identified inconsistencies. The Working Group also agreed that the revised DNA quality guidelines (see Item 4.1) would contain a section discussing the precautions that should be used when including *GenBank* sequences in a study.

3.3 Collection and archiving of tissue samples from catches and bycatches

The Committee previously endorsed a new standard format for the updates of national DNA registers to assist with the review of such updates (IWC, 2012a, p.53), and the new format worked well the last years. This year the update of the DNA registers by Japan, Norway and Iceland were based again on this new format.

Goto reported on the status of their register (see Appendix 3). The collection of samples is from scientific whaling in the North Pacific (1994-2016 JARPN-JARPNII) and the Antarctic (1987/88-2015/16, JARPA-JARPAII and NEWREP-A), and from bycatch (2001-16).

Skaug reported on the status of the Norwegian register (see Appendix 4). The collection of samples of North Atlantic common minke whale is from commercial catches for the period 1997 to 2016.

Pampoulie reported on the status of the Icelandic register (Appendix 5), which includes samples from scientific whaling (2003-07) and commercial catches (2006-16).

3.4 Reference databases and standards for diagnostic DNA registries

An update of the Japanese register is shown in Appendix 3. For North Pacific minke whales bycaught or sampled under JARPN II in 2016, mtDNA and microsatellite analyses of 100% (n=169, bycatch; n=37, JARPNII) has been completed. For North Pacific Bryde's whales and North Pacific sei whales sampled under JARPNII in 2016, mtDNA and microsatellite analyses have been completed for 100% of the samples (n=25, Bryde's whales; n=90, sei whales). No bycatch of North Pacific Bryde's whales or North Pacific sei whales occurred in 2016. No sampling or bycatch of sperm whales occurred in 2016. Bycatches of North Pacific humpback whales (n=2), North Pacific right whales (n=1), and North Pacific fin whales (n=1) occurred; mtDNA and microsatellite analyses is complete for 100% of these samples.

For Antarctic minke whales sampled under NEWREP-A in 2016, mtDNA and microsatellite analyses have been completed for 100% of the samples (n=333).

With regard to the Japanese register, it was noted that no gray whales were listed in the register, despite reports of some bycaught whales being mentioned in the Japanese progress reports. Japan responded that these specimens have been genotyped but are not included in the register, because the register only concerns market products and sales of gray whale are prohibited by domestic law.

An update of the Norwegian register is shown in Appendix 4. After discounting for missing samples, 100% of the North Atlantic common minke whales (n=578) caught in 2016 were screened microsatellites.

An update of the Icelandic registry is shown in Appendix 5. 100% of the fin whales caught by commercial whaling between 2006 and 2016 (n=688) were screened for both mtDNA and microsatellites. The North Atlantic common minke whales caught by commercial whaling in 2016 (n=36) have not yet been screened for either mtDNA or microsatellites.

During presentation and discussion of the Norwegian register, the Working Group was informed about the discontinuation of mtDNA analysis on Norwegian samples, as well as an eventual replacement of microsatellite typing by SNP analysis. Regarding this issue, the following was noted: Last year the Committee welcomed Norway's plan to add SNPs in its register and noted that SNP genotyping should be seen as a complement, not as a replacement of the current microsatellite genotyping. No technical details of the plan were available last year, and therefore, the Committee recommended that those details are provided at future meetings so that the Committee can provide technical advice (IWC, 2017b, p.71). Following the new information from Norway as to the discontinuation of mitochondrial DNA and eventually microsatellite analyses, there were concerns among the SDWG as to the comparability of the DNA registers in the future. The Working Group reiterates the recommendation from the Committee's last year. The SDWG acknowledges that DNA registries are maintained on a voluntary basis; it encourages coordination of all DNA registers so that they are based on comparable genetic markers.

The WG appreciated the efforts of Japan, Norway and Iceland in compiling and providing this detailed information of their registries.

4. GUIDELINES AND METHODS FOR GENETIC STUDIES AND DNA QUALITY

This agenda item relates to two sets of guidelines that the Scientific Committee has requested the Working Group to develop for reference in the Committee's discussions of stock structure. Both sets are subject to ongoing update as appropriate.

4.1 DNA quality

The DNA data quality control guidelines are already available as a 'living document' on the IWC website (*http://iwc.int/scientific-committee-handbook#ten*). In recent meetings, data derived from next generation sequencing approaches, including SNPs, have been utilised to address stock structure questions. In light of these developments, the Working Group agreed that it would be timely to update the DNA data quality control guidelines to cover these types of data. During SC/67a, Tiedemann presented a draft of the updated guidelines, which included added text addressing issues associated with SNP genotyping, next generation sequencing, and sequencing of nuclear genes. During discussion, several suggestions on topics to add to the draft were mentioned. An intersessional email group was formed to implement these suggestions and discuss any additional revisions [see Item 8.2]. A revised version of the guidelines will be presented at SC/67b.

4.2 Genetic analysis guidelines

This document provides guidelines for some of the more common types of statistical analysis of genetic data that are employed in IWC management contexts. The main section is intended as guidance for managers and also contains examples of management problems that are regularly faced by the Committee. There is also an extensive appendix of genetic analysis techniques for specialist readers. This guidelines document was completed intersessionally and has been accepted for publication in the *Journal of Cetacean Research and Management*. In discussion, the Working Group suggested that it would be valuable to make these guidelines, as well as those discussed in Item 4.1 when completed, available electronically as well as through the journal. Lang offered to follow up with the journal on this suggestion.

Given that this intended to act as a 'living document', it may be subject to updates in the future as the Working Group sees fit.

4.3 Other issues

No other issues were discussed.

5. TERMINOLOGY

Following a recommendation arising in 2012 (IWC, 2012b, p.219), the Working Group began compiling a 'go-to' glossary of stock related terms, with the aim of encouraging consistent use of stock structure related terms within Scientific Committee reports and in papers submitted to the Scientific Committee and within SC reports and discussions. Initial work on this glossary focused on defining terms most commonly used in assessments of baleen whales. At SC/65b and SC/66a, joint sessions of the SDWG and the Small Cetaceans sub-committee were held to evaluate how the terms in this glossary aligned with terminology used in the SM sub-committee discussions (IWC, 2015, p.231; 2016, p.290). During these discussions, concerns were raised regarding the application of these terms to small cetaceans, in part due to differences in the behaviour and life history of small cetaceans relative to baleen whales. There is also some reluctance as to changing terminology which may be well established within a particular sub-committee and the related scientific community. Limited progress was made in addressing the concerns of the SM sub-committee, and the Working Group noted that even within sub-committees that focus on assessments of baleen whales, stock-structure related terms continue to be used inconsistently.

The Working Group decided to revisit this issue at SC/67b, with a focus on coming to an agreement within the group with respect to how terms are defined. At SC/67b the Working Group plans to invite Punt and Butterworth to provide a short tutorial on how the advice of the Working Group is utilised by the RMP and other sub-committees. While this exercise is intended to increase understanding of the role filled by the Working Group in the context of other sub-committees' work, it will also provide an opportunity to get feedback from the presenters as to how stock-structure related terms are utilised within other sub-committees.

6. NEW STATISTICAL AND GENETIC ISSUES RELATING TO STOCK DEFINITION

6.1 Simulation tools for spatial structuring (e.g. TOSSM, Testing of Spatial Structure Models)

TOSSM was developed with the intent of testing the performance of genetic analytical methods in a management context using simulated genetic datasets (Martien *et al.*, 2009), and more recently the TOSSM dataset generation model has been used to create simulated datasets to allow the plausibility of different stock structure hypotheses to be tested (Archer *et al.*, 2010; Lang and Martien, 2012). The Working Group noted that while TOSSM has been particularly valuable in informing the interpretation of results of stock structure related analyses, it has not been broadly utilised within the IWC Scientific Committee for this purpose.

A wide-range of software packages are now available for producing simulated datasets that can be used for statistical inference and/or validating statistical methods, reviewed in Hoban (2014). The Working Group agreed that reviewing the available packages and evaluating their utility to address issues of interest to the Scientific Committee would be useful.

An email correspondence group was formed to conduct this review intersessionally and to provide a summary of their findings at SC/67b (see Item 8.3). In addition, the Working Group looks forward to reviewing papers demonstrating the utility of simulation-based approaches to inform stock structure questions in future sessions.

6.2 Other

6.2.1 Close-kin mark-recapture

At SC/67a, Bravington was invited to provide a presentation to the Scientific Committee on the close-kin mark-recapture (CKMR) approach (Bravington *et al.*, 2016b) and the utility of linking it to epigenetic aging from DNA samples. These are new techniques (5-10 years), based on tissue samples, which could be very useful to the IWC Scientific Committee for reliable and relatively inexpensive population assessment - e.g. in evaluating the conservation significance of bycatch and/or directed takes. CKMR uses multi-locus genotyping to find close relatives among tissue samples from dead and/or live animals; the number of kin-pairs found, and their pattern in time and space, can be embedded in a statistical mark-recapture framework to infer absolute abundance, parameters like survival rate, and even stock structure. The spatial distribution of kin-pairs has been used qualitatively for stock structure investigation several times in the SC (e.g. SC/67a/SDDNA01 and SC/67a/SDDNA05). CKMR for abundance estimation is much more recent (and requires greater surety in the genotyping); it has been successfully applied to southern bluefin tuna (Bravington *et al.*, 2016a), and is being used in several current international projects on endangered sharks and commercial fish stocks. CKMR is not to be undertaken lightly, since the genotyping and the statistical modelling are demanding and sample-size requirements must be thought through carefully, but it is cheap and powerful provided enough samples can be collected. Although CKMR should be useful without additional information in many cetacean stock delimitation applications, it will yield precise results much faster if age can be estimated, even roughly. While age can already be obtained in some situations (e.g. bycatch of odontocetes where teeth can be obtained and sectioned), the utility of CKMR for cetaceans will be now increased given the new capability to use the same tissue-samples for epigenetic ageing which (after many unsuccessful attempts) has in the last few years been successfully demonstrated in humpback whales and other mammal species (Jarman *et al.*, 2015; Polanowski *et al.*, 2014). Although species-by-species or even population-specific calibration of epigenetic age is of course challenging for species with few or no reference, Bravington suggested that it may be possible to infer the calibration indirectly in the course of a CKMR study, with the two approaches giving mutual support.

Whether hidden population structure is problematic when using this method was discussed. Bravington noted that, in the absence of differential sampling, having multiple, unrecognised stocks would not bias an estimate of overall abundance. While estimates of relatedness, which are calculated using allele frequency information, can be artificially inflated if unrecognised population structure is present, CKMR requires that identified parent-offspring pairs (POPs) match at least one allele at every locus (i.e. no mismatching loci are allowed) and thus is not as sensitive to undetected structure if a sufficiently large number of informative loci is typed. However, CKMR requires that genotyping error rates be stringently controlled to prevent the identification of true POPs from being obscured by a large number of false positives.

The value of integrating data from epigenetic aging into CKMR was noted (see discussion below, Item 6.2.2). It was noted that, as research into epigenetic aging in model species, such as mice, has progressed, the techniques used have become more reliable as well as more affordable. However, methylation rates may be specific to species or even populations, and thus epigenetic age estimates need to be verified. This may be easier with odontocetes, where epigenetic age estimates could be calibrated by comparison to ages estimated by counting growth layer groups in teeth (Perrin and Myrick, 1980). It was noted that while estimates of the actual age of animals is needed for some applications, inference of relative age is sufficient in other cases. Such inferences can be used in calibration of epigenetic methods when long-term close kin sampling is pursued.

In conclusion, the Working Group thanked Bravington for presenting an overview of this approach, which has multiple applications within the Scientific Committee's scope of work. The Working Group looks forward to reviewing more papers using CKMR in the future.

6.2.2 Epigenetic aging

Epigenetic (DNA-methylation) aging has been successfully used to estimate age in humpback whales (Polanowski *et al.*, 2014). As noted above, epigenetic aging is particularly valuable in the context of estimating abundance with the close-kin mark-recapture (CKMR) approach, as it can increase precision in such estimates by allowing the parent to be distinguished from the offspring. It may further be informative in the context of RMP *Implementation*. Given the utility of these methods for the work of the Scientific Committee, at SC/66b the SH sub-committee endorsed a proposal to organise an open presentation on new epigenetic developments for measuring whale age, with the goal of introducing the Scientific Committee to the concept and methodological developments in the technique (IWC, 2017c). Although it was not possible to coordinate such a presentation for SC/67a, the Working Group agreed that learning more about the applicability of epigenetic aging to the work of the Scientific Committee is important and encouraged that submission of papers relevant to this topic be presented next year.

6.2.3 Inference of demographic history using whole genome sequences

SC/67a/SDDNA04 explored the use of genome sequence data from two western gray whales (WGW) sampled near Sakhalin Island and one putative eastern gray whale (EGW) from Barrow, Alaska to reveal the demographic history and structure of populations. Notwithstanding that this analysis is based on a small sample size, a genome possesses an extensive record of the ancestry of an individual and individuals belonging to the same population are expected to exhibit the signatures of shared historical events not present in genomes from individuals of different populations. Our ability to reconstruct these histories has increased recently due to the reduced cost of genome sequencing and advances in bioinformatics and analytical methods largely originating from human population genomics.

Results indicated that gray whale genomes contain substantial nucleotide diversity even though effective population sizes have declined substantially since the last glacial maximum. Contemporary gray whale genomes, both eastern and western, contain levels of autosomal nucleotide diversity that exceed levels found in many endangered species. The extent of recent historical inbreeding is shown here to be greater in WGW genomes, as measured

Table 1

Summary of the work plan.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Item 4.1 DNA quality guidelines	Intersessional email group to discuss updating guidelines to include data produced using next generation sequencing approaches	Review intersessional progress
Item 6.1 Simulation-based tools	Intersessional email group to review software packages and evaluate utility to the SDDNA WG	Review intersessional progress

by autozygosity, compared to the single EGW genome. It appears that individuals from the western Pacific have been subject to recent inbreeding that likely stemmed from bottlenecks induced by commercial whaling in the 20th century. However, the status of the Sakhalin whales as belonging to either, or both, of the EGW or WGW population is not resolved as some of the analyses employed in this study fail to differentiate them. In discussion, the authors recognised that the current study was based on a very small sample size of whales and they indicated that follow on work will involve re-sequencing the genomes with shallow coverage of 20 to 30 individuals each of WGW and EGW.

The Working Group thanked the authors for their presentation, which focuses on an analysis that has not previously been presented to the group. In discussion, the Working Group noted that the inferred trajectories of effective size over time derived from the eastern and two western genomes seemed to be generally similar until the late Pleistocene. While these results are interesting, the authors noted that sequencing of additional samples was needed to have confidence in the inferred trajectories. This work was largely intended as a 'proof of concept' exercise to demonstrate the feasibility of using this approach with the gray whale genome data, and sequencing of the genomes of additional samples is planned.

The Working Group noted that some limitations are inherent in this approach. First, the analysis is not informative with respect to recent population history. Secondly, both the inferred dates and the estimates of effective size (N_e) over time depend on parameter values used for generation time and mutation rate; particularly in the latter case, there is uncertainty about the best estimate to use. Thus while the estimates of N_e and divergence times may not be that accurate, higher confidence can be placed in the trends in N_e, which are independent of the generation time and mutation rate used.

7. OTHER ISSUES

No other matters were discussed by the Working Group.

8. WORK PLAN

8.1 DNA testing

The terms of reference for the DNA Testing agenda item will remain the same for the next year, unless the Commission requests other information in the interim. Members of the Working Group were encouraged to submit papers relating to these terms of reference and to propose additional agenda items. Comparison of methods for SNP development and assessment will be continued next year. Any progress on efforts to identify a mechanism to amend misclassified sequences in *GenBank* will be reported.

8.2 DNA quality guidelines

The email group formed to discuss updating the DNA quality guidelines will continue intersessionally. Using the draft updated guidelines produced during SC/67a, the group will continue to review and update sections covering data, including SNPs, produced using next generation sequencing (NGS) approaches. Topics to be addressed include analytical procedures to process the raw NGS data (trimming, filter settings, etc.) as well as issues arising from biological phenomena related to the markers of choice (e.g. linkage, selection *vs* neutrality, locus orthology). The group was convened under Tiedemann and included Baird, Baker, Bickham, DeWoody, Goto, Hoelzel, Jackson, Lang, Leslie, M., Natoli, Palsbøll, Pampoulie, Rosel, Skaug, Taguchi, and Waples.

8.3 Simulation tools for spatial structuring

An intersessional email group will be convened to discuss the utility of simulation tools for evaluating spatial structure. The focus of this intersessional email group will be to: (1) review available software packages for conducting genetic and/or genomic simulations; and (2) evaluate the utility of these packages to address issues of interest to the Working Group. A summary of these intersessional discussions will be provided during SC/67b. The group was convened under Lang and included Bickham, DeWoody, Hoelzel, Kitakado, and Tiedemann.

9. ADOPTION OF REPORT

This report was adopted at 12:00 on 17 May 2017.

REFERENCES

Archer, F.I., Martien, K.K., Taylor, B.L., LeDuc, R.G., Ripley, B.J., Givens, G.H. and George, J.C. 2010. A simulation-based approach to evaluating population structure in non-equilibrial populations. *J. Cetacean Res. Manage.* 11(2): 101-14.

Baird, A.B., George, J.C., Suydam, R.S. and Bickham, J.W. 2016. Population genetic studies of bowhead based on mtDNA sequences and SNPs. Paper SC/66b/BRG07 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Baker, C.S., Steel, D., Hamner, R.M., Hickman, G., Boren, L., Alridge, W. and Constantine, R. 2017. Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2015–16, with retrospective matching to 2001–16. Department of Conservation, Auckland. 75pp.

Branch, T.A., Abubaker, E.M.N., Mkango, S. and Butterworth, D.S. 2007. Separating southern blue whale subspecies based on length frequencies of sexually mature females. *Mar. Mamm. Sci.* 23(4): 803-33.

Bravington, M.V., Grewe, P.M. and Davies, C.R. 2016a. Absolute abundance of southern bluefin tuna estimated by close-kin mark-recapture. *Nature Comm.* 7.

Bravington, M.V., Skaug, H.J. and Anderson, E.C. 2016b. Close-Kin Mark-Recapture. *Stat. Sci.* 259-74.

Chandler, T.E., Calambokidis, J. and Rasmussen, K. 1999. Population identity of blue whales on the Costa Rica Dome. Abstract presented to the Thirteenth Biennial Conference on the Biology of Marine Mammals, Maui, Hawaii. [Available from: *Calambokidis@CascadiaResearch.org*].

Cooke, J.G., Weller, D.W., Bradford, A.L., Sychencko, O., Burdin, A.M., Lang, A.R. and Brownell, R.L., Jr. 2016. Updated population assessment of the Sakhalin gray whale aggregation based on a photoidentification study at Piltun, Sakhalin, 1995-2015. Paper SC/66b/BRG25 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 14pp. [Paper available from the Office of this Journal].

Damgaard, P.B., Margaryan, A., Schroeder, H., Orlando, L., Willerslev, E. and Allentoft, M.E. 2015. Improving access to endogenous DNA in ancient bones and teeth. *Sci. Rep.* 5(11184).

DeWoody, J.A., Fernandez, N.B., Brüniche-Olsen, A., Antonides, J.D., Doyle, J.M., San Miguel, P., Westerman, R., Godard-Codding, C. and Bickham, J.W. 2016. Novel single nucleotide polymorphisms from functional genes in the gray whale (*Eschrichtius robustus*) genome provide a powerful genotyping platform. Paper SC/66b/DNA04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 58pp. [Paper available from the Office of this Journal].

Douglas, A., Sears, R., Denkinger, J., Dobson, E., Olson, P., Gerrodette, T. and Calambokidis, J. 2015. Management implications of the first documented cross-equatorial movement. Abstract presented to the 21st Bienniel Conference on the Biology of Marine Mammals. San Francisco, CA.

Durban, J.W., Moore, M.J. and Chiang, G. 2016. Photogrammetry of blue whales with an unmanned hexacopter. *Mar. Mamm. Sci.* 32(1510-1515).

Gilpatrick, J.W. and Perryman, W.L. 2008. Geographic variation in external morphology of North Pacific and Southern Hemisphere blue whales (*Balaenoptera musculus*). *J. Cetacean Res. Manage.* 10(1): 9-22.

Hamner, R.M., Constantine, R., Mattlinc, R., Waples, R. and Baker, C.S. In press. Genotype-based estimates of local abundance and effective population size for Hector's dolphins. *Biol. Cons.* [Available at: *http://dx.doi.org/10/1016/j.biocon.2017.02.044*].

Hoban, S. 2014. An overview of the utility of population simulation software in molecular ecology. *Mol. Ecol.* 23: 2383-401.

Ichihara, T. 1966. The pygmy blue whale, *Balaenoptera musculus brevicauda*, a new subspecies from the Antarctic. pp.79-113. *In*: Norris, K.S. (eds). *Whales, Dolphins and Porpoises*. University of California Press, Berkeley and Los Angeles. xv+789pp.

International Whaling Commission. 2000. Chairman's Report of the Fifty-First Annual Meeting. Appendix 9. IWC Resolution 1999-8. Resolution on DNA testing. *Ann. Rep. Int. Whal. Comm.* 1999:55.

International Whaling Commission. 2010. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.

International Whaling Commission. 2012a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 13:1-74.

International Whaling Commission. 2012b. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 13:217-20.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 16:222-35.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 17:283-92.

International Whaling Commission. 2017a. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.

International Whaling Commission. 2017b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

International Whaling Commission. 2017c. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

Jarman, S.N., Polanowski, A.M., Faux, C.E., Robbins, J., De Paoli-Iseppi, R., Bravington, M. and Deagle, B.E. 2015. Molecular biomarkers for chronological age in animal ecology. *Mol. Ecol.* 24: 4,826-47. [Available at: *doi:10.1111/mec.13357*].

Korlević, P., Gerber, T., Gansauge, M.T., Hajdinjak, M., Nagel, S., Ayinuer-Petri, A. and Meyer, M. 2015. Reducing microbial and human contamination in DNA extractions from ancient bones and teeth. *Biotechniques* 59: 87-93.

Lah, L., Trense, D., Benke, H., Berggren, P., Gunnlaugsson, Þ. and Lockyer, C. 2016. Spatially Explicit Analysis of Genome-Wide SNPs Detects Subtle Population Structure in a Mobile Marine Mammal, the Harbor Porpoise. *PLoS ONE* 11(10): e0162792. [Available at: *https://doi.org/10.1371/journal.pone.0162792*].

Lang, A.R. 2010. The population genetics of gray whales (*Eschrichtius robustus*) in the North Pacific. PhD thesis, University of San Diego. 202pp.

Lang, A.R. and Martien, K.K. 2012. Update on the use a simulation-based approach to evaluate plausible levels of recruitment into the Pacific Coast Feeding Group of gray whales. Paper SC/64/AWMP4 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 34pp. [Paper available from the Office of this Journal].

Lang, A.R., Weller, D.W., LeDuc, R.G., Burdin, A.M. and Brownell, R.L., Jr. 2010. Genetic differentiation between western and eastern (*Eschrichtius robustus*) gray whale populations using microsatellite markers. Paper SC/62/BRG11 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 18pp. [Paper available from the Office of this Journal].

Leduc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., van Waerebeek, K., Brownell, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern pacific: implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26: 740-51. [Available at: doi:10.1111/mec.13940].

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S., LeDuc, C.A. and Brownell, R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales, and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9(1): 73-80.

Lodi, L., Tardin, R.H., Hetzel, B., Maciel, I.S., Figueiredo, L.D. and Simao, S.M. 2015. Bryde's whale (Cetartiodactyla: Balaenopteridae) occurrence and movements in coastal areas of southeastern Brazil. *Zoologia* 32: 171-75.

Malde, K., Seliussen, B.B., Quintela, M., Dahle, G., Besnier, F., Skaug, H.J., Oien, N., Solvang, H.K., Haug, T., Skern-Mauritzen, R., Kanda, N., Pastene, L.A., Jonassen, I. and Glover, K.A. 2017. Whole genome resequencing reveals diagnostic markers for investigating global migration and hybridization between minke whale species. *BMC Genomics* 18: 76pp.

Martien, K.K., Gregovich, D., Bravington, M.V., Punt, A.E., Strand, A.E., Tallmon, D.A. and Taylor, B.L. 2009. TOSSM: an R package for assessing performance of genetic analytical methods in a management context. *Mol. Ecol. Resour.* 9(6): 1,456-59.

Morin, P.A., Luikart, G., Wayne, R.K. and Workshop Group, S.N.P. 2004. SNPs in ecology, evolution and conservation. *Trends Ecol. Evol.* 19(4): 208-16.

Morin, P.A., Martien, K.K. and Taylor, B.L. 2009. Assessing statistical power of SNPs for population structure and conservation studies. *Mol. Ecol. Res.* 9: 66-73.

Mountain, J.L., Knight, A., Jobin, M., Gignoux, C., Miller, A., Lin, A.A. and Underhill, P.A. 2002. SNPSTRs: empirically derived, rapidly typed, autosomal haplotypes for inference of population history and mutational processes. *Genome Res.* 12: 1766-72.

Pastene, L.A., Acevedo, J., Siciliano, S., Sholl, T.G.C., F. de Moura, J., Ott, P.H. and Aguayo-Lobo, A. 2012. Population genetic structure of the South American Bryde's whale. Paper SC/64/SH7 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 13pp. [Paper available from the Office of this Journal].

Pastene, L.A., Goto, M., Taguchi, M. and Kitakado, T. 2016. Temporal and spatial distribution of the 'J' and 'O' stocks of common minke whale in waters around Japan based on microsatellie DNA. Paper SC/F16/JR38 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 15pp. [Paper available from the Office of this Journal].

Perrin, W.F. and Myrick, A.C. 1980. Age determination of toothed whales and sirenians. *Rep. Int. Whal. Commn.*: 229pp.

Polanowski, A.M., Robbins, J., Chandler, D. and Jarman, S.N. 2014. Epigenetic estimation of age in humpback whales. *Mol. Ecol. Resour.* 14(5): 976-87.

Taguchi, M., Goto, M., Takahashi, M., Kitakado, T. and Pastene, L.A. 2017. DAPC analysis for Bryde's whales in the North Pacific using microsatellite DNA data. Paper SC/M17/RMP01 presented to the RMP Bryde's Whale Workshop, March 2017, Tokyo, Japan (unpublished). 8pp. [Paper available from the Office of this Journal].

Tamura, T., Kitakado, T. and Pastene, L.A. 2017. Progress report of the work responding recommnendations from the JARPNII final review Workshop. Paper SC/J17/JR02rev1 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 51pp. [Paper available from the Office of this Journal].

Torres-Florez, J.P., Hucke-Gaete, R., LeDuc, R., Lang, A., Taylor, B., Pimper, L.E., Bedriñana-Romano, L. and Rosenbaum, H.C. 2014. Blue whale population structure along the eastern South Pacific Ocean: evidence of more than one population. *Mol. Ecol.* 23(24): 5998-6010.

Wada, S., Oishi, M. and Yamada, T.K. 2003. A newly discovered species of living baleen whale. *Nature* 426: 278-81.

Wade, P.R. and Baker, C.S. 2012. High plausibility of Hypothesis III for stock structure of the western North Pacific minke. Paper SC/64/NPM11 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 7pp. [Paper available from the Office of this Journal].

Wiseman, N., Parsons, S., Stockin, K.A. and Baker, C.S. 2011. Seasonal occurrence and distribution of Bryde's whales in the Hauraki Gulf, New Zealand. *Mar. Mamm. Sci.* 27: E253-E67.

Yakovlev, Y.M., Tyurneva, O.N. and Vertyankin, V.V. 2013. Photographic identification of the gray whale (*Eschrichtius robustus*) offshore northeastern Sakhalin Island and the southeastern shore of the Kamchatka Peninsula, 2012: Results and discussion. WGWAP 13/8.

Yakovlev, Y.M., Tyurneva, O.N. and Vertyankin, V.V. 2014. Photo-identification of gray whales (*Eschrichtius robustus*) off the northeast coast of Sakhalin Island in 2013. WGWAP 14/12.

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair and appointment of rapporteurs
   1.3 Adoption of agenda
   1.4 Review of documents
2. Provide scientific advice on stock structure to other sub-groups
   2.1 Southern and Northern Hemisphere blue whales
   2.2 Western North Pacific common minke whales
   2.3 North Pacific sei and Bryde's whales
   2.4 Other
3. DNA testing
   3.1 Genetic methods for species, stocks and individual identification
   3.2 'Amendments' of sequences deposited in GenBank
   3.3 Collection and archiving of tissue samples from catches and bycatches
   3.4 Reference databases and standards for diagnostic DNA registries
4. Guidelines and methods for genetic studies and DNA data quality
   4.1 DNA quality guidelines
   4.2 Genetic analysis guidelines
   4.3 Other developments
5. Terminology
6. New statistical and genetic issues relating to stock definition
   6.1 Simulation tools for spatial structuring (e.g. TOSSM, Testing of Spatial Structure Models)
   6.2 Other
7. Other issues
8. Work plan

Appendix 2

SEX RATIOS IN PARENT-OFFSPRING PAIR INFERENCE AMONG WESTERN NORTH PACIFIC COMMON MINKE WHALES

Ralph Tiedemann[1], Magnús R. Tiedemann[2], Mutsuo Goto[3], Mioko Taguchi[3] and Luis A. Pastene[3]
[1]*Unit of Evolutionary Biology/Systematic Zoology, Institute of Biochemistry and Biology, University of Potsdam, D-14476 Potsdam, Germany*
[2]*Faculty of Computer Science, University of Magdeburg, D-39016 Magdeburg, Germany*
[3]*Institute of Cetacean Research, Toyomi-cho 4-5, Chuo-ku, Tokyo 104-0055, Japan*

This appendix provides information on sex ratios in datasets used for kinship inference in western North Pacific common minke whales (SC/67a/SDDNA01).

Sex	Stock			Foetuses	Total
	J*	O*	Unassigned		
Male	844	1,660	278	0	2,782
Female	921	657	141	0	1,719
Unidentified	0	0	0	53	53
Total	1,765	2,317	419	53	4,554

*Without foetuses.

Appendix 3

AN UPDATE OF THE JAPANESE DNA REGISTER FOR LARGE WHALES

Mutsuo Goto, Hiroyuki Oikawa and Mioko Taguchi
The Institute of Cetacean Research, 4-5 Toyomi-cho, Chuo-ku, Tokyo, 104-0055, Japan

The status of the Japanese DNA register for large whales was presented and discussed during the 2005 IWC SC meeting (IWC, 2006). Since then, the number of genetic samples and the number of individuals analysed and registered have been reported to the IWC SC annual meetings. The annual reports include information of whales taken by the scientific whaling in the North Pacific (JARPN/JARPNII) and the Antarctic (JARPA/JARPAII and NEWREP-A), and from bycatches and stranding. The most recent full description of the protocol used by the Institute of Cetacean Research for the genetic analyses in the context of the IWC guidelines was presented by Kanda *et al.* (2014). The update of the Japanese DNA register for large whales till 2016 is as follows.

REFERENCES

International Whaling Commission. 2006. Report of the Working Group on DNA testing. *J. Cetacean Res. Manage. (Suppl.)* 8: 252-258.

Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014. Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research. Paper SC/65b/DNA1 presented to the IWC Scientific Committee, May 2014 (unpublished). 6pp. [Paper available from the Office of this Journal].

Table 1

Japan DNA register.

Footnote no.	1	2	3	4	5	6	7	8	9	10	11	12
Species/Year	Type	No. whales	No. duplicates	No. missing	No. lab problems	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	Note
North Pacific minke whale												
1994-2015	SP	2,643	0	0	8	2,635	100	2,635	100	2,643	100	
2016	SP	37	0	0	0	37	100	37	100	37	100	
2001-2015	BC	1,839	0	26	2	1,839	100	1,811	98	1,809	98	
2016	BC	169	0	0	0	169	100	169	100	169	100	
North Pacific Bryde's whale												
2000-2015	SP	705	0	0	3	702	100	705	100	705	100	
2016	SP	25	0	0	0	25	100	25	100	25	100	
2001-2015	BC	5	0	0	0	5	100	4	80	4	80	Include 3 Omura's whale and 1 from the East China Sea stock
2016	BC	0	0	0	0	0	0	0	0	0	0	No BC
North Pacific sei whale												
2002-2015	SP	1,264	0	0	4	1,260	100	1,264	100	1,264	100	
2016	SP	90	0	0	0	90	100	90	100	90	100	
North Pacific sperm whale												
2002-2015	SP	56	0	0	0	56	100	56	100	56	100	
2001-2015	BC	2	0	0	0	2	100	2	100	2	100	
2016	BC	0	0	0	0	0	0	0	0	0	0	No BC
Antarctic minke whale												
1987/88-2004/05	SP	6,794	0	10	0	1,118	17	6,271	92	6,794	100	Incl. dwarf; 87/88-88/89 no. microsats
2005/06-2013/14	SP	3,884	0	549	162	2,645	68	3,173	82	3,884	100	Some missing in the 03/11 tsunami in 2011
2015/16	SP	333	0	0	0	333	100	333	100	333	100	
Antarctic fin whale												
2005/06-2013/14	SP	18	0	0	0	18	100	18	100	18	100	
North Pacific humpback whale												
2001-2015	BC	61	0	0	0	61	100	61	100	61	100	
2016	BC	2	0	0	0	2	100	2	100	2	100	
North Pacific right whale												
2001-2015	BC	2	0	1	0	2	100	1	50	1	50	Missing by the 2011 tsunami, no micrsats
2016	BC	1	0	0	0	1	100	1	100	1	100	
North Pacific fin whale												
2001-2015	BC	10	0	0	0	10	100	10	100	10	100	
2016	BC	1	0	0	0	1	100	1	100	1	100	

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding.
[2]Number of whales that potentially entered by the previous years and enters (new year) the markets.
[3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
[4]Number of individuals for which tissue samples are missing for reasons other than sample switching.
[5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
[6]Number of samples analysed for mitochondrial control region.
[7]% of total samples analysed for mitochondrial control region.
[8]Number of samples analysed for microsatellites.
[9]% of total samples analysed for microsatellites.
[10]Number of samples analysed for sex.
[11]% of samples analysed for sex.
[12]Other problems or information.

Appendix 4

AN UPDATE OF THE NORWEGIAN MINKE WHALE DNA REGISTER

Hans J. Skaug
University of Bergen and Institute of Marine Research

Table 1

Norwegian minke whale DNA register.

Footnote no.	1	2	3	4	5	6	7	8	9	10	11	12
Species/Year	Type	No. whales	No. duplicates	No. missing	No. lab problems	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	Note
NA minke whale												
1997-2015	C	10,721	109	67	2	10,552	100	10,552	100	10,552	100	-
2016	C	586	0	8	0	0	0	578	100	578	100	-

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding.
[2]Number of whales that potentially entered by the previous years and enters (new year) the markets.
[3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
[4]Number of individuals for which tissue samples are missing for reasons other than sample switching.
[5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
[6]Number of samples analysed for mitochondrial control region.
[7]% of total samples analysed for mitochondrial control region.
[8]Number of samples analysed for microsatellites.
[9]% of total samples analysed for microsatellites.
[10]Number of samples analysed for sex.
[11]% of samples analysed for sex.
[12]Other problems or information.

Appendix 5

STATUS OF THE ICELANDIC WHALE DNA REGISTER

Christophe Pampoulie and Gisli A. Víkingsson

Practical arrangements regarding the establishment of the Icelandic DNA register were concluded in 2007. The Marine Research Institute, Reykjavik, is responsible for the establishment and maintenance of the registry that is of the same format as the Norwegian DNA registry. An ORACLE database has now been created and contains all genotyped individuals information as well as tissue collected ID of individuals collected but not genotyped. In parallel, a DNA tissue bank has been achieved and is now fully functional. Table 1 gives the present status of the registry. Samples from all the common minke whales landed as a part of the Icelandic research program (2003-07) and recent commercial catches (2008-16), as well as from commercial North Atlantic fin whale catches have been genotyped and information stored in the database.

Table 1

Icelandic whale DNA register.

Footnote no.	1	2	3	4	5	6	7	8	9	10	11	12
Species/Year	Type	No. whales	No. duplicates	No. missing	No. lab problems	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	Note
NA minke whale												
2003-07	SP	189	0	0	0	189	100	189	100	189	100	-
2008-15	C	378	0	0	0	362	97	365	97	367	98	-
2016	C	36	0	0	0	0	0	0	0	0	0	-
NA fin whale												
2006-16	C	688	0	0	0	688	100	688	100	688	100	-

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding.
[2]Number of whales that potentially entered by the previous years and enters (new year) the markets.
[3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
[4]Number of individuals for which tissue samples are missing for reasons other than sample switching.
[5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
[6]Number of samples analysed for mitochondrial control region.
[7]% of total samples analysed for mitochondrial control region.
[8]Number of samples analysed for microsatellites.
[9]% of total samples analysed for microsatellites.
[10]Number of samples analysed for sex.
[11]% of samples analysed for sex.
[12]Other problems or information.

Annex J

Report of the Working Group on Non-Deliberate Human-Induced Mortality of Cetaceans

Members: Leaper (Convenor), Al Jabri, Baldwin, Baulch, Bell, Bjørge, Brockington, Brownell, Cabrera, Castro, Cipriano, Clapham, Collins, Cooke, Cosentino, Currey, de Freitas, Donovan, Double, Elwen, Enmynkau, Ferriss, Filatova, Fortuna, Fretwell, Frey, Fruet, Funahashi, Galletti-Vernazzani, Genov, George, Goodman, Greig, Gulland, Hall, Haug, Herr, Hielscher, Holm, Hughes, Iñíguez, Jelić, Kato, Kim, Konan, Lang, Langerock, Lauriano, Lee, Leslie, Long, Lovell, Lundquist, Mallette, Mate, Mattila, Minton, Moore, Nelson, Palka, Panigada, Parsons, Pierce, Redfern, Reeves, Rendell, Reyes, Ridoux, Ritter, Robbins, Rodriguez-Fonseca, Rojas-Bracho, Rose, Rosel, Rosenbaum, Rowles, Ryeng, Santos, Sequeira, Simeone, Simmonds, Slooten, Slugina, Stachowitsch, Stimmelmayr, Strbenac, Thomas, Urbán, Van Waerebeek, Víkingsson, Wade, Walters, Weinrich, Weller, Willson, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Leaper welcomed participants. He reminded the participants that the terms of reference for the Working Group had been expanded to include consideration of non-deliberate Human Induced Mortality in all cetaceans rather than just large whales.

1.2 Election of chair and appointment of rapporteurs
Leaper was elected chair, Currey was elected co-chair and Mattila offered to rapporteur.

1.3 Adoption of agenda
The agenda was adopted, see Appendix 1.

1.4 Available documents
SC/67a/HIM01-12, SC/67a/HIM14-16, Redfern *et al.* (2017), Hill *et al.* (In press), Robbins *et al.* (2015), van der Hoop *et al.* (2016), George *et al.* (2017), Williams *et al.* (2016), Knowlton *et al.* (2015), Carretta *et al.* (2016), Anderson (2014) and SC/67a/SM20.

2. BYCATCH AND ENTANGLEMENT

As vice-chair of the Commission's new working group on bycatch mitigation, Bjørge presented a brief overview of the Bycatch Mitigation Initiative. The proposed actions in IWC/66/CC05, concerning the scope and urgency of the bycatch issue were endorsed by the Conservation Committee and the Commission in 2016. These included the formation of a Standing Working Group (SWG) under the Conservation Committee which will supervise the establishment of an Expert Panel and a coordinator position for the initiative. The SWG has been formed and is currently made up of 11 member countries and six NGOs and IGOs. It is chaired by Belgium and co-chaired by Norway. Simmonds was appointed by the Commission as the interim coordinator. He suggested that one of the first tasks that the Committee could assist with is to provide nominations for the Expert Panel.

2.1 Review new estimates of entanglement rates, risks and mortality (large whales)
SC/67a/HIM04 describes the use of aerial photographs taken of bowhead whales in the Bering-Chuckchi-Beaufort Sea (B-C-B Seas) area over multiple years for analysis of scars indicating non-lethal encounters with anthropogenic sources. Scars associated with entanglement injuries and ship strikes have been documented on B-C-B Seas bowhead whales harvested by Alaskan Eskimos for several decades. In 2016, preliminary estimates of the frequency of such injuries were presented (Kim *et al.*, 2015) and these have subsequently been published by George *et al.* (2017). The authors of that study estimated that ~12% of bowhead whales harvested by Alaska Native hunters show evidence of rope scarring likely associated with Bering Sea pot fisheries and that about 2% of these animals carry injuries/scars from ship strikes.

An aerial photo-identification survey was conducted during the spring 2011 migration near Barrow, Alaska. Inter-year matches, dating to 1985, were made against the long-term NSB, NMMF, LGL photo database to estimate abundance and survival rates (SC/67a/AWMP08). These photos also provided an opportunity to independently estimate line entanglement frequency for B-C-B bowheads (SC/67a/HIM04). The analysis of aerial photographs (n=693) with adequate photo quality of the caudal peduncle from the 2011 survey suggests ~12.6% of the whales showed evidence of entanglement scarring. An additional three whales were observed dragging gear (0.4%). Subsequently, photographs of all inter-year matches (between 1985, 1986, 2003, 2004, 2005 and 2011) from a multi-year photo mark-recapture study (SC/67a/AWMP08) were examined to identify whales that had acquired entanglement injuries during the study period. The probability of a bowhead acquiring an entanglement injury was estimated using two statistical methods: interval censored survival analysis and a simple binomial model. Both methods give similar results, suggesting a 2.4% (1.2%, 3.6%) annual probability of acquiring a scar. The estimated annual scar acquisition rate (2.4%) may seem high, particularly since both analyses suggest that the probability of acquiring a scar over 25 years is around 40%. However, this estimate is also consistent with the observation that of the 15 recaptures when the elapsed time was at least 25 years, five whales (38.5%), had acquired a scar. George *et al.* (2017) found that about 50% of large (~17m) and presumably old, harvested whales carried entanglement scars. Furthermore, when chronological ages were assigned to the dataset used in George *et al.* (2017), it was found that about 47% of the whales >50 years old carried entanglement scars (Wetzel *et al.*, 2014). These various metrics from independent data sources are in close agreement, and therefore suggestive that fishing gear entanglement is a concern for B-C-B Seas bowheads that requires further consideration.

The Working Group thanked the authors and noted that this work is based on a unique, long-term and multifaceted dataset for bowhead whales. Data for monitoring of changes in abundance and scarring would be improved through more frequent aerial surveys of (at least) every five years. In addition, increased engagement with the Bering Sea Crab Association would be very helpful, as to date, the only identified gear (n=2) removed from B-C-B Seas bowhead whales has been from that fishery, and it is the dominant fishery in the region. Although the fishery is not known to co-occur with bowhead presence in time, they do share the same region and, as has been noted previously, and this suggests that the surprisingly high level of interaction with this gear type may be with gear lost due to movements of the ice. Recognising the value of this work, and the increasing concern about the prevalence of large whale interactions with fishing gear, the Working Group suggested examination of other datasets to provide insights into the rates of interaction (e.g. scar acquisition) for other populations. It was suggested that the advances in drone technology might help to obtain useable images for these types of analyses.

George also noted that the careful examination of carcasses, as described in George *et al.* (2017), has been very helpful in understanding the wounds and in ground-truthing the inferences from aerial images. It was suggested that expanding the examinations of hunted whales to other local communities would increase the power of the analyses. With respect to ship strikes, the examination of carcasses described in George *et al.* (2017) indicates that visible (non-lethal) ship strike wounds are rare. However, the authors noted that with the anticipated increase in shipping through the region an increase in full examinations (e.g. for blunt force trauma) may be called for.

Non-hunting, human-caused injuries and mortalities (NHHCIM) can have significant impacts and gray whales are likely more vulnerable than most whale populations to interactions with fishing gear due to their nearshore migratory and feeding behaviour. SC/67a/HIM06 compiled all known sources of data on NHHCIM of gray whales in the North Pacific to document the frequency and source of NHHCIM. Data were compiled from national stranding and human-interaction databases, published reports, and newspaper articles. 397 reports of NHHCIM of gray whales were documented for the time period of 1924 through 2015. The majority of reports were from the time period of 1980 through 2015 when stranding networks were established along the US Pacific coast. Of the 397 reports, 152 documented whale deaths. The remaining 245 reports were assessed using the policy developed by NOAA for distinguishing serious from non-serious injuries and pro-rating a probability of death to seriously injured whales. Fifty-three cases were determined to be non-significant injury with the primary reason being that human intervention resulted in the disentanglement of the whale. The pro-rated sum of serious injuries and mortalities was 299.8 gray whales. Causes of NHHCIM were net fisheries (39.7%), unknown entanglements (21.5%), ship strikes (19.1%), and pot fisheries (17.1%). The primary regions for reports were California (62.8%) and Northern California through Northern British Columbia (21.5%). The most common form of NHHCIM in gray whales was entanglement in net fisheries in the 1980s and 1990s. In the 2000s and 2010s the most common cause of NHHCIM was entanglement in pot fisheries (assuming most unknown entanglements were from pot fisheries). This report represents a minimum estimate of the number of NHHCIM because it is difficult to definitively determine the cause of death of stranded whales, stranding networks had poor spatial coverage during all or part of the reporting time period, and because injured or killed whales not documented at sea may not wash to shore or be reported at-sea.

It was noted that the region covered by SC/67a/HIM06 was quite extensive, and in many cases remote, and that it might therefore be valuable to attempt to extrapolate, using these data, to the regions of gray whale habitat not covered by the established stranding networks. Scordino noted that this was currently being attempted by modelling the reporting rates before and after the establishment of the stranding networks, in order to gain insight into those areas that are currently not covered by networks.

There is clear evidence that gray whales can and do become entrapped or entangled in fishing gear, particularly gillnets and vertical lines used for pots or traps. SC/67a/HIM17 reports on the available evidence of gray whale entanglements in the western North Pacific, and reviews the literature on gear types used in the Russian Far East (RFE) that are known or suspected to impact gray whales. Additionally, the paper included: (1) an overview on the legal/regulatory situation in at least the Sakhalin Oblast region, including salmon fishing as well as other fisheries with potential risk of entangling or entrapping gray whales; (2) descriptions and maps of the relevant fisheries in the RFE and details on how they operate; (3) recognised gaps in knowledge and actions to close them; and (4) potential approaches to mitigation and consistent reporting and documentation of interactions of whales and fishing gear. The coastal salmon trap fishery off northeastern Sakhalin Island, which overlaps spatially and temporally with feeding gray whales during the summer and fall was identified as an area where entanglement risk is very high. This risk is of particular concern because adult females and their calves show strong site fidelity to this area at a critical time when the females are recovering from pregnancy and lactation and the calves are being weaned.

In response to a question about the relative risk of gear type versus geographic location, it was noted that extended co-occurrence with any static gear was the greatest risk, and in this area the whales overlap in distribution with (salmon) nets all season. Given the status of this population, Weller noted that this document had been sent to the relevant government agencies in Sakhalin and the Russian Federation.

SC/67a/HIM14 reports on an entanglement and death of an eastern South Pacific (ESP) southern right whale. The whale was first seen alive on 09/02/2017 off northwestern Isla de Chiloe, southern Chile, with clear wounds caused by entanglement in fishing gear and numerous cyamids with an abnormal distribution. The whale was compared to the Centro de Conservacion Cetacea southern right whale catalogue comprising of 39 individuals, but no match was found. Genetic samples were also collected which are the first for this population. The 13m long carcass of undetermined sex stranded and was examined ten days after the whale was seen alive at sea. Almost all the skin showed lineal marks of monofilament fishing line, most of them in the form of an 8x8cm (±2cm) net. A linear impression was found around the neck area, behind the blowholes, probably caused by a rope and on the right side of the body, four white wound circles of about 20cm in diameter were probably caused by buoys. Blubber thickness measured along the lateral mid-line was considered normal for the species showing no evidence of emaciation. Although no ropes or nets were found on its body, the pattern of the marks observed suggested that the whale was severely entangled and this was among the main factors that caused its death. This is the third entanglement reported in Chile since 1986 and the second in a relatively short period of time (approx. 2.5 years), for this Critically Endangered population, raising concerns about the negative impacts this threat is causing to the recovery. The Working Group thanked the authors and **recommended** that the planned expansion of entanglement response capability in the region, as part of the implementation of the CMP for this population, be considered as a matter of urgency.

Robbins *et al.* (2015) reported on the apparent survival of North Atlantic right whales after entanglement in fishing gear. The study used documented entanglements, long-term population studies and mark-recapture statistical techniques to evaluate the effect of entanglement events on survival. Estimates were based on 50 individuals observed carrying entangling gear between 1995 and 2008, and compared to 459 others that were never observed with gear during the same period. Entangled adults had low initial apparent survival (0.749, 95% CI: 0.601-0.855), but those that survived the first year achieved a survival rate (0.952, 95% CI: 0.907-0.977) that was more comparable to unaffected adult females (0.961, 95% CI: 0.941-0.974) and males (0.986, 95% CI: 0.975-0.993). Juveniles had a post-entanglement survival rate that was comparable to the initial survival of entangled adults (0.733, 95% CI: 0.532-0.869) and lower than un-impacted juveniles (0.978, 95% CI: 0.969-0.985). Of three entanglement characteristics examined, health status was the best predictor for subsequent survival, but the entanglement configuration and the resulting injuries also appeared to affect the outcome. When the entanglement configuration was assessed as high risk, human intervention (disentanglement) improved survival. The authors concluded a need for continued mitigation efforts for this species, as well as for a better understanding of entanglement impacts in other baleen whale populations.

The Working Group thanked the authors and George noted that their finding of a lower likelihood of juveniles surviving an entanglement might be an alternative explanation for the lower entanglement scarring observed on juvenile bowhead whales compared to adults. The possibility of inferring survival (and mortality) from scarring rates was discussed and Robbins noted that it had been previously estimated for humpback whales (Robbins *et al.*, 2009). However, estimates of the frequency of entanglement (e.g. through wound acquisition) and an estimate of survival when entanglement does occur (e.g. through monitoring the outcomes of actual documented cases), are required. In discussion of the lower survival rate of entangled females, it was noted that this may be due to higher energetic burdens related to pregnancy and lactation.

The success of a disentanglement intervention varies between species, as well as the complexity and severity of the entanglement itself, but its (positive) effect on subsequent survival of right whales is most pronounced for severely entangled whales. Robbins noted that it is likely to be similar for other species, but that a comparable analysis for humpback whales was complicated by the fact that it was often harder to identify individuals, as their flukes (e.g. their individual identifying mark) are often involved in the entanglement and not available for a surface photo, unlike the callosity patterns on the heads of right whales. Also, right whales appear to be stronger than humpbacks and can drag entangling gear for a longer period of time, giving them more opportunities to be found and released, but also, potentially resulting in more severe wounds. In contrast, humpback whales are easier to release, but those with severe entanglements may be more likely to die if not found quickly. Death can be by drowning, a gradual decline in body condition from impaired feeding, or a chronic infection. It was noted that recent work by van der Hoop *et al.* (2016) showed that even a relatively short length of rope can create significant energetic costs when dragged for extended periods of time behind an entangled whale.

2.2 Reporting of entanglements and bycatch in National Progress Reports

As in previous years, the Working Group reviewed summary tables of bycatch and ship strikes from National Progress Reports. These are shown in Appendix 3. Discussions related to changes to the National Progress Reports are given under Item 22 in the main Scientific Committee report.

2.3 Mitigation measures for preventing large whale entanglement

The work of the Technical Advisor to the Secretariat on human impact reduction is primarily reported to the Commission's Working Group on Whale Killing Methods and Welfare Issues. However, Mattila identified aspects of the work relevant to the Working Group. The curriculum that has been developed and endorsed by the IWC's entanglement advisory group, recognises that disentanglement is not the solution to the problem and that proper entanglement response must therefore include good documentation of the gear and the whale, that will hopefully lead to a better understanding of the issue, with an ultimate goal of prevention. This was stressed to the almost 600 trainees from 15 different countries (October 2014 to May 2017), and it is anticipated that, especially when the IWC's entanglement database is available, most of these newly formed networks will use it and submit data. In addition, a recently convened IWC workshop on cooperation for transboundary entanglements between Mexico, USA and Canada (Puerto Vallarta, 2016) has already increased communication on gear removed in Mexico this past winter, resulting in the identification of the type and origin of much of it.

The members welcomed the report, **agreed** that the IWC's initiative to develop a global entanglement response network was valuable to its work, and encouraged its continued expansion. It was noted that upcoming trainings were being planned for Russia, Colombia, Chile/Peru and Norway, and that several Pacific Island Countries had also expressed interest.

SC/67a/HIM10 described a study that evaluated the effectiveness of gear modifications in the Western Australian rock lobster fishery to reduce large whale entanglements. The Western Australian population of humpback whales is recovering rapidly and yet between 1990 and 2010 the reported entanglement rate in gear from the pot-based western rock lobster (*Panulirus cygnus*) fishery was relatively stable at around one or two per year. However, from 2010, reported entanglements increased dramatically, peaking at 17 in 2013, with this increase linked primarily to the fishery moving from a 7.5-month season to operating all year. To reduce entanglements a series of fishing gear modifications were implemented into the commercial rock lobster fishery, eliminating surface rope in waters deeper than 20 metres and minimising float numbers. The utility of these measures has been assessed using entanglements reported between 2000 and 2016. The assessment model incorporated expected changes in whale population size, entanglement sighting probability, commercial fishing effort, inter-annual variation in the timing of the whale migration and the implementation of gear modifications. The analyses suggest gear modifications reduced entanglements by ~65% with two and four entanglements in 2015 and 2016, respectively. The model also highlighted the northward migration and water depths of 37-73m as the times and areas with the greatest rate of entanglements. This is the first assessment that examines the effectiveness of such gear modifications to reduce whale entanglements and highlights the importance of incorporating all factors which may impact on entanglement rates to assess the effectiveness of gear modifications.

The group thanked the authors and commended Australia and its fishers for their rapid response to what had become a sudden, growing problem, and for what appears to be a major reduction in the numbers of whales entangled in this fishery. Similar gear modifications (e.g. reduced rope from pot gear) along the New England coast of the USA has not produced similar measurable reductions. Several possible explanations for this were discussed including differences in habitat characteristics and associated whale behaviours, as well as difference in the density of gear. The whales along Australia's coast are migrating, and closer to the breeding grounds than feeding grounds, while those in New England are foraging on their feeding grounds. Secondly, because official entanglement rates in both areas are primarily calculated using changes in the number or timing of reports, and those come from a variety of sources (e.g. fishers, whale watchers and the public) it is possible that changes in reporting could play a role. In a number of other areas evidence has caused concern that the threat of perceived negative management initiatives (e.g. fines, closures, gear restrictions) may reduce incentives to report. However, the Western Australian rock lobster fishers engaged in developing mitigatory gear modifications and information on the source of reported entanglements does not indicate that a fall in reporting by fishers could explain the observed reduction in the total number of reported entanglements (see Appendix 2). Double stated that the proportion of reports from fishers in the rock lobster fishery compared to other sources before and after the drop in reported entanglements showed no change. This suggests that the western rock lobster fishers have not biased their reporting, and that the reduction in reported entanglements after the modifications are consistent across all sources.

Nevertheless the Working Group also **agreed** that the numbers of witnessed (and reported) entanglement events in both areas are likely a subset of the total entanglements. Double agreed that this is a concern in Western Australia, as both of the two entangled whales that have been tracked with a telemetry device (for later intervention) had moved far offshore, where they were very unlikely to be reported or responded to. It was suggested that a dedicated scar study might be another way to assess the level of interaction between whales and gear in the region. In response to a question about modifications affecting catches of the target species, it was noted that all changes only impacted the gear retrieval system, and were therefore very unlikely to affect catches, but that this is an important variable to be considered for acceptance of mitigation measures.

Knowlton *et al.* (2015) reported on the effects of fishing rope strength on the severity of large whale entanglements. The authors examined live and dead whales entangled in fishing gear along the US east coast and the Canadian Maritimes from 1994 through 2010. Portions of entangling gear were recovered by the Atlantic Large Whale Disentanglement Network and the US Marine Mammal Stranding Network. These samples were used to determine rope polymer type, breaking strength, and diameter of the recovered gear. Rope characteristics were studied in relation to whale species, age, and injury severity. For the 132 retrieved ropes from 70 cases, tested breaking strength range was 0.80-39.63 kN (mean=11.64 kN, SD 8.29), which was 26% lower than the strength at manufacture (range 2.89-53.38 kN, mean=15.70 kN, SD 9.89). Median rope diameter was 9.5mm. Right and humpback whales were found in ropes with significantly stronger breaking strengths at time of manufacture than minke whales (19.30, 17.13, and 10.47 mean kN, respectively). Adult right whales were found in stronger ropes (mean=34.09 kN) than juvenile right whales (mean=15.33 kN) as well as all humpback whale age classes (mean=17.37 kN). For right whales, injury severity increased since the mid-1980s, possibly due to changes in rope manufacturing in the mid-1990s that resulted in production of stronger ropes at the same diameter. The authors concluded that if the sampled gear is representative of the entanglements, then broad adoption of ropes with breaking strengths of ≤7.56 kN could potentially reduce the number of life-threatening entanglements for large whales by at least 72%, and yet could provide sufficient strength to withstand the routine forces involved in many fishing operations. A reduction of this magnitude would achieve nearly all the mitigation legally required for US stocks of North Atlantic right and humpback whales.

Robbins noted that most of the lines removed from the whales and tested were in 'good' to 'very good' condition and potentially in better condition, and closer to the strength of new line, at the time the entanglement initially occurred. The Working Group welcomed this promising work and **recommended** that ropes with reduced breaking strength should be developed and tested to evaluate efficacy and to determine feasibility of use in a variety of fisheries. The group also noted that a potentially costly switch of all line was not likely to be successfully accomplished by voluntary methods. However, each country could have different schemes for implementing a switch like this if it was warranted. Several members noted that line in other parts of the world may vary, being either lighter (e.g. many UK fisheries) or stronger (e.g. Bering Sea fisheries) than those in the study.

Through the use of case studies, SC/67a/HIM01 summarised mitigation methods that have been undertaken with the objective of reducing cetacean bycatch, and assessed their efficacy and future potential. These included methods for reducing risk of contact between cetaceans and fishing gear, such as effort reduction, fishing bans and gear modifications, together with methods for reducing harm should entanglement occur. The review focussed on specific technical measures but these need to be considered as part of overall strategies involving all stakeholders. There are rather few examples of implemented mitigation measures substantially reducing cetacean bycatch. Enforcement and compliance were identified as key to the success of any measures, and the lack thereof has been one cause of many mitigation programmes' failure to meet their objectives. Generally, mitigating cetacean bycatch has not been viewed as intrinsic to successful fisheries management, but rather as a separate management issue. However, where reductions in bycatch have occurred, a feature of these situations has often been that a systemic change in the fishery itself has resulted in reduced cetacean bycatch, rather than the success of any mitigation measures specifically imposed for cetaceans.

The group thanked the authors for a thorough and helpful review. Long noted some new information related to weak hooks on long lines. Leaper welcomed the feedback and will include this in a revised draft. A. Leslie noted that this review is intended to become a Technical Briefing published by the Convention on Migratory Species. Based on this paper and previous Committee discussions a summary table outlining options for mitigation of large whale entanglement, with simple descriptions and examples, was agreed (see Table 1). The Working Group noted that this table is intended to be of use to the Commission's Bycatch Mitigation Initiative. The Working Group also **agreed** that a similar table covering measures to mitigate bycatch of small cetaceans would be valuable and included this on the work plan for SC/67b. It was also suggested that the Working Group should also list and prioritise recommendations for research into the most promising modifications of fishing practices and/or gear. This was not discussed in detail but attention was drawn to a table produced by the USA's Atlantic Large Whale Take Reduction Team[1]. It was also noted that the report of the Portsmouth Workshop held in 2016 (IWC, 2017) would also include research recommendations related to large whale entanglement prevention. As noted in the discussions of Knowlton *et al.* (2015), further testing involving weaker rope was identified as a high priority.

2.4 Estimation of rates of bycatch, risks of, and mortality for small cetaceans

Anderson (2014) highlights the scope and scale of cetacean bycatch in the Western, Central and Northern Indian Ocean tuna fisheries. Gillnets are the main source of bycatch of cetaceans throughout this region, including in coastal fisheries (Kiszka *et al.*, 2008). Although large-scale drift gillnetting on the high seas (using nets in excess of 2.5km length) is banned by both UN resolution 44/225 and IOTC resolution 12/12, there is evidence that it still occurs on vessels from Iran, Pakistan and possibly other countries. Furthermore, gillnet fleets are believed to be expanding throughout the region (SC/67a/CMP05, SC/67a/CMP12). Around 10% of purse seine sets were previously associated with baleen whales (most likely mainly Bryde's whales), and 30-40% of endangered Arabian Sea humpback whales (*Megaptera novaeangliae*) photographed off the coast of Oman bear scarring consistent with entanglement in fishing gear (Minton *et al.*, 2011).

In light of this information, and also recognising the considerable data gaps concerning cetacean bycatch associated with intensive and extensive gillnet fisheries in the Western, Central and Northern Indian Ocean, the Working Group **recommended** that bycatch in the Western, Central and Northern Indian Ocean be included in the work plan for the 2018 meeting. Through this, the Committee can encourage increased research and data collection efforts to assess and monitor fisheries bycatch of cetaceans in the region, in both industrial (open-ocean) and small-scale (more coastal) fisheries. The Working Group also **recommended** that the Secretary write to the IOTC to offer help and advice from the Committee in efforts to implement cetacean bycatch data collection and reporting protocols.

Ridoux described two recent unusual multiple stranding events of common dolphins that occurred in February-March 2017 along the French Atlantic coast. A total of approximately 800 common dolphins have been reported stranded (dead) from January 1st to March 31st 2017, mostly during two distinct unusual stranding events. Overall, 90% of them have been identified as common dolphins. Bycatch in fisheries was reported to be the primary cause of death given for 119 individuals of the 134 carcasses necropsied before mid-March.

The Working Group noted that this large number of strandings highlighted the need for accurate estimates of bycatch. The Committee has previously concluded that independent observer programs are the best way to estimate bycatch. In 2016 it was agreed that studies on monitoring bycatch through stranding data should complement observer programs and not be seen as potential replacements, and that the approaches together provide a means of ground-truthing each other. The Committee also encouraged papers on the use of strandings data for quantitative estimation of bycatch, including evaluation of different modelling approaches.

No such primary papers were received, but given the information presented by Ridoux on the large numbers of common dolphin strandings in France in early 2017, it was agreed that there was a pressing need to progress an expert evaluation of the bycatch estimates derived from strandings in the Bay of Biscay. It was **agreed** to establish an Expert Group including specialists in interpreting strandings and oceanographers, to provide an independent review. The terms of reference for the Expert Group are as follows.

(1) Review the methodology (i.e. modelling the drift of carcasses) and bycatch estimates in Peltier *et al.* (2016) and compare with any comparable results in the area using observer methodology.
(2) Review any new data provided by the authors of Peltier *et al.* (2016) that are intended for consideration by the Committee in 2018.
(3) Review whether modelling drift of bycaught carcasses can help identify the fisheries involved.
(4) In the light of (3), make recommendations for the design of new or existing observer programmes.
(5) Provide advice to the Committee on general issues (e.g. beyond the specific case of Bay of Biscay) that need to be considered whenever estimates based on strandings are being evaluated.

The Expert Group will need to include people with expertise outside of the Committee. It was proposed that Currey work with the Head of Science, Chair of the Committee and Chair of the Bycatch Mitigation Initiative to identify suitable experts. It is expected that the Expert Group will work remotely including video conferencing. Ridoux noted that the French authorities are also reviewing the situation. This might provide further information relevant to the work of the Expert Group.

2.4.1 Consider scientific aspects of bycatch mitigation measures and prevention

SC/67a/HIM07 estimated that reported bycatch of Hector's and Māui dolphins was 4-5% of actual bycatch, due to very low levels of observer coverage and voluntary reporting by fishermen. Current bycatch is estimated at 32-40 Hector's dolphins per year off the South Island east coast, 42-55 Hector's dolphins per year off the South Island west coast and 2.4-3.8 Māui dolphins per year, substantially exceeding PBR. Observer coverage in Māui dolphin habitat is 14.6% for trawling and 12.7 % for gillnetting vessels > 6m (IWC, 2016). This drops to 2% for all gillnet vessels regardless of size (Ministry for Primary Industries and Department of Conservation New Zealand Government, 2016). Current observer coverage off the east coast South Island is 2-3%. Observer coverage would need to increase to 81-91% to achieve bycatch estimates with a CV of 30%. Government plans for video camera monitoring of all inshore fishing vessels could substantially increase the amount and quality of information on dolphin bycatch. Video monitoring would be feasible in areas where dolphin densities are relatively

[1]*https://www.greateratlantic.fisheries.noaa.gov/protected/whaletrp/docs/Research/gear_research_matrix_2015.pdf.*

Table 1

Summary table of large whale mitigation measures that have been implemented to mitigate large whale bycatch and entanglement.

Measure	Situation to which it might be applied	Implementation process	Selected examples (not comprehensive)	Evaluation
Reducing amount of high risk gear in areas with whales				
Reduce fishing effort with high risk gears across a fishery.	Limits on effort are used in many fisheries management situations to address over capacity and reduce fishing mortality for target species.	A strategic component of fisheries management. Requires better coordination with fisheries management organisations such that effort reductions are prioritised in fisheries which pose a high risk to whales.	Rates of humpback whale entanglement off Newfoundland and Labrador (Canada) showed a clear relationship with fishing effort.	Will reduce risks if part of an overall fisheries management strategy with appropriate monitoring and enforcement.
Long-term or seasonal restrictions to reduce effort with high risk fishing gears in specific areas (e.g. time-area closures).	Any substantial overlap between whale distribution and high risk gears (throughout the year or seasonal).	Implemented by fisheries management organisations at global, regional, national and local levels.	High Seas and European Union (EU) driftnet bans, seasonal closures in New England (USA) trap/pot fisheries.	Only effective for the area and duration to which they apply. Limited efficacy if areas only address a proportion of the overlap between gear and whale distribution.
Reducing amount of line and surface systems in the water in pot/trap fisheries.	Pot/trap fisheries marked with surface floats and with pots/traps linked together by groundline.	Measures taken at local level.	New England vertical line restrictions, sinking ground line and minimising surface floats. Australian western rock lobster fishery. Timed or acoustic release of surface floats to remove vertical line.	Insufficient data from New England (USA) to demonstrate reduced entanglement rates but monitoring ongoing. Humpback whale entanglements in western Australia appear to have reduced.
Reduce gear loss.	Particularly pot/trap fisheries in areas covered by ice or with severe weather or in areas with gear conflicts (mobile gear).	Measures taken at national and local levels. Needs to be incentivised through fisheries management.	Bering Sea-Aleutian Island Crab Rationalization Program (USA).	Mainly relevant for fisheries with high rates of lost gear.
Reduce 'wet storage' of gear.	Fishers sometime leave gear in water even when not actively fishing.	Requirements to lift or attend to gear within a set time. Better coordination between fishers who may be using gear just to preserve their patch.	In the Australian West Coast Rock Lobster fishery, pots must be hauled every seven days.	Limited potential for risk reduction but may be achieved through engagement with fishers.
Gear modification to reduce the risk of whales making contact with gear				
Net sleeves or other devices to protect bait/catch to reduce depredation and associations between whales and long-lines.	Long-line interactions with odontocetes including sperm whales.	Co-operative development of practical systems with fishers who benefit from less interference with target catches.	Chilean Patagonian toothfish demersal long-line fishery.	Effective at reducing entanglement risk if feeding opportunities are removed such that whales are no longer attracted to the long-lines.
Pingers and acoustic alarms.	Attempting to keep whales away from gear e.g. large set nets.	Pinger requirements have been implemented for set net fisheries to reduce small cetacean bycatch.	No data demonstrating effective use. Studies of commercially used devices on migration routes of humpback whales showed no measurable avoidance response.	Although effective in certain circumstances for small cetaceans, no current systems appear effective for large whales.
Coloured or more visible line.	Allowing whales to detect and avoid gear.	Measures taken at national and local levels.	Not yet implemented.	Proof of concept research undertaken thus far that appears promising, but needs further research for low light and other species.
Reducing the risk of severe or fatal injury if contact does occur				
Weak links and reduced line strength allowing whales to break free from entanglement.	Any line that can pose risk of entanglement; links that break at points such as floats or weights which likely to get jammed around a whale.	Measures taken at national and local levels.	Weak links and limits on line strength required on North Atlantic right whale calving grounds off US.	Studies of gear recovered from entangled whales suggests risks could be reduced by limiting line strength.
Disentanglement.	Areas where whales are likely to be observed and suitably trained and motivated people are equipped to respond.	The IWC has held a number of workshops and training sessions for large whale disentanglement.	In South Africa interventions were successful in removing gear from 81% of whales entangled in shark nets off Kwa Zulu-Natal.	Not a prevention measure. Only a small fraction of the entanglements that occur are likely to be successfully disentangled in most areas.

high (e.g. South Island east and west coasts), but not for small populations (e.g. Māui dolphin) because in very small populations (such as Māui dolphin and vaquita) it becomes very difficult to accurately estimate bycatch and population size (Slooten and Dawson, 2016), let alone establish a causal link between protection measures and either increasing population size or decreasing bycatch.

In discussion, Lundquist noted difficulties with stratifying the effort and dolphin density used to determine the bycatch estimates in SC/67a/HIM07 because of protected areas with fishing restrictions. This could introduce bias resulting in an overestimate of bycatch rates. Ministry for Primary Industries in New Zealand (MPI) is currently conducting a spatially explicit risk assessment, which should address these concerns. He also noted that MPI are investigating how best to implement video monitoring and would welcome advice from the Committee. Slooten noted that she did not believe there was any reason to expect the bycatch estimates in SC/67a/HIM07 to be over-estimates. She also noted that quantitative targets for precision and bias of bycatch estimates would be useful in designing the video monitoring programme. She also suggested that observers would still be needed to estimate drop out and ground truth the video data (e.g. proportion released alive). ASCOBANS held a workshop on remote electronic monitoring in 2015 which noted the relatively rare occurrence of cetacean bycatch and recommended that all of the collected video footage be viewed rather than just shorter samples which are used for other fisheries monitoring purposes (ASCOBANS, 2015).

In 2016, the Committee made a number of recommendations related to Māui dolphins including that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expressed continued grave concern over the status of this small, severely depleted subspecies.

SC/67a/HIM12 suggests that currently less than 30% of Māui habitat is protected from set nets and only 8% is protected from both set net and trawl threats. Gear switching from set net and trawl to longlining has been identified as one potential alternative to reduce the impact of fisheries on this dolphin population. Between 2002 and 2014 there were over 1,800,000 observed bottom longline hooks set in the Northland and Hauraki Gulf area and zero dolphin bycatch events were reported (Dragonfly, 2017a). During the same period, over 500 thousand surface longline hooks were observed, with only one dolphin capture (not death) reported (Dragonfly, 2017b). In addition to data on fishing effort, SC/67a/HIM12 also contained an economic analysis investigating the costs of transitioning away from commercial set netting and trawling within Māui habitat. The key finding was that by financially enabling set net and trawl fishers to switch to longlining, a higher proportion of fishers could remain fishing. The fishing industry is taking proactive steps towards transition and two of the largest fishing industry representatives have committed to transitioning between 40-50% of their fleet to alternative gears.

The discussion focussed on the risk reduction that might be achieved by switching to long lines. It was noted that an important risk statistic is the relative risk for the same catch of the target fish species. To evaluate this it would be useful to know the number of hooks that might be needed to be set to catch the equivalent of the current catch using set nets and trawls. Trials in the German Baltic Sea using automatic long lines as alternatives to set nets had resulted in lower catches but might still represent a viable fishing method. Lundquist noted that the reported bycatch of dolphins from long lines in New Zealand this year had been six events, five in surface long-line, and one in bottom long-line. The species involved were: three common dolphins, one bottlenose dolphin, two unidentified dolphins which were likely common or bottlenose based on the reported locations, which were well away from Hector's/Māui and dusky dolphin habitat. It is not known whether these involved animals that were hooked (suggesting depredation) or that were entangled.

The Working Group **agreed** that the evidence presented suggests that longlines are a potential alternative to reduce risk from the set nets and trawling currently associated with bycatch of Māui dolphin. Government support is required to develop and implement such alternatives and assess any associated impacts on target catch or other marine species.

SC/67a/SM20 described vaquita bycatch in multiple gear types from the mid-1980s to the early 1990s. These observations were possible because the population and bycatch reporting rates were much greater during that period than the present day.

In discussion, it was noted that even though no bycatch had been observed in 900 ghost gillnets that had been recovered, this does not mean that those nets did not pose a threat to the population. For a population at such small numbers (see Annex M, item 17.5) it is not surprising that no bycatch had been observed in the recovered gear.

2.5 Recommendations related to membership of the FAO Coordinating Working Party on Fisheries Statistics

IWC is a member of the FAO Coordinating Working Party on Fisheries Statistics (CWP). No one from IWC has attended CWP meetings for a number of years and the Secretariat had been asked by FAO if IWC wished to remain a member of this group. It was noted that recent reports of CWP meetings did not show any activities related to cetacean bycatch. The CWP handbook (*http://www.fao.org/fishery/cwp/en*) does provide useful information on definitions to describe fisheries including for fishing effort and fishing gears. The Working Group **agreed** that it would be useful to use these definitions wherever possible (National Progress reports already use FAO codes for gear types) but also **agreed** that there was no need, for the purposes of the Working Group, for IWC to remain a member of the CWP. However, the Working Group encouraged continued IWC engagement with FAO, including COFI.

2.6 Other

Reeves presented Williams *et al.* (2016) which evaluated a new rule requiring countries exporting seafood to the United States to demonstrate that their fisheries comply with the US Marine Mammal Protection Act (MMPA). The MMPA mandates periodic estimation of marine mammal population sizes (and uncertainty) to set PBR, monitoring of bycatch rates, and implementation of mitigation measures, such as gear modifications or fishery closures when PBR is exceeded. This has resulted in improvements in the status of cetacean populations, including Eastern Tropical Pacific dolphins and harbour porpoises. Countries will be given a (maximum) five-year grace period to achieve and document compliance before import restrictions come into force. The new regulations present opportunities but also risks to addressing cetacean bycatch effectively in different countries.

It was noted that one of the risks relevant to the Working Group is the potential for unintended consequences including reduced reporting. In some situations, introduction of penalties for fisheries with cetacean bycatch appear to have caused reporting rates to drop. Another potential risk is that fisheries with a high cetacean bycatch may simply switch markets. The Working Group **recommended** that updates on the implementation of the rule (from the United States or other countries that are affected), be provided for future meetings.

3. SHIP STRIKES

3.1 Review estimates of rates of ship strikes, risk of ship strikes and mortality

The Working Group briefly considered SC/67a/HIM05. This paper used an encounter model to estimate the relative spatial distribution of strike risk and estimate ship strike mortality for blue, humpback and fin whales in the US West Coast Exclusive Economic Zone (EEZ). The spatial distribution of risk showed high risk areas along the southern half of California, extending offshore where major trans-Pacific routes occur indicating the majority of strike risk could be addressed with measures that affect only 10% of the EEZ.

The Working Group noted that the authors had made a number of assumptions to develop total estimates of ship strike mortality from predicted encounter rates. This is a topic that the Committee has been considering for a number of years and has not been able to develop any appropriate factors to incorporate avoidance response by the whale. In the absence of the authors to discuss some of the parameters and assumptions it was agreed to consider the paper again in 2018 if the authors were able to be present.

Hill *et al.* (In Print) described a study of vessel collision injuries on live North Atlantic humpback whales in the southern Gulf of Maine. The research was based on 624 individuals that were photographed from commercial whale watch and research vessels from 2004 through 2013. Multiple reviewers evaluated 210,733 photos for five categories of injury consistent with a vessel strike. Injury severity, state of healing and timing of acquisition were examined, as were the sex and age class of the individual. The resulting documentation and assessments were most complete for dorsal body regions and the ventral fluke. In total, 14.7% (n=92) of individuals exhibited injuries consistent with one or more vessel strikes. Among dorsal areas, the flanks and peduncle were preferentially affected. When the age class at acquisition was known, the majority were adults (55%, n=31), including mothers with dependent calves. Of the injuries documented, 29% (n=44) involved propeller evidence, and most were only known to penetrate the skin (29%, n=43) or into the blubber (66%, n=98). Ten percent (n=15) of injuries were fresh at first observation, and 29% (n=43) were in the process of healing, including one that was not considered fully healed until two years later. These results likely underestimate vessel collision rates and impacts because multiple events, events resulting in acute mortality, and those that involved only blunt force trauma could not necessarily be detected. There was only one vessel strike formally reported in the area during the study period, and so these results also indicate that events are underreported. The authors recommend that a management strategy be developed for all classes of vessels transiting in the vicinity of whales.

The group welcomed this paper as it represents the first published attempt to undertake this type of analysis for humpback whales, and they commended the authors for not only obtaining the extensive photographic coverage over the nine years, but also for the detailed analysis. Robbins noted that much of the coverage was due to the participation of data collectors aboard whale watch vessels in the region. With visible wounds it was hard to determine the depth of wounds, and so the authors used the qualitative approach (i.e. skin, blubber, muscle). It was suggested that although gauging the depth might be difficult, perhaps the spacing between the propeller wounds might help to determine the size of the colliding vessel. Rowles noted that this method of visually scoring trauma will inherently have a very difficult time determining blunt trauma. The Working Group **recommended** that a careful examination of stranded carcasses and comparison with catalogues of images, that might include the stranded animal pre-mortem, would be valuable, and in some cases might assist the determination of blunt force trauma. Robbins noted that, while several individuals had large portions of the fluke missing, there were not any in this study that had completely lost one side of the fluke. However, several such cases have been documented throughout the years in the study area.

The dynamics of collisions between large ships and large whales was explored in SC/67a/HIM16, taking into account the flexible nature of whale bodies. Although there is a considerable literature on injuries to humans from traffic and other collisions, the physical parameters that determine impact injuries each scale differently with body size, which makes extrapolation to animals as large as whales difficult. A simple equation of motion was derived for flexible bodies and applied to simulated whale-ship collisions. Side-on, glancing and 'snagging' collisions were considered, depending on the orientation of whale relative to the trackline and the point of impact relative to the whale's centre of mass. An exploratory analysis assuming a body size and mass typical of a fin whale suggests that only at high vessel speeds or with side-on collisions would the impact energy be in the range required to cause death by blunt trauma. However even at moderate speeds the collision can impose a lateral bending moment on the whale's spine sufficient to cause serious or catastrophic spinal injury, but not necessarily near the point of impact. The model predicts that snagged whales will tend to slide and rotate into a side-on position across the bow, with a high bending moment maintained for several seconds. Spinal injury that is not immediately fatal may compromise the motility of the whale and render it incapable of feeding, leading to death from malnutrition over time. Carcasses from such delayed deaths may not be readily recognised as ship strike mortalities.

The group welcomed this study as an advancement of the effort to model the dynamics of whale and vessel collisions that could help refine understanding of the relationship between speed and lethal impacts. It was noted that the results could help with advice on identifying whether a ship strike had occurred. The group also **agreed** that some sightings of animals in poor body condition, but with no obviously compromising external trauma, could have been compromised by internal injuries that hinder their mobility enough to impact their health. Depending on the vessel size, this type of not-immediate lethal injury would be more likely to occur with vessels traveling at moderate speeds. In response to questions about data gaps and how to fill them, it was noted that human cadavers have been used to test the body's resilience to various forces, and therefore perhaps whale carcasses could be as well, in order to assist with improving the models. Leaper noted that there had been reports from whale watch operators of blue whales off southern Sri Lanka that were unable to swim effectively but showed no other signs of injury. The results of SC/67a/

HIM16 would be consistent with such animals having been struck by a ship and could help investigation of similar cases in the future. The group **recommended** that the work continue, and that the author discuss with relevant stranding coordinators, what type of data could be collected to help improve the models.

Galletti Vernazzani reported on a new case of a dead blue whale by ship collision in Southern Chile. On 22/02/2017, a dead blue whale was reported at Estero Mena, southern Chile, and the condition of the carcass was good (fresh) and not bloated. Fundacion Meri attended the stranding on 6th March and confirmed it was a female blue whale with a total estimated length of 12m (not including the tail). The carcass had at least four clear propeller cuts on the peduncle and the entire tail was missing. The cuts look closely spaced, and thus they probably do not correspond to a large vessel. This recent event represents the third confirmed case of a dead baleen whale from ship collision in this area. The first confirmed case corresponded to a female sei whale in 2009 (Brownell *et al.*, 2009) and the second was a male blue whale in 2014 (Brownell *et al.*, 2014). Southern Chile is an important feeding area for blue whales and other baleen whales. The reported cases of baleen whales from ship strikes in the area raises concerns about this threat and highlights the need to take immediate actions to reduce risk of ship strike with whales.

In discussion, members wondered if, with access to the best images, the size of the vessel might be estimated from the spacing between propeller cuts. In addition, the possibility that the toxins of a Harmful Algal Bloom (HAB) might influence an animal's ability to manoeuvre to avoid an oncoming ship was also mentioned. Galletti indicated that Redfern would be assisting with modelling whale and shipping distribution in the area, which might allow high risk portions of the habitat to be identified. The Working Group **recommended** that this work to identify high risk zones be undertaken, so that possible mitigation options might be evaluated.

3.1.1 Review progress on global ship strike database

Ritter presented an update on the work conducted by the ship strike data coordinators work in the past year (SC/67a/HIM08). General inquiries about the database were followed up and advice was given wherever possible. New incidents of collisions were searched for on the internet, in the news, in relevant Facebook groups, cetacean related emails lists, and in the scientific literature. Where necessary, additional information was solicited and authors were invited to make use of the database. Thirty-five new reports were received, with a total of around 1,200 reports now being hold in the database. Most of these new records came from scientists and the general public, indicating the database is being used increasingly. A close connection was held with ASCOBANS and ACCOBAMS and relevant meetings were attended. In terms of outreach, the IWC information banner, the ship strike leaflet and the Power Point presentation were utilised, the latter being presented on different occasions in Belgium and Germany. During an Antarctic cruise, a briefing on ship strikes was given to the ship crew and substantive information material was provided. Together with the Secretariat, the coordinators were in contact with various maritime and nongovernmental organisations. A magazine article was published in cooperation with Sailors for the Sea. The focus of the data coordinators, however, was data review. 112 existing reports in the database were reviewed in detail (spanning from most recent cases back to 2008), the majority of which were categorised according to the agreed criteria. In a number of cases, supplementary information was solicited; all other reports needing review were forwarded to the Data Review Group (DRG). Open issues remaining include: (a) the fact that collision incidents identified by the coordinators need to be entered into the database; and (b) the development of a tool to bulk uploads into the database.

The group welcomed this summary of the work and **recommended** that it continue according to the work plan agreed in 2016. In discussion it was noted that the hundreds of records, which still need to be bulk uploaded, will also need to be reviewed by the coordinators and, if needed, by the Data Review Group (DRG). However, Panigada noted that, with recent input from the DRG and suggestions for new 'reminders' during web entry, the review process is still improving, and should be less time consuming in the future. Some new members were appointed to the DRG (see Annex W) which will continue to work with the same terms of reference.

It was noted that most, but not all, of the identified ship strikes reported in SC/67a/HIM06, were included in the USA ship strike database, and would be uploaded to the IWC global database with the rest of the USA data. The Working Group requested Scordino to work with the database coordinators to identify and enter any reports that may not be in the USA database into the IWC database.

3.2 Mitigation of ship strikes in high risk areas

3.2.1 Review progress towards assessing and mitigating ship strikes in previously identified high risk areas

SC/67a/HIM11 notes that large dead whales have been recorded from the Sri Lankan coast since 1832 (Blyth, 1859). Between 1889 and 2004, there were records of 67 large whales stranded around Sri Lanka (Ilangakoon, 2002; 2006). Additional records for 54 large whales that stranded in the region over the next ten years (2005-14) were compiled creating a new total of 121 individuals (38 blue whales, *Balaenoptera musculus*; 5 Bryde's whales, *B. edeni*; 2 humpback whales, *Megaptera novaeangliae*; 33 sperm whales, *Physeter macrocephalus*, 28 unidentified baleen whales, and 15 unidentified large whales). The larger number of records over the more recent 10-year period reflects better reporting. The first two large whales that were confirmed deaths from ship strikes were in July 2002 and November 2003. It was not possible to determine the cause of death for any stranded individual before 2002, except for one humpback whale entangled in fishing gear in 1981. The authors could only determine the cause of death for two of the 54 strandings after 2004 and both were ship strikes. There were 12 additional deaths that were reported as ship strikes but these could not be confirmed due to the limited available details. However, the true number of whales killed from vessel strikes must be much greater than the confirmed number. Stranded individuals reported by Ilangakoon (2002) as either fin, *B. physalus* (9) or minke whales, *B. acutorostrata* (8) before 2005 were misidentified. The reported fin whales were most likely blue or Bryde's whales and the reported minke whales were likely Bryde's whales, or perhaps Omura's whales, *B. omurai*. There are no confirmed records of fin, sei, *B. borealis*, or minke whales from Sri Lankan waters, nor from the Northern Indian Ocean (Arabian Sea).

Brownell indicated that this review of historical information was undertaken because of recent concern expressed by the Scientific Committee about ship strikes in this region. Indeed in all cases where cause of death was known, it was due to ship strike, however the vast majority of the cases reviewed had very little information and so cause of death could not be determined. It was not clear if a stranding network currently operates in the area, and therefore whether documented increases were due to increases in strike fatalities or increased reporting

The goal of Redfern *et al.* (2017) was to develop methods for predicting cetacean distributions in data poor ecosystems. Blue whales (*Balaenoptera musculus*) were used as a case study because they are an example of a species that have well-defined habitat and are subject to anthropogenic threats. Models were based on 377 sightings of one or more blue whales from approximately 225,400km of effort during surveys conducted by NOAA Fisheries' Southwest Fisheries Science Center from August through November (California Current: 1991, 1993, 1996, 2001, 2005, 2008, and 2009; eastern tropical Pacific: 1998, 1999, 2000, 2003, and 2006). Blue whale data in the northern Indian Ocean (NIO) study area (defined as north of the equator) are extremely limited. Large scale blue whale distribution models cannot be built using the NIO data because of their limited spatial and temporal resolution. Models using the combined California Current (CC) and eastern tropical Pacific (ETP) data were used to predict blue whale distributions in the NIO because of the potential similarity of blue whale ecology in both regions. The accuracy of models built with combined CC and ETP data was similar to the accuracy of ecosystem-specific models in both eastern Pacific ecosystems. The predictions of blue whale habitat in the NIO from these models compare favourably to hypotheses about NIO blue whale distributions, provide new insights into blue whale habitat, and can be used to prioritise research and monitoring efforts.

The authors noted that they were now in a position to explore the potential for using these models to assess ship-strike risk in the NIO. In 2016 the Committee had agreed that the results previously presented from this study on large scale distribution patterns together with those of Priyadarshana *et al.* (2016), covering a smaller area, were sufficiently consistent to support a proposal to IMO to move the shipping lanes off the southern coast of Sri Lanka, should Sri Lanka so wish.

The Working Group **agreed** that the results presented would allow the Committee to provide advice on the relative risks of different routing options south of Sri Lanka. This type of analyses had been discussed during the most recent IWC convened ship strike Workshop (IWC, 2016) and further recommended at SC/66a. The Working Group also noted that this approach could be advanced in a number of possible ways and extended to multispecies modelling as well as expanded to other regions. In particular, telemetry data could assist in developing models of habitat use. In response to a query about this type of modelling approach in a time of relatively rapid climate change, it was noted that the information derived is useful over timescales relevant to managing shipping threats (such as routeing measures), but that models could also potentially include further relevant variables associated with climate change to make longer term predictions.

SC/67a/HIM03 describes using Automatic Identification System (AIS) data provided by Global Fishing Watch to reconstruct the track of a container vessel which docked in Colombo, Sri Lanka. The vessel arrived from Chennai, South India having travelled along the southeast coast of India and east coast of Sri Lanka prior to turning west along the southern coast and north along the west coast of Sri Lanka where it docked. After it docked, a dead blue whale (*Balaenoptera musculus*) with an estimated total length of 18m was discovered wrapped over the bulbous bow. This incident was reviewed by the Committee in 2013 (De Vos *et al.*, 2013). SC/67a/HIM03 provided further information on the track and speed of the vessel.

Although in the case of the incident described in SC/67a/HIM03 it had not been possible to match a change in vessel speed with the location of the ship strike, it was noted that the Committee had previously considered the potential for 'forensic' use of AIS data (IWC, 2014). AIS data is transmitted with a duty cycle of a few minutes but in the case of SC/67a/HIM03 the time interval between satellite passes meant that there were gaps of several hours in received signals.

Leaper noted that AIS data was being increasingly used within the Committee for a range of applications but that many researchers had found difficulty in obtaining data. There are several commercial providers who may be willing to provide data for conservation related purposed. For some of the studies previously considered by the Committee, Marine Traffic (*http://www.marinetraffic.com*) had generously provided data. However, providers may not wish to have to deal with large numbers of different requests. The Working Group **agreed** that IWC could play a valuable role in coordinating data requests for work which was intended to be considered by the Committee. It recommended that the Secretariat and HIM Convenor explore possibilities for developing a memorandum of understanding between IWC and a data provider. IWC could then pass on data requests in a standardised format which would minimise the work for the data provider. The data provider would then only have to deal with one organisation and may be pleased to be able to say that they have a relationship with IWC. It was suggested that IWC might maintain its own AIS database but this would have substantial cost and workload implications. However, if IWC was coordinating data requests then any data that was provided could be archived along with the request specification, for future use.

3.2.2 Consideration of methods to identify 'high risk' areas

In 2013, the International Union for Conservation of Nature (IUCN) established a Task Force (TF) on Marine Mammal Protected Areas (MMPA). This group grew out of the International Committee on Marine Mammal Protected Areas, which was established in 2006, and which has reported on its activities to the IWC since 2009. As its first major initiative the IUCN MMPA TF began an effort to develop criteria for identifying Important Marine Mammal Areas (IMMAs) through a consistent expert process, independent of any political and socio-economic concerns, to provide input of information regarding marine mammals into existing national and international conservation tools with respect to marine protected areas, including Ecologically or Biologically Significant Areas (EBSAs) under the Convention on Biological Diversity (CBD), and Key Biodiversity Areas (KBAs) identified through the IUCN Standard. The IMMA process also assists in providing strategic direction and priorities to the development of spatially explicit marine mammal conservation measures.

Notarbartolo di Sciara, co-chair of the MMPA TF, presented an overview of the IMMA process, and the results of the TF's first regional workshops to identify IMMAs in the Mediterranean Sea (SC/67a/HIM15) and in the Pacific Islands region. He briefly explained that the process of IMMA identification is articulated into successive regional expert workshops tasked to assess the scientific validity of 'Areas of Interest' previously proposed to the workshop for consideration. Regional workshops submit candidate IMMAs (cIMMAs) to subsequent review by an independent panel. Future workshops are being planned in the North-East Indian Ocean (2018), West Indian Ocean (2019), waters adjacent to Australia and New Zealand (2020), and East Pacific Ocean off Latina America (2021).

An overview of the IMMA criteria and process can be found online[2].

The working group thanked Notarbartolo for taking time to present on this important IUCN initiative, which has the potential to assist the work of the IWC. It was noted that the IMMA process is purely scientific, only looking at the biology and ecology of the marine mammals, and therefore it does not consider threats in the process. Any use for management (e.g. spatial planning, regulatory designation) would come later if warranted. However, it was noted that one candidate IMMA in the Mediterranean coincided with an existing high risk area for ship strikes in the Hellenic Trench where the Committee had considered routing measures. The current mechanism for using IMMAs to inform management would be through the work of regional IMMA groups, whose core make up comes from key experts who participated in the regional workshop that identified the candidate IMMAs. It is recommended that those regional groups then initiate engagement with the relevant local, or in some cases international, management bodies for those IMMAs that might need management of particular threats. It was noted that, in addition to their potential relevance to ship strikes (e.g. through voyage planning or speed reduction), managers might consider using them in co-occurrence analyses with fishing, noise (e.g. soundscape) or other spatial threats.

In response to a question about the recent Mediterranean Workshop, only the waters of Libya, Syria and Egypt did not produce identified candidate IMMAs, but this was likely due to data deficiency. The group discussed the use of historical data (e.g. whaling data), especially for those areas with little current information. A small intersessional group agreed to review historical data sources, and recommend their appropriate use in the process.

Both the IWC Scientific Committee and the Commission's standing working group on ship strikes have recognised that the IMMA process may be of value to the work of the Committee in several ways, but most immediately in assisting to identify potential 'high risk' areas for ship strikes. Following the SSWG strategic plan, the Working Group **recommended** to continue with the effort on identifying IMMAs, and suggested that a joint IWC-IUCN TF group be formed and charged with identifying those IMMAs which should be taken forward to the IMO, perhaps starting with the Mediterranean Sea. It also suggested that a small group work with the IUCN MMPA TF intersessionally in order to provide advice on the most appropriate use of the IWC's (and other) historical datasets in the IMMA consideration process.

3.3 Co-operation with IMO Secretariat and relevant IMO committees

SC/67a/HIM09 reviewed developments in the marine mammal avoidance provision of the Polar Code, along with a general review of available information on collection of data and mechanisms to convey these data to ships masters. The review highlighted the possible impacts of Polar shipping, and the context for the creation of the Polar Code, in particular a provision in Chapter 11 which calls on Masters to note current information on marine mammals densities and migratory routes, any known recommendations and measures that could be taken in the event of an encounter (IMO, 2014). The authors then reviewed available sources of information on marine mammal densities, noting its fragmentation across agencies, nations, NGOs, and intergovernmental organisations. SC/67a/HIM09 also highlighted the prospect of incorporating traditional ecological knowledge in implementation. This information could then be relayed to masters through notices to mariners, electronic navigation charts, pre-voyage planning documents, mariners guides, maps published by NGOs to highlight at risk cetaceans, apps like WhaleAlert, AIS communication, and in the event of effective collation, risk assessment tools.

The Working Group welcomed the information provided in SC/67a/HIM09. It **recommended** that information on known cetacean densities and migratory routes in the Arctic and Southern Ocean, including appropriate models of distribution patterns, should be compiled and reviewed by the Committee and made available in an appropriate form to assist the Polar states, IMO, and Arctic Council in the implementation of the IMO Polar Code's marine mammal avoidance provision. The Working Group recognised that this is a substantial task and **agree**d to include consideration of what can be made available in the work plan, including encouraging relevant papers in 2018.

The Working Group further **recommends** that information regarding cetaceans in the Western Arctic and Bering Strait migratory routes should also be integrated with the Arctic Waterways Safety Committee (AWSC) in order to support its development of traffic mitigation measures in those waters.

4. REVIEW SOURCES OF INFORMATION THAT WILL INFORM TIME SERIES ON ENTANGLEMENT AND SHIP STRIKE AFFECTING LARGE WHALE POPULATIONS

The Working Group reviewed Table 2, which assessed the available sources of data for 57 large whale populations to classify: (i) risk of ship strikes and entanglement; and (ii) reports of ship strikes and entanglements including time series where these are available. The Working Group thanked Double and the intersessional group for their work on this and noted that information was still being sought from regional experts to fill some data gaps within this table which would be reviewed again in the light of any new information.

5. OTHER

Rosenbaum provided a description of a cooperative effort, between a number of NGOs, IGOs and UN member countries, to bring issues of shipping and cetaceans, primarily noise and ship strikes, to the attention of the UN. A more detailed description was provided to the Environmental concerns sub-committee. In brief, the initial action is to bring a 'Call for Action' to the UN Ocean Conference (June, 2017), that would help to generate Voluntary Commitments that help to achieve the UN's Sustainable Development Goal 14 (SDG 14). SDG 14 reads as follows 'Conserve and sustainably use the oceans, seas, and marine resources for sustainable development'.

The group welcomed this effort, and discussed the best way for the IWC's ship strike work to complement it. While the Committee might be helpful in the future by providing

[2]*https://www.marinemammalhabitat.org/download/imma-guidance-document-october-2016/.*

Table 2

Available sources of data.

Entry	Species	Population	Time series - entanglement data?	Structured/ comprehensive entanglement reporting?	Overlap with high risk fisheries	Evidence of substantial entanglement numbers	Entanglement data sources	Time series - vessel strike data?	Structured/ comprehensive vessel strike reporting?	Overlap with high density of shipping	Evidence of substantial vessel strike incidents	Vessel strike data sources	Notes	Record entered by	Last up-dated
1	Bowhead whale	Bering-Chukchi-Beaufort Sea	Yes	Yes	Medium	Yes	NOAA, NSB publications	Yes	Some records	Medium	No	NOAA, NSB	Spatial overlap with Bering Sea crabbing; little temporal overlap; shipping through Bering Strait likely increasing	Craig George, David Matilla	2017
2	Bowhead whale	Okhotsk Sea	-	-	-	-	-	-	-	-	-	-	-	-	2016
3	Bowhead whale	Svalbard-Barents Sea	-	-	-	-	-	-	-	-	-	-	-	-	2016
4	NA right whale	-	Yes	Yes	Yes	Yes	NOAA, NEAq	Yes	Yes	High	Yes	NOAA	-	David Mattila	2016
5	Northern Pacific right whale	-	No	Some records	Yes	Don't know	NOAA, Russia	-	-	-	-	-	-	-	2016
6	Southern right whale	Western South Atlantic	-	-	-	-	-	-	-	Medium	-	CCC	One documented ship strike, Strait of Magellan, probable from western South Atlantic Population reported on Chile Voluntary Conservation report (IWC/62/CC15)	Barbara Galletti	2016
7	Southern right whale	Eastern South Pacific	No	Not comprehensive	Yes	Don't know	CCC, Sernapesca	-	-	-	-	-	One whale reported in October 2014 entangled. Reported to IWC Galetti-Vernazzani (2015).	Barbara Galletti	2016
8	Southern right whale	Australia	Yes	Not comprehensive	Yes	No	-	Yes	-	Medium	No	-	-	Mike Double	2016
9	Southern right whale	Southern Africa	Yes	Not comprehensive	Medium	No	SAWDN	Yes	Not comprehensive	Medium	No	SAWDN/ DEA	-	Mike Meyer	2017
10	Southern right whale	New Zealand	No	Some records	Low	No	DOC	No	No	Low	No	DOC	Low incidence of SRW around mainland NZ means low overlap with fisheries or shipping. Entanglement records will be included in DOC marine mammal incidents database, but unlikely to be comprehensive or easily identified.	Dave Lundquist	2017
11	Pygmy right whale	-	-	-	-	-	-	-	-	-	-	-	-		2016
12	Gray whale	Western North Pacific	No	Not comprehensive	Medium	Yes	NOAA	No	Not comprehensive	Medium	No	NOAA	Scarring analysis from Bradford *et al.* (2009); shipping information unclear.	Kristy Long	2016
13	Gray whale	E North Pacific	Yes	Not comprehensive	Yes	Don't know	NOAA, UABCS	Yes	Not comprehensive	High	No	NOAA	-	Kristy Long	2016
14	Humpback whale	SH Oceania	No	Some records	Low	No	DOC, SPWRC	No	Not comprehensive	Low	No	DOC, SPWRC	Low level of entanglement in pot fisheries in New Zealand. Entanglement records will be included in DOC marine mammal incidents database, but unlikely to be compre-hensive or easily identified.	David Mattila, Dave Lundquist	2017

Entry	Species	Population	Time series - entanglement data?	Structured/ comprehensive entanglement reporting?	Overlap with high risk fisheries	Evidence of substantial entanglement numbers	Entanglement data sources	Time series - vessel strike data?	Structured/ comprehensive vessel strike reporting?	Overlap with high density of shipping	Evidence of substantial vessel strike incidents	Vessel strike data sources	Notes	Record entered by	Last up-dated
15	Humpback whale	SH East Australia	Yes	Not comprehensive	No	No	State agencies, progress reports	Yes	Some records	High	No	Progress rep-ort, Peel *et al.*	-	Mike Double	2016
16	Humpback whale	SH West Australia	Yes	Not comprehensive	Yes	Yes	WA entanglement database	Yes	Some records	Medium	No	Progress rep-ort, Peel *et al.*	-	Mike Double	2016
17	Humpback whale	SH East Africa	Yes	Not comprehensive	Yes	Yes	SA DOC,	-	-	-	-	-	-	-	2016
18	Humpback whale	SH West Africa	Yes	Not comprehensive	High	Yes	SAWDN	Yes	Not comprehensive	High	Yes	SAWDN/ DEA	-	Mike Meyer	2017
19	Humpback whale	SH Eastern South America	Yes	Some records	Yes	Yes	ICMBIO	Don't know	Some records	Medium	Don't know	ICMBIO	-	David Mattila	2017
20	Humpback whale	SH Western South America	Yes	Not comprehensive	Yes	Yes	IMARPE, CPPS, ARAP, Sernapesca	Don't know	Some records	High	Don't know	CPPS, ARAP, Sernapesca	Time series from Ecuador	David Mattila	2017
21	Humpback whale	Western North Atlantic	Yes	Yes	Yes	Yes	NOAA, DFO,	Yes	Not comprehensive	Medium	No	NOAA	-	David Mattila and Kristy Long	2016
22	Humpback whale	Greenland	Don't know	Not comprehensive	Yes	Yes	Greenland Fisheries, MFH	-	-	-	-	-	-	David Mattila	2016
23	Humpback whale	North Pacific	Yes	Yes	Yes	Yes	NOAA, DFO, CRI, RABEN	Yes	Some records	Medium	No	NOAA	Summary of mortalities from US Stock Assess-ment Reports available	David Mattila, Kristy Long and Phil Clapham	2017
24	Humpback whale	Arabian Sea	Don't know	Not comprehensive	Yes	Yes	MECA, ASWN	-	-	-	-	-	Ask Rob Baldwin and Andy Willson for info on this population	David Mattila	2016
25	Common minke	Western North Pacific	-	-	-	-	-	-	-	-	-	-	-	-	2016
26	Common minke	SoJ/East Sea	Yes	Yes	Yes	Yes	CRI, NRIFSF	-	-	-	-	-	-	-	2016
27	Common minke	North Eastern Atlantic	-	Not comprehensive	Low	Some records	UK CSIP	-	Not comprehensive	Medium	Some records	UK CSIP	Has been considered in the context of *Implementation Review*	Russell Leaper	2016
28	Common minke	Central Atlantic	-	-	-	-	-	-	-	-	-	-	-	-	2016
29	Common minke	West Greenland	-	-	-	-	-	-	-	-	-	-	-	-	2016
30	Dwarf minke	-	-	-	-	-	-	-	-	-	-	-	-	-	2016
31	Antarctic minke	-	No	No records	No	No	-	No	No records	Low	No	-	-	Mike Double	2016
32	Bryde's whale	Western North Pacific	No	No records	Low	No	-	No	No records	Low	No	-	This is for the IWC-POW-ER survey observations in Central North Pacific area	Koji Matsuoka	2017
33	Bryde's whale	Eastern North Pacific	-	-	-	-	-	-	-	-	-	-	-	-	2016
34	Bryde's whale	Indian Ocean	No	Not comprehensive	High	-	MECA, ASWN	No	-	-	-		Check with Aida Al Jabri, Baldwin and Wilson	David Matttila	2017
35	Bryde's whale	North Atlantic	No	No records	Low	No	NOAA	No	Some records	Low	No	NOAA	This is for the Northern Gulf of Mexico area	Kristy Long	2016
36	Bryde's whale	Southern Hemisphere	No	Some records	Low	No	SAWDN	No	Some records	Low	No	SAWDN/ DEA	-	Mike Meyer	2017
37	Bryde's whale	New Zealand	No	Some records	Low	No	DOC	Yes	Yes	High	Yes	U of Auckland, DOC	Check with R. Constantine for ship strike records; voluntary protocol in place to reduce speeds and thereby risk of lethal ship strike. Entanglement records will be included in DOC marine mammal incidents database, but unlikely to be comprehensive or easily identified	Dave Lundquist	2017
38	Omura's whale	-	-	-	-	-	-	-	-	-	-	-	-	-	2016

Entry	Species	Population	Time series - entanglement data?	Structured/ comprehensive entanglement reporting?	Overlap with high risk fisheries	Evidence of substantial entanglement numbers	Entanglement data sources	Time series - vessel strike data?	Structured/ comprehensive vessel strike reporting?	Overlap with high density of shipping	Evidence of substantial vessel strike incidents	Vessel strike data sources	Notes	Record entered by	Last up-dated
39	Sei whale	North Atlantic	No	No records	Low	No	NOAA	No	Some records	Medium	No	NOAA	-	Kristy Long	2016
40	Sei whale	North Pacific	No	No records	Low	No	-	No	No records	Low	No	-	This is for the IWC-POWER survey observations in Central North Pacific area	Koji Matsuoka	2017
41	Sei whale	Indian Ocean	-	-	-	-	-	-	-	-	-	-	-	-	2016
42	Sei whale	Southern Hemisphere	-	-	-	-	-	No	Not comprehensive	Medium	No	CCC	One dead whale on bow of cruise ship reported in Brownell *et al.* (2009)	Barbara Galletti	2016
43	Fin whale	E Greenland to Faroes	-	No records	Low	No	-	-	Some records	Medium	Yes	IWC SS database	Whales found on the bows of vessels reported to IWC SC. Has been considered in the context of *Implementation Review*.	Russell Leaper	2016
44	Fin whale	W Greenland	-	-	-	-	-	-	-	-	-		-	-	2016
45	Fin whale	Mediterranean	No	No records	No	No	-	Yes	Yes	High	No	National stranding networks, ferry captains, NGOs, ACCOBAMS, Pelagos	-	Simone Panigada	2016
46	Fin whale	Southern Hemisphere	-	-	-	-	-	-	-	-	-	-	-	-	2016
47	Antarctic blue whale	-	-	-	-	-	-	-	-	-	-	-	-	-	2016
48	Pygmy blue whale	Indian Ocean	No	Some records	Medium	Don't know	SC/66b/SH34	No	Some records	High	Yes	-	Some records in de Vos *et al.* (2013). Risk analysis in Priyadarshana *et al.* (2015)	Russell Leaper	2016
49	Pygmy blue whale	Chilean	-	-	-	-	-	No	Not comprehensive	Medium	No	CCC	One dead whale struck by cruise ship reported in Brownell *et al.* (2014)	Barbara Galletti	2016
50	Pygmy blue whale	Indo-Australian	No	Some records	Low	No	WA entanglement database, Australia progress reports	No	Some records	Low	No	Australia progress reports	-	Mike Double	2016
51	Pygmy blue whale	Tasman Sea	No	No records	Low	No	Australia/NZ progress reports	No	No records	Low	No	Australia/NZ progress reports	-	Mike Double	2016
52	Sperm whale	Northern Hemisphere	No	Some records	Don't know	Don't know	NOAA, NRIFSF, Guadeloupe stranding	Don't know	Some records	Low	No	NOAA	-	Kristy Long	2016
53	Sperm whale	Mediterranean	Yes	Yes	Yes	Yes	National stranding records	Yes	Yes	High	No	National stranding networks, ferry captains, NGOs, ACCOBAMS, Pelagos	Bycatch rates in pelagic driftnets has been very high in the past; now this fishing gear is banned and there are only few nets still illegally used	Simone Panigada	2016
54	Sperm whale	Southern Hemisphere	-	-	-	-	-	-	-	-	-	-	-	-	2016
55	Blue whale	Eastern North Pacific	No	No records	Low	No	NOAA	Yes	Some records	High	No	NOAA	-	Kristy Long	2016
56	Fin whale	Western North Atlantic	Yes	Some records	Low	Yes	NOAA	Yes	Some records	Medium	No	NOAA		Kristy Long	2016
57	Common minke whale	Canada Eastern coastal	Yes	Some records	Medium	No	NOAA	Yes	Some records	Medium	No	NOAA	-	Kristy Long	2016

Table 3

Work plan.

Intersessional 2017/18	2018 Annual Meeting (SC/67b)
13. BYCATCH	
	Review new estimates of entanglement rates, risks and mortality (large whales).
Develop a global database from disentanglement activities conducted by members of the IWC network.	Review progress on database.
	Mitigation measures for preventing large whale entanglement (including collaboration with Bycatch Mitigation Initiative).
	Estimation of rates of bycatch, risks of, and mortality for small cetaceans.
	Consider scientific aspects of small cetacean bycatch mitigation measures and prevention (including collaboration with Bycatch Mitigation Initiative).
	Develop summary table of small cetacean bycatch mitigation measures.
	Review bycatch issues in the Western, Central and Northern Indian Ocean.
Secretary write to the IOTC to offer help and advice from the SC in efforts to implement cetacean bycatch data collection and reporting protocols.	
Establish Expert Group to review use of strandings and observer data to estimate bycatch.	Review work of Expert Group.
14. SHIP STRIKES	
	Review estimates of rates of ship strikes, risk of ship strikes and mortality.
Ongoing data entry into Ship Strike Database and validation of records by Data Review Group.	Continuing development and of the international database of ship strikes.
	Mitigation of ship strikes in high risk areas.
Continue co-operation with IMO Secretariat/relevant IMO committees.	Review co-operation.
	Consider how to make information available in an appropriate form to help in the implementation of the IMO Polar Code's marine mammal avoidance provision.
Secretariat and HIM Convenor explore possibilities for developing a memorandum of understanding between IWC and an AIS data provider.	Review access to AIS data.
Respond to any requests for advice regarding routing proposals that may be presented to IMO.	
Consider how to collate information regarding cetaceans in the Western Arctic and Bering Strait migratory routes.	Review progress and recommendations from intersessional group.
Provide input into the IMMA process related to shipping.	Review progress on designating IMMAs.
	Consider workplan and funding priorities for 2018-20.

its expertise on this issue, it **agreed** that, as the current effort is largely policy oriented, in the first instance the Secretariat should communicate with the authors of the initiative to see what role IWC might appropriately play. It was also noted that the IWC has been asked to increase its engagement with the UN on this, and other relevant issues of common interest.

6. WORK PLAN

See Table 3 for the work plan.

7. ADOPTION OF REPORT

The report was adopted at 11:50 on 17 May 2017.

REFERENCES

Anderson, R.C. 2014. Cetaceans and tuna fisheries in the western and central Indian Ocean. IPNLF Technical Report 2, International Pole and LIne Foundation, London. 133pp.

ASCOBANS. 2015. Report of the workshop on remote electronic monitoring with regards to bycatch of small cetaceans. The Hauge, Netherlands. Steering Group: Meike Scheidat and Sara Konigson.

Blyth, E. 1859. On the great rorqual of the Indian Ocean, with notices of other cetals, and of the Syrenia or marine pachyderms. *J. Asiatic Soc. Bengal* 28: 481-98.

Bradford, A.L., Weller, D.W., Ivashchenko, Y.V., Burdin, A.M. and Brownell, R.L., Jr. 2009. Anthropogenic scarring of western gray whales (*Eschrichtius robustus*). *Mar. Mamm. Sci.* 25(1): 161-75.

Brownell, R.L., Jr., Cabrera, E. and Vernazzani, B.G. 2014. Dead blue whale in Puerto Montt, Chile: another case of ship collision mortality. Paper SC/65b/HIM08 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Brownell, R.L., Jr., Vernazzani, B.G. and Carlson, C.A. 2009. Vessel collision with a large whale off southern Chile. Paper SC/61/BC7 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 6pp. [Paper available from the Office of this Journal].

Carretta, J.V., Danil, K., Chivers, S.J., Weller, D.W., Janiger, D.S., Berman-Kowalewski, M., Hernandez, K.M., Harvey, J.T., Dunkin, R.C., Casper, D.R., Stoudt, S., Flannery, M., Wilkinson, K., Huggins, J. and Lambourn, D.M. 2016. Recovery rates of bottlenose dolphins (*Tusiops truncatus*) carcasses estimated from stranding and survival data. *Mar. Mamm. Sci.* 32(1): 349-62.

De Vos, A., Wu, T. and Brownell, R.L., Jr. 2013. Recent blue whale deaths due to ship strikes around Sri Lanka. Paper SC/65a/HIM03 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 8pp. [Paper available from the Office of this Journal].

Dragonfly. 2017a. Capture of whales and dolphins in bottom longline fisheries, in the Northland and Hauraki area. Data accessed from: *https://data.dragonfly.co.nz/psc/v20150002/whales-and-dolphins/bottom-longline/allvessels/northland-and-hauraki/all/*.

Dragonfly. 2017b. Capture of whales and dolphins in surface longline fisheries, in the Northland and Hauraki area: *https://data.dragonfly.co.nz/psc/v20150002/whales-anddolphins/surface-longline/all-vessels/northland-and-hauraki/all/*.

Galletti Vernazzani, B. 2015. Progress on the IWC Conservation Management Plan for the Critically Endangered Eastern South Pacific southern right whale population. Paper SC/66a/BRG15 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 4pp. [Paper available from the Office of this Journal].

George, J.C., Sheffield, G., Reed, D.J., Tudor, B., Stimmelmayr, R., Person, B.T., Sformo, T. and Suydam, R. 2017. Frequency of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort seas bowhead whales. *Arctic* 70(1): 37-46.

Hill, A.N., Karinski, C., Robbins, J., Pitchford, T., Todd, S. and Asmutis-Sivia, R. In Print. Vessel collision injuries on live humpback whales, Megaptera novaeangliae, in the southern Gulf of Maine. *Mar. Mam. Sci.* [Available at: DOI: 10.1111/mms.12386].

Ilangakoon, A. 2002. *Whales and Dolphins of Sri Lanka*. WHT Publications, Sri Lanka. 99pp.

Ilangakoon, A. 2006. Large whale stranding in Sri Lanka 1889-2004. *Pakistan J. Oceanog.* 2(2): 61-68.

IMO. 2014. International Code for Ships Operating in Polar Waters (Polar Code). MEPC 68/21/Add.1. Available at: *http://www.imo.org/en/MediaCentre/HotTopics/polar/Documents/POLAR%20CODE%20TEXT%20AS%20ADOPTED.pdf*.

International Whaling Commission. 2014. Report of the Scientific Committee. Annex J. Report of the Working Group on Non-deliberate Human-induced Mortality of Large Whales. *J. Cetacean Res. Manage. (Suppl.)* 15:289-99.
International Whaling Commission. 2016. Report of the Joint IWC-SPAW Workshop to Address Collisions Between Marine Mammals and Ships with a Focus on the Wider Caribbean, 18-20 June 2014, Gamboa Rainforest Resort, Panama. *Report of the 65th Meeting of the International Whaling Commission* 2014:197-224.
International Whaling Commission. 2017. Report of the Scientific Committee. Annex J. Report of the Working Group on Non-deliberate Human-induced Mortality of Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 18:277-94.
Kim, H.W., Park, K.J., Sohn, H.S., An, Y.R. and An, D.H. 2015. Entanglement of North Pacific right whale (*Eubalaena japonica*) off Korean waters. Paper SC/66a/HIM15 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished).7pp. [Paper available from the Office of this Journal].
Kiszka, J., Muir, C., Chris, P., Cox, T.M., Amir, O.A., Bourjea, J., Razafindrakoto, Y., Wambij, N. and Bristol, N. 2008. Marine mammal bycatch in the southwest Indian Ocean: review and need for a comprehensive status assessment. *West Ind. Ocean J. Mar. Sci.* 7: 119-36.
Knowlton, A.R., Robbins, J., Landry, S., McKenna, H.A., Kraus, S.D. and Werner, T.B. 2015. Effects of fishing rope strength on the severity of large whale entanglements. *Cons. Biol.* 30(2): 318-28.
Ministry for Primary Industries and Department of Conservation New Zealand Government. 2016. Māui dolphin: 2016 update on New Zealand's research and management approach. Paper SC/66b/SM12 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].
Minton, G., Collins, T., Findlay, K., Baldwin, R., Ersts, P.J., Rosenbaum, H., Berggren, P. and Baldwin, R.M. 2011. Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *J. Cetacean Res. Manage. (special issue 3)*: 183-98.
Peltier, H., Authier, M., Deaville, R., Dabin, W., Jepson, P.D., Van Canneyt, O., Daniel, P. and Ridoux, V. 2016. Small cetacean bycatch as estimated from stranding schemes: the common dolphin case in the northeast Atlantic. *Environ. Sci. Pol.* 63(2016): 7-18.
Priyadarshana, T., Randage, S.M., Alling, A., Calderan, S., Gordon, J., Gordon, T., Leaper, R., Lewis, T., Porter, L. and Van Thillo, M. 2015. An update on work related to ship strike risk to blue whales off southern Sri Lanka. Paper SC/66a/HIM09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 15pp. [Paper available from the Office of this Journal].
Priyadarshana, T., Randage, S.M., Alling, A., Calderan, S., Gordon, J., Leaper, R. and Porter, L. 2016. Distribution patterns of blue whale (*Balaenoptera musculus*) and shipping off southern Sri Lanka. *Regional Studies in Marine Science* 3: 181-88.
Redfern, J.V., Moore, T.J., Fiedler, P.C., De Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23: 394-408. [Available at: *http://www.wileyonlinelibrary.com*].
Robbins, J., Knowleton, A.K. and Landry, S. 2015. Apparent survival of North Atlantic right whales after entanglement in fishing gear. *Biol. Conserv.* 191: 421-7.
Robbins, J., Landry, S. and Mattila, D.K. 2009. Estimating entanglement mortality from scar-based studies. Paper SC/61/BC3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 4pp. [Paper available from the Office of this Journal].
Slooten, E. and Dawson, S.M. 2016. Updated population viability analysis, population trends and PBRs for Hector's and Māui dolphin. Report to NOAA, USA *https://www.regulations.gov/document?D=NOAA-NMFS-2016-0118-0076.*
van der Hoop, J.M., Corkeron, P., Henry, A.G., Knowlton, A.R. and Moore, M.J. 2016. Predicting lethal entanglements as a consequence of drag from fishing gear. *Mar. Poll. Bull.*: 14pp.
Wetzel, D.I., Reynolds, J.E., III, Mercurio, P., Givens, G.H., Pulster, E.I. and George, J.C. 2014. Age estimation for bowhead whales, *Balaena mysticetus*, using aspartic acid racemization with enhanced hydrolysis and derivatization procedures. Paper SC/65b/BRG05 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].
Williams, R., Burgess, M.G., Ashe, E., Gaines, S.D. and Reeves, R.R. 2016. US seafood import restriction presents opportunity and risk. *Science* 354(6318): 1372-76.

Appendix 1

AGENDA

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of chair and appointment of rapporteurs
   - 1.3 Adoption of agenda
   - 1.4 Available documents
2. Bycatch and entanglement
   - 2.1 Review new estimates of entanglement rates, risks and mortality (large whales)
   - 2.2 Reporting of entanglements and bycatch in national progress reports
     - 2.2.1 Review summary table
     - 2.2.2 Review the information submitted in National Progress Reports and evaluate its adequacy
   - 2.3 Mitigation measures for preventing large whale entanglement
     - 2.3.1 Review progress on developing a summary table of measures
   - 2.4 Estimation of rates of bycatch, risks of, and mortality for small cetaceans
     - 2.4.1 Consider scientific aspects of bycatch mitigation measures and prevention
   - 2.5 Recommendations related to joining the FAO Coordinating Working Party on Fisheries Statistics
   - 2.6 Other
3. Ship strikes
   - 3.1 Review estimates of rates of ship strikes, risk of ship strikes and mortality
     - 3.1.1 Review progress on global database
   - 3.2 Mitigation of ship strikes in high risk areas
     - 3.2.1 Review progress towards assessing and mitigating ship strikes in previously identified high risk areas
     - 3.2.2 Consideration of methods to identify 'high risk' areas
   - 3.3 Co-operation with IMO Secretariat and relevant IMO committees
     - 3.3.1 Review co-operation
4. Review sources of information that will inform time series on entanglement and ship strike affecting large whale populations
5. Other

Appendix 2

GEAR MODIFICATIONS IN COASTAL FISHERIES OFF WESTERN AUSTRALIAN TO REDUCE WHALE ENTANGLEMENTS

Mike Double and Jason How
West Coast Rock Lobster Managed Fishery

Gear restrictions were a reduction in float numbers and rope length used, while gear modifications were introduced to eliminate surface rope in waters generally deeper than ~20 m (see Table 1). A number of operational or occupational health and safety measures were identified by industry which led to a few minor changes to the gear restriction regulations in the 'shallow' waters (Table 2). Despite this the overall objectives of reduced rope length and float numbers, with no surface rope in 'deeper' water remained.

Octopus Interim Managed Fishery and Cockburn Sound Line and Pot Managed Fishery

Gear modifications were also introduced to the two octopus fisheries, Octopus Interim Managed Fishery (OIMF) and Cockburn Sound Line and Pot Managed Fishery (CSLPMF). They covered the full extent of the CSLPMF and zones 1 and 2 of the OIMF, which both occur on the state's west coast. Due to the different fishing methods in the octopus fisheries, two sets of gear modifications were available to fishers. Those fishers that longlined (a series of pots/cradles connected by an underwater line) must have at least 20 pots/cradles per longline. This served to reduce the number of vertical lines in the water column. They had no other restrictions on their gear configuration. Those fishing with less than 20 pots (usually fished as single pots/cradles) were required to have no surface rope with at least one third of the line held vertical in the water column. Gear modifications in both octopus fisheries regardless of fishing method were from 1 May to 14 November in all water depths. There were no alterations to the gear restrictions in these two octopus fisheries, as occurred in the rock lobster fishery, since their initial implementation.

REFERENCE

Bellchambers, L.M., How, J., Evans, S.N., Pember, M.B., de Lestang, S. and Caputi, N. 2017. Ecological Assessment Report: Western Rock Lobster Resource of Western Australia Fisheries Research Report No. 279, Department of Fisheries, Western Australia. 92pp.

Table 1

Gear modification requirements for maximum rope length, surface rope, floats and float rig length and periods between pulling pots for both shallow and deep water.

	Shallow water* (~<20m)	Deeper water (>20m)
Rope length	No rope/water depth ratio	Rope (bridal-float) <2x water depth
Surface rope	Surface rope permitted	No surface rope [negatively buoyant rope (top third)]
Float rig	Float rig inc. in total rope	Max float rig 5 fathoms (inc. tail)
Floats	Max. 2 floats	Max. 2 floats (<30 fathoms); Max. 3 floats (>30 fathoms)
Pull Period	No max pull period	Pots pulled once every 7 days

*Shallow water was defined by the depth that could be fished with the maximum unweighted rope component (see Table 2) (adapted from Bellchambers *et al.,* 2017).

Table 2

Changes to the maximum unweighted rope and season timings by season since the gear modifications were introduced (adapted from Bellchambers *et al.,* 2017).

Season	Maximum unweighted rope	Whale mitigation season
2014	15 fathoms	1 Jul.-14 Nov.
2015	18 fathoms (inside whale zone[1])	1 May-14 Nov.
2016	18 fathoms	1 May-31 Oct.

[1]The 'whale zone' was a defined region within the fishery that generally encompassed waters less than 20m.

Appendix 3

DATA EXTRACTED FROM NATIONAL PROGRESS REPORTS

Complied by Marion Hughes, IWC Secretariat

Table 1

Bycatch of large whales entered into the National Progress Report database in 2017.

ID	Large Area	Species	Local area	Unk: Injured	Unk: Unk	RMP Small Area	Targeted species	Gear	Comments
Australia: 2016									
PR/R/6965	Pacific Ocean - South	Humpback whale	Queensland	0	2	Unknown or N/A	-	GN; FPO	Records from StrandNet.
PR/R/6980	Pacific Ocean - South	Humpback whale	Queensland	0	5	Unknown or N/A	White, tiger and bull sharks	NSC	All whales released alive.
PR/R/7002	Pacific Ocean - South	Unidentified large baleen whale	-	0	1	Unknown or N/A	-	FPO	-
PR/R/7067	Indian Ocean	Humpback whale	Hillary's Boat Harbour	0	1	Unknown or N/A	Crayfish	FPO	Confirmed entanglement in afternoon and animal not resighted.
PR/R/7068	Indian Ocean	Humpback whale	Jurien Bay	0	1	Unknown or N/A	Rock lobster	FPO	Animal cut free via disentanglement team.
PR/R/7069	Indian Ocean	Humpback whale	Tanabiddi Exmouth	0	1	Unknown or N/A	Rock lobster	FPO	Satellite tracker placed on by disentanglement team, came away days after. Animal not resighted.
PR/R/7071	Indian Ocean	Humpback whale	Geraldton	0	1	Unknown or N/A	Rock lobster	FPO	Animal had float cut off by fisherman. Headed south and picked up as a secondary entanglement a day later and then seen in Cervantes. Animal not re-sighted again after Cervantes.
PR/R/7097	Southern Ocean	Humpback whale	Tasmania	0	1	Unknown or N/A	Unknown	LL	Adult humpback observed entangled in heavy 4-strand gear off Tasman Peninsula in November, no injury observed. Travelling south, same animal sighted in NSW during northern migration 4 months earlier. Material suspected from illegal long-line operations in Southern Ocean.
PR/R/7288	Pacific Ocean - Tasman Sea	Humpback whale	-	4	0	Unknown or N/A	Crab/lobster/fish	FIX	NSW whale disentanglement data.
PR/R/7289	Atlantic Ocean - North	Andrews's beaked whale	-	10	0	Unknown or N/A	Unknown	MIS	NSW NPWS whale disentanglement data.
PR/R/7331	Pacific Ocean - South	Humpback whale	-	0	5	Unknown or N/A	-	FPO; GND; GNS	All whales released alive. From SOCI reports. Location or dates not provided by DAF.
PR/R/7370	Indian Ocean	Humpback whale	-	0	0	Unknown or N/A	-	-	-

ID	Large Area	Species	Local area	Males: Dead	Females: Dead	Unknown: Unknown	Targeted species	Gear	Comments
Denmark: 2016									
PR/R/8110	Arctic Ocean - Davis Strait	Common minke whale	West Greenland, near Maniitsoq	0	1	0	Cod	FPN	1 minke whale female, near Maniitsoq (4.3m) entangled in fishing gear from pond net, dead, November 2016.
PR/R/8111	Arctic Ocean - Davis Strait	Humpback whale	West Greenland, near Maniitsoq	1	0	0	Cod	FPN	1 humpback whale male, near Maniitsoq (9.4m) entangled in fishing gear from pond net was permitted euthanized, June 2016.
PR/R/8112	Arctic Ocean - Davis Strait	Fin whale	West Greenland, near Aasiaat	1	0	0	Crab	FPO	1 fin whale male, near Aasiaat (18m) entangled in fishing gear for crab fishing, dead, September 2016.
PR/R/8113	Arctic Ocean - Davis Strait	Humpback whale	West Greenland, near Ikerasaarsuk	0	1	0	Cod	FPN	1 humpback whale female, near Ikerasaarsuk (8.5m) entangled in fishing gear from pond net, permitted euthanized, July 2016.
PR/R/8114	Arctic Ocean - Davis Strait	Humpback whale	West Greenland, Fyllas Banke	0	0	1	Crab	FPO	1 humpback whale sex unknown near Fyllas Banke, off shore (10m) entangled in gear for crab fishing was observed and disentangled by fishermen, May 2016.

<table>
<tr><th>ID</th><th>Large Area</th><th>Species</th><th>Local area</th><th>Male: Dead</th><th>Fem: Dead</th><th>Unk: Dead</th><th>Unk: Unk</th><th>RMP Small Area</th><th>Gear</th><th>How observed</th><th>Contacts</th></tr>
<tr><td>Japan: 2016</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PR/R/7650</td><td>Pacific Ocean - North</td><td>Fin whale</td><td>Kanagawa prefecture</td><td>1</td><td>0</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7651</td><td>Pacific Ocean - North</td><td>Humpback whale</td><td>Aomori prefecture</td><td>1</td><td>0</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
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<tr><td>PR/R/7658</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Kanagawa prefecture</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7659</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Niigata prefecture</td><td>0</td><td>4</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7660</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Toyama prefecture</td><td>6</td><td>6</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7661</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Ishikawa prefecture</td><td>12</td><td>16</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7662</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Fukui prefecture</td><td>1</td><td>5</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7663</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Shizuoka prefecture</td><td>1</td><td>1</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7664</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Mie prefecture</td><td>2</td><td>1</td><td>2</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7665</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Kyoto prefecture</td><td>6</td><td>2</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7666</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Hyogo prefecture</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7667</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Wakayama prefecture</td><td>3</td><td>2</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7668</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Shimane prefecture</td><td>1</td><td>6</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7669</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Yamaguchi prefecture</td><td>0</td><td>1</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7670</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Kochi prefecture</td><td>3</td><td>9</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7671</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Nagasaki prefecture</td><td>5</td><td>14</td><td>2</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7672</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Oita prefecture</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7673</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Miyazaki prefecture</td><td>0</td><td>0</td><td>3</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7674</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Kagoshima prefecture</td><td>0</td><td>3</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7675</td><td>Pacific Ocean - North</td><td>North Pacific right whale</td><td>-</td><td>1</td><td>0</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7676</td><td>Pacific Ocean - North</td><td>Unidentified large baleen whale</td><td>-</td><td>0</td><td>0</td><td>0</td><td>1</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7699</td><td>Pacific Ocean - North</td><td>Humpback whale</td><td>Kumamoto prefecture</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
<tr><td>PR/R/7706</td><td>Pacific Ocean - North</td><td>Common minke whale</td><td>Miyagi prefecture</td><td>1</td><td>8</td><td>0</td><td>0</td><td>Unknown or N/A</td><td>FPN</td><td>Fisherman</td><td>PR/C/243 | FAJ ()</td></tr>
</table>

ID	Data Year	Large Area	Species	Local area	Local taxonomy	Males: Dead	Females: Dead	Unk: Injured	How observed	References
Spain: 2016/17										
PR/R/7618	2016	Atlantic Ocean - North	Fin whale	Ribeira (A Corunha)	Balea comun (*Balanoeptera physalus*)	0	1	0	Observer or inspector	PR/B/690: Agreement between Xunta de Galicia and Cemma for the assistance, rehabilitation and study of stranded marine mammals and reptiles along the Galician coast - 2016 Report. CEMMA, unpublished.
PR/R/7623	2016	Atlantic Ocean - North	Common minke whale	-	-	1	0	0	Observer or inspector	PR/B/690 as above.
PR/R/7819	2017	Atlantic Ocean - North	Bryde's whale	Canary Islands	Rorcual tropical	0	0	2	Public	-

ID	Large Area	Species	Local area	Males: Dead	How observed	Contacts	References	Comments
UK: 2016								
PR/R/8432	Atlantic Ocean - North	Common minke whale	Fife, Scotland	1	Scientist	PR/C/248: A. Brownlow (*andrew.brownlow@sac.co.uk*); PR/C/249: N. Davison (*nick.davison@sac.co.uk*)	PR/B/709: CSIP Annual Report to UK Government for 2016. Deaville, R (compiler). Unpublished.	Diagnosed as entanglement case through necropsy carried out under the UK strandings scheme.

ID	Data year	Large Area	Species	Fem: Dead	Unk: Dead	Unk: S. Injured	Unk: Injured	Gear	Contacts	References
USA: 2014-15										
PR/R/8163	2014	Atlantic Ocean - North	North Atlantic right whale	0	2	7	0	NK	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: Henry, A.G., T.V.N. Cole, L. Hall, W. Ledwell, D. Morin and A. Reid. Mortality and serious injury determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast and Atlantic Canadian Provinces, 2010-14. Published.
PR/R/8164	2014	Atlantic Ocean - North	Humpback whale	0	2	3	5	NK	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702 as above.
PR/R/8165	2014	Atlantic Ocean - North	Fin whale	0	1	0	2	NK	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702 as above.
PR/R/8166	2014	Atlantic Ocean - North	Common minke whale	0	3	1	1	NK	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702 as above.
PR/R/8247	2015	Pacific Ocean - North	Blue whale	0	0	0	1	FPO	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8248	2015	Pacific Ocean - North	Fin whale	0	0	2	0	NK	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8249	2015	Pacific Ocean - North	Gray whale	0	0	1	2	GN	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8250	2015	Pacific Ocean - North	Gray whale	0	0	2	2	NK	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8251	2015	Pacific Ocean - North	Gray whale	0	0	0	2	FPO	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8252	2015	Pacific Ocean - North	Humpback whale	1	0	5	14	NK	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8253	2015	Pacific Ocean - North	Humpback whale	0	0	1	0	GN	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8254	2015	Pacific Ocean - North	Humpback whale	0	0	0	11	FPO	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8255	2015	Pacific Ocean - North	Unid. large whale	0	1	0	7	NK	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8256	2015	Pacific Ocean - North	Unid. large whale	0	0	0	2	GN	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-

Table 2

Non-Direct Anthropogenic Mortality of Large Whales entered into the National Progress Report database in 2017.

ID	Large Area	Species	Local area	Local taxonomy	Fem: Ser Inj	Fem: Unk	Unk: Inj	Unk: Unk	Submitted to Ship Strikes	Comments
Australia: 2016										
PR/R/7001	Pacific Ocean - South	Humpback whale	Queensland	-	0	1	0	0	-	One adult female rescued from rope entanglement.
PR/R/7442	Pacific Ocean - Coral Sea	Unidentified large whale	Double Island	-	0	0	0	1	Unknown	From StrandNet: 21/08/2016. Mop on board vessel *Surfari*; reported strike with whale about 2nm nth of double island. Unknown size or species, unknown if injured.
PR/R/7443	Pacific Ocean - Coral Sea	Unidentified large whale	Keppel Bay	-	0	0	1	0	Unknown	From StrandNet: While en route between Rosslyn Bay Harbour and Pumpkin Island, the 11.1m catamaran *Gormans Removals Rescue*; collided with a whale (presumed humpback, larger than the 11m vessel) at position 23°7; 36°S 150°; 50°; 20°E in Keppel Bay. The whale was in a pod of three travelling North to South at the time. The vessel had eight people on board and was travelling at approximately 20 knots. The vessel was stopped after the collision but was undamaged. One member on board suffered significant bruising when he was thrown against a solid part of the cabin. The whale proceeded on its way but small amounts of skin tissue were later found on the outboard motors. A sample was sent to CQUtin Rockhampton.
PR/R/7472	Southern Ocean	Southern right whale	Head of Bight, Great Australian Bight, SA	*Eubalaena australis*	1	0	0	0	No	Adult female seen with large cuts on the back by C. Charlton (Curtin University) and F. Christiansen (Murdoch University). Accompanied by a calf in an apparently good body condition. First sighting of the female in the area (no sightings in previous years). Last sighting on 18th Sep. 2016 with total of 11 re-sights for the season.

ID	Data year	Large Area	Species	Local area	Local taxonomy	Unk: Dead	Submitted to Ship Strikes	Contacts
Spain: 2016-17								
PR/R/7161	2016	Atlantic Ocean - North	Sperm whale	Canary Islands	Cachalote	2	Yes	
PR/R/7820	2017	Atlantic Ocean - North	Sperm whale	Canary Islands	Cachalote	2	Unknown	PR/C/664: M. Arbelo (*manuel.arbelo@ulpgc.es*) PR/C/665: A. Fernandez (*antonio.fernandez@ulpgc.es*)

ID	Large Area	Species	Local area	Females: Dead	Submitted to Ship Strikes	Contacts	References	Comments
UK: 2016								
PR/R/8430	Atlantic Ocean - North	Common minke whale	Essex, England	1	No	PR/C/247: R. Deaville (*rob.deaville@ioz.ac.uk*)	PR/B/709: Deaville, R. CSIP Annual Report to UK Government for 2016. Unpublished.	Diagnosed as possible ship strike through examination carried out under the UK strandings scheme. Deep, linear incision to lateral caudal peduncle.
PR/R/8431	Atlantic Ocean - North	Fin whale	Norfolk, England	1	Unknown	PR/C/247: R. Deaville (*rob.deaville@ioz.ac.uk*)	PR/B/709: Deaville, R. CSIP Annual Report to UK Government for 2016. Unpublished.	Diagnosed as probable ship strike through necropsy carried out under the UK strandings scheme.

ID	Data Year	Large Area	Species	Local Area	Males: Dead	Females : Dead	Unk: Dead	Unk: Injured	Submitted to Ship Strikes	Contacts	References
USA: 2014/15											
PR/R/8158	2014	Atlantic Ocean - North	North Atlantic right whale		0	0	0	1	Unknown	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: Henry, A.G., T.V.N. Cole, L. Hall, W. Ledwell, D. Morin and A. Reid. Mortality and serious injury determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast and Atlantic Canadian Provinces, 2010-14. Published.
PR/R/8159	2014	Atlantic Ocean - North	Humpback whale		0	0	1	0	Unknown	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: as above.
PR/R/8160	2014	Atlantic Ocean - North	Fin whale		0	0	1	0	Unknown	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: as above.
PR/R/8161	2014	Atlantic Ocean - North	Sei whale		0	0	3	0	Unknown	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: as above.
PR/R/8162	2014	Atlantic Ocean - North	Common minke whale		0	0	1	0	Unknown	PR/C/124: R. Pace (*richard.pace@noaa.gov*)	PR/B/702: as above.
PR/R/8424	2015	Pacific Ocean - North	Fin whale	California-Oregon-Washington	2	0	0	0	Unknown	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8425	2015	Pacific Ocean - North	Humpback whale	California-Oregon-Washington	1	1	0	0	Unknown	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8426	2015	Pacific Ocean - North	Sei whale		0	0	1	0	Unknown	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-
PR/R/8427	2015	Pacific Ocean - North	Gray whale		0	1	0	0	Unknown	PR/C/708: C. Fahy (*christina.fahy@noaa.gov*)	-

Key to gear types
[FIX] TRAPS - Traps (not specified)
[FPN] TRAPS - Stationary uncovered pounds nets
[FPO] TRAPS – Pots
[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
[GND] GILLNETS AND ENTANGLING GEAR – Driftnets
[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
[LL] HOOKS AND LINES - Longlines (not specified)
[MIS] MISCELLANEOUS GEAR
[NK] GEAR NOT KNOWN OR NOT SPECIFIED
[NSC] SHARK CONTROL NETS

Annex K

Report of the Standing Working Group on Environmental Concerns

Members: Rowles, Hall (co-Convenors), Aisha, Arguedas, Baulch, Bell, Bickham, Bjørge, Brockington, Burkhardt, Cabrera, Canadas, Castro, Cerchio, Cholewiak, Cipriano, Collins, Cooke, Cosentino, Cubaynes, de Freitas, Donovan, Double, Elwen, Enmynkau, Filatova, Fortuna, Fretwell, Frey, Friedlaender, Fruet, Funahashi, Gallego, Galletti Vernazzani, Garcia-Vernet, Genov, George, Kaufman, Greig, Haug, Herr, Hielscher, Holm, Hubbell, Iñíguez, Isoda, Ivashchenko, Jelić, Kelkar, Kitakado, Konan, Lang, Langerock, Lauriano, Lee, Leslie, A., Leslie, M., Lovell, Lundquist, Mallette, Mate, Mattila, Mazzariol, Miller, Minton, Moore, Morita, Nelson, Palka, Panigada, Parsons, Phay, Pierce, Porter, Redfern, R. Reeves, S. Reeves, Rendell, Reyes, Ridoux, Ritter, Rodriguez-Fonseca, Rojas-Bracho, Rose, Rosel, Rosenbaum, Ryeng, Santos, Sequeira, Simeone, Simmonds, Širović, Slooten, Slugina, Stachowitsch, Stimmelmayr, Strbenac, Suydam, Tamura, Thomas, Urbán, Víkingsson, Von Duyke, Wade, Walters, Weinrich, Weller, Yasokawa, Yasunaga, Ylitalo, Zerbini.

1. INTRODUCTION

1.1 Opening remarks
Co-Convenors Rowles and Hall welcomed the participants to the Standing Working Group on Environmental Concerns (SWG).

1.2 Election of Chairs
Rowles and Hall were elected as co-Chairs.

1.3 Appointment of rapporteurs
Greig, Simeone and Ylitalo were appointed as rapporteurs.

1.4 Adoption of Agenda
The adopted agenda is given as Appendix 1.

1.5 Review of available documents
The documents available to the SWG were identified as SC/67a/E01-04; SC/67a/E05rev1; SC/67a/E06rev1; SC/67a/E07-08; SC/67a/E09rev1; SC/67a/HIM02; Arctic Council (2017); Berdalet *et al.* (2015); Carretta *et al.* (2016); Citta *et al.* (2017); Clarke *et al.* (2016); Glibert and Burford (2017); Haug *et al.* (2017); Hauser *et al.* (2017); Lefebvre *et al.* (2017); McCabe *et al.* (2016); Moore (2016); Anon. (2016); Paerl and Otten (2013); Otten and Paerl (2015); Reyes Reyes *et al.* (2016); Simmonds (2016); Starr *et al.* (2017) and Vacquié-Garcia *et al.* (2017).

2. POLLUTION 2020

2.1 Review on intersessional progress persistent organic pollutants
Hall provided a summary on the progress of the intersessional group for persistent organic pollutants (Appendix 2).

(a) Continue modelling of contaminants, including potential addition of PBDEs
Development and refinement of the individual based model (EffectS of Pollutants On Cetacean populations, SPOC) has continued during the intersessional period. The problems with hosting the web-based version of the model on the University of St Andrews server, whilst allowing public access through the University's firewall, have been resolved through the use of a very short registration requirement. Two further aspects have also now been included in the model or are being actively explored for the future. The additional uncertainty around the *in utero* transfer parameter, based on the data from harbour porpoise female foetus pairs presented at SC/66b in Hall *et al.* (2016) has now been completed. Efforts in the intersessional year will focus on integrating a bioenergetic and/or physiologically based pharmacokinetic approach that will allow oral dose response functions to be used in the SPOC risk assessment framework, making use of the published toxicological data for PBDEs (Kodavanti *et al.*, 2010) and assessing resulting impacts on reproduction and offspring survival.

(b) National and international progress on risk and mitigation for PCBs
A number of news items reporting the high levels of PCBs in killer whales and other European cetaceans published by Jepson *et al.* (2016) resulted in a call for countries to adhere to the Stockholm Convention on Persistent Organic Pollutants (an international environmental treaty that aims to eliminate or restrict the production and use of persistent organic pollutants). This was reiterated by a resolution at the European Cetacean Society meeting in Denmark in May, 2017. The SWG endorsed this Resolution and suggested that other mitigation methods be explored. In discussion it was noted that the SPOC model might be used to estimate the population half-life of PCBs in cetaceans under different remediation scenarios to inform managers of how long it would take for any measures to be apparent in a particular population, given the very persistent nature of the POPs and the high level of trans-generational transfer. Two examples of PCB environmental mitigation projects in the US were also summarised and the general approach of Europe under the Marine Strategy Framework Directive to ensure European seas achieve 'Good Environmental Status' was highlighted as this may also assist in reducing environmental levels.

(c) Data integration and mapping
Work on the contaminant mapping tool continued intersessionally and many of the suggestions and comments provided by the Committee members at SC/66b have now been implemented. Data on POP concentrations have been obtained from over 70 peer reviewed publications and is now incorporated into the map. It will be available on the website by SC/67b.

The SWG thanked Hall for her continued improvements to the contaminant mapping tool and the modeling modifications. The SWG **recommended** these tools be made available to the public and proposed the model modifications and the population half-life of POPs objectives be progressed next year (SC/67b).

Genov presented new information on polychlorinated biphenyls (PCBs) in free-ranging common bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Trieste (northern Adriatic Sea), in relation to demographic parameters (SC/67a/E09rev1). The dolphin population inhabiting these waters has been the focus of a continuous long-term study since 2002 (Genov *et al.*, 2008; 2016) and is relatively well studied. Blubber tissue samples were collected from 32 male and female dolphins during 2011-17, together with concurrent photo-identification, in order to link PCB levels to various individual-specific parameters. A total of 25 PCB congeners were determined in the samples, and the values summed to obtain the Σ25PCB (mg/kg lipid weight) for each animal. The authors tested for the effects of sex, parity and social group membership on contaminant concentrations.

Σ25PCB ranged from 3.34 to 293mg/kg lipid weight, with an arithmetic mean of 80.7 (95%CI=56.3-105.1) and a geometric mean of 51.0 (95%CI=34.4-75.5). Males had significantly higher Σ25PCB concentrations than females, suggesting offloading of PCBs from reproducing females to their offspring via gestation and/or lactation. Furthermore, nulliparous females had significantly higher concentrations than parous ones, further confirmingthe maternal offloading. Several social groups have previously been identified in this population, which display differences in behaviour as well as feeding strategies in relation to fisheries, but no significant differences in Σ25PCB were found among social groups. This indicates that PCBs pose a threat to these animals regardless of social group membership and potential associated dietary differences. Overall, 88% of dolphins had Σ25PCB concentrations above the toxicity threshold of mg/kg lw for the onset of physiological effects in experimental marine mammal studies (Kannan *et al.*, 2000), while 66% had concentrations above the highest threshold (41mg/kg lw) published for marine mammals based on reproductive impairment in ringed seals (Helle *et al.*, 1976). This is of concern, particularly in combination with other known or suspected threats to this population, including marine litter, disturbance from boat traffic, frequent interactions with fisheries, and occasional bycatch (Genov *et al.*, 2008).

Given the long-term and ongoing monitoring of this population, future work incorporating individual re-sighting histories, information on reproductive rates and PCB monitoring may provide further insight into possible links between pollutant loads and recruitment, as well as other population parameters. In conclusion, PCBs may be causing population-level effects in this population.

The SWG discussed possible sources of PCB pollution into the Adriatic Sea (Po River runoff, ports, resuspension of sediment, contaminated pelagic food web, and decommissioned military equipment like submarines) and the ubiquity of this problem. It was noted that, in the Mediterranean and other regions with semi-closed bodies of water, remediation plans should take into account the long marine system retention times. Identification of regions where contaminant levels have decreased (with known remediation actions) could help direct future mitigation recommendations in more contaminated regions. Some discussion followed about how to respond more generally to the ongoing chronic PCBs threat and it was noted that it had been suggested that lessons might be learnt from parts of the world where PCB levels had fallen further to clean-up efforts (Law and Jepson, 2017). The SWG **agreed** to maintain its intersessional group on PCBs remediation as a part of the Pollution 2020 and looked forward to a report from this group at its next meeting (SC/67b).

The SWG **agreed** that PCB monitoring combined with long-term photo-identification and population ecology studies can be highly informative for assessing the impacts of POP pollution, especially as such information is often lacking for wild populations. Also, the SWG encouraged modelling studies in cetaceans to estimate changes in POP concentrations in individuals, as well as populations, over time. Such studies could then be compared to predicted model outputs (see for, example, work outlined in 2.1) to indicate ongoing or new sources of contaminants to a particular region.

The SWG thanked Genov for this update on PCB concentrations in dolphins from the Adriatic Sea. The SWG **recommended** that Genov and colleagues continue this contaminant monitoring work and integrate their data into the modelling and mapping work presented by Hall in Item 2.1 next year (SC/67b).

2.2 Review on mercury in cetaceans

SC/67a/E08 reported heavy metal concentrations in muscle, kidney, liver, blubber and blood of gray whales (*Eschrichtius robustus*) and Pacific walruses (*Odobenus rosmarus*) collected by TINRO-Center and ChukotTINRO scientists after their aboriginal harvest and landing by Chukotka Natives. Animals came from the coastal waters of the Chukchi Peninsula (the Mechigmenskiy Bay, Western Bering Sea, Russia) from 2008-16. The levels of iron, zinc, copper, arsenic and mercury were significantly higher in the liver of animals than in the other tissues sampled. The Russian State Sanitary, Epidemiological and Hygienic Requirements regulate the level of toxic elements of arsenic, cadmium, mercury and lead in marine mammal meat. The maximum permissible levels (MPL) in muscle are 5ppm for arsenic, 0.2ppm for cadmium and 0.5ppm for mercury and 1.0ppm lead (wet weight). Cadmium exceeded the MPL in two liver samples and lead exceeded the MPL in one liver and two kidney samples. One of the elevated cadmium results and all three of the elevated lead results were from 'stinky' whale samples in 2008. The development of portable methods of measuring toxic elements in marine mammal tissues and organs could be critically useful to avoid consumption of inedible and dangerous traditional food products by Native people.

The SWG noted that the elevated cadmium and lead concentrations in the gray whales are of interest. Elevated hepatic cadmium was not seen in an earlier study of whales harvested in 2001 (Dehn *et al.*, 2006). As previously noted in SC/66b (IWC, 2017), the SWG reiterated that these gray whale metal concentrations should be compared with levels previously published from harvested or stranded eastern gray whales (Tilbury *et al.*, 2002; Varanasi *et al.*, 1994). Additionally, investigations of isotopic species of certain metals might inform on whether these contaminants are coming from natural or anthropogenic sources.

SC/67a/E04 provided a summary review of the significant amount of data on mercury in cetacean species that have been reported globally since the first reports in the 1970s. The aim was to provide a snapshot of existing peer reviewed papers and technical reports on levels and trends in various species. It provides an additional evaluation regarding which species would be considered more at risk for mercury and which ocean basins.

The SWG welcomed this review and recognised that it was a preliminary review and that further synthesis was needed. The SWG noted the difficulties of using the data together due to the heterogeneity of the methods and data including sensitivity, accuracy and reporting formats. Discussion ensued on the value of having a review of prey contaminant data. The SWG noted that such data on prey contaminants might be available regionally or nationally and links to such data sources might be useful.

In discussion, the SWG **recommended** that mercury and selenium levels provided in the review and solicited from additional technical experts be added to the contaminant mapping tool. In addition, SWG **recommended** that a more in-depth synthesis of available data be undertaken and that experts in mercury cycling and mercury toxicology in cetaceans participate in providing further information for this endeavor. A report will be delivered to the Commission by SC/67.

The SWG thanked the authors for providing this information, particularly the preliminary review on mercury which has helped guide the development of the response to the Commission's resolution.

3. OIL SPILL IMPACTS

3.1 Development of information resource and communication strategy

Information on a number of oil spill planning and preparedness guidance documents that are nearing completion in the US and internationally were presented. In the US, NOAA has completed the National Marine Mammal Oil Spill Response Guidelines for pinnipeds and cetaceans and are now developing regional annexes which are the specific operational plans.

NOAA is also developing regional disaster response plans which cover an 'all hazards' response including for die-offs, with the Arctic plan out for public review and the Gulf of Mexico and Gulf of Alaska-Cook Inlet and Kodiak plans in development. NOAA's National Ocean Service Office of Response and Restoration and NMFS Office of Protected Resources have recently drafted a document entitled 'Guidelines for Assessing Exposure and Impacts of Oil Spills on Marine Mammals' that will provide updated information and guidance to NOAA offices and programs charged with protecting, assessing and restoring marine mammals injured by oil spills, primarily for Natural Resources Damage Assessments conducted under the Oil Pollution Act. This document, to be published in late 2017, outlines methods and approaches to evaluate exposure and effects on cetaceans and pinnipeds. In addition, the University of New Hampshire Coastal Response Research Center has developed 'State of Science for Dispersant Use in Arctic Waters' which covers topics such as efficacy and effectiveness and ecotoxicology effects of dispersant, including effects on fish, invertebrates, birds and marine mammals[1].

Internationally, the first phase of a global oiled wildlife emergency response system (a two-year project funded by the International Association of Oil and Gap Procedures/International Petroleum Industry Environmental Conservation Association (IOGP/IPIECA) Oil Spill Response-Joint Industry Project - Phase II) was completed in December 2016. The purpose of the system is to enhance response internationally to Tier 3 oil spills[2]. This project is now in the beta phase of deployment. In addition, funding was also awarded to a cohort of leading oiled wildlife response specialists to develop a 'Good Practice Guide on Wildlife Response Preparedness' (IPIECA-OGP, 2014)[3]. This guide placed the topic of wildlife planning into the broader context of how to effectively operationalise wildlife response through a multi-tiered, multi-stakeholder approach. These documents can provide guidance on oil spill response and preparedness for IWC member nations.

The SWG noted that although the global oiled wildlife response system is primarily bird-focused, it does include marine mammals. The SWG was also directed to a special issue of *Endangered Species Research*[4] on marine mammals and sea turtles with articles about the response to, and oil spill effects from the *Deepwater Horizon* oil spill. See SOCER report (Appendix 5, Section 12) for summaries of papers.

3.2 New information on oil spill risks

SC/67a/E03 reported information on heavy fuel oil (HFO) with regard to Arctic cetaceans, and updated the SWG on efforts in other international fora to study and mitigate the risk of use and carriage of HFO by vessels in the Arctic. The paper reviewed the changing international context for shipping in the Arctic, and provided the working definition for HFO and the primary types of ships using it as fuel. The author emphasised the persistence of HFO in Arctic conditions, in both a controlled test in the Canadian Arctic, as well as an accidental discharge in the White Sea. In the White Sea case, Andrianov *et al.* (2016) presented a case study of HFO's negative impact on a local beluga population over a studied ten-year period. SC/67a/E03 updated the SWG on developments at the International Maritime Organization to address the use of HFO in the Arctic, including a recently submitted work plan item to mitigate the risks of use and carriage of HFO by Canada, Finland, Germany, Iceland, Netherlands, Norway and the United States to be discussed at MEPC 71, in July 2017. A further update on the work of the Arctic Council to study the impacts of HFO use and past incidents was also presented, including the recent inclusion of concerns surrounding HFO presented in the Fairbanks Declaration of May 11, 2017 (Arctic Council, 2017).

The SWG thanked the presenter and encouraged submissions of papers for future Scientific Committee meetings, under the standing item Pollution 2020, on impacts of HFO on cetaceans, as well as potential mitigation measures.

The SWG **recommended** the collection of baseline data for cetaceans in the Arctic, including standardisation of measures between bowhead whales and belugas, recognising what is already taking place in the Arctic Council, Circumpolar Biodiversity Monitoring Program. This work is ongoing.

4. CUMULATIVE IMPACTS

4.1 Brief update on intersessional progress and plans for 2018

The SWG considered the five research recommendations from the recent Cumulative Impact of Stressors on Marine Mammals Report (Anon., 2016). One recommendation concluded that future research should focus on efforts to develop case studies that apply the Population Consequences of Multiple Stressors (PCoMS) framework to actual marine mammal populations and the SWG noted that this recommendation was applicable to the upcoming cumulative effects on cetaceans Workshop for the SC/67b. In discussion, Simmonds noted that the 2004 IWC Workshop on Habitat Degradation (IWC, 2006) was also highly relevant to this topic and would provide additional important guidance for the proposed Workshop.

[1]*http://crrc.unh.edu/dispersant_science*.
[2]Tier 3 oil spill is the most severe category as defined by IPIECA. The spill cannot be contained and requires significant additional resources for response.
[3]*http://www.oiledwildlife.eu/sites/default/files/Wildlife_response_2017.pdf*.
[4]*http://www.int-res.com/abstracts/esr/v33/*.

The SWG **endorsed** this recommendation, and tasked the intersessional working group with planning and executing a Workshop on cumulative effects on cetaceans. Terms of Reference for the Workshop include:

(1) review the various methods available and data required for assessing the consequences of cumulative effects on cetacean populations;
(2) using case study populations, model the impact of multiple stressors to provide relevant and practical guidance for conservation managers; and
(3) produce a technical report and identify authors and topics for a special issue in a peer-reviewed journal to bring together current knowledge on this topic.

The SWG **recommended** that the Workshop on cumulative effects on cetaceans proceed as planned and **agreed** that it would be very valuable and looked forward to receiving the Workshop report by SC/67b.

5. HARMFUL ALGAL BLOOMS

During SC/66b, the SWG noted that there had not been a focus session on HABs in 10 years (IWC, 2008) and with growing concern for potential impacts of HABs on cetaceans, the SWG agreed at SC/66b that a HAB-focused pre-meeting be planned for SC/67a. On 7-8 May 2017, a pre-meeting Workshop entitled 'Workshop on Harmful Algal Blooms (HABs) and Associated Toxins' was held at the Hotel Golf in Bled, Slovenia (SC/67a/Rep09). Subject-matter experts were invited to the Workshop and presented information related to HAB dynamics and drivers, including mechanisms underlying toxin production and detection, as well as major HABs and their toxins of concern for cetaceans.

5.1 Bloom dynamics and drivers

Hall summarised information presented during the HAB Workshop and their potential impacts to cetaceans. The Workshop concluded that the global distribution and increasing ubiquity of HABs and their toxins has resulted in an increasing risk to cetacean health at the individual and population levels. To better understand the contribution of HAB toxins to marine mammal mortality and morbidity, the Workshop noted that data from HAB monitoring, marine mammal strandings and toxin analysis in tissues and environmental samples should be integrated at an appropriate spatial and temporal scale, depending on the particular questions to be addressed. Assistance in this endeavor could be facilitated by the following.

(1) Informing marine mammal scientists of HAB databases by country and region. This will enable marine mammal scientists to access real-time data and annual summaries of HAB observations and will allow them to collaborate more closely with HAB scientists who are leading the monitoring programs. Examples of these programs include the Harmful Algal Event Database (HAEDAT, an annual summary database led by researchers in many countries, *http://www.haedat.iode.org*) and the Soundtoxins database (*http://www.soundtoxins.org*). A 'traffic-light pattern' alerts managers to the real-time threat of HAB toxins in shellfish.
(2) Working with these networks and others to collect routine water samples at sites appropriate for marine mammals rather than relying on the shellfish monitoring sites that have been set up for human health protection.
(3) Partnering with One Health initiatives, such as the database maintained by the Centers for Disease Control (*http://www.cdc.gov/onehealth/*) which strives to include both human and animal HAB associated illness data.
(4) Including marine mammal scientists in HAB Bulletin (early warning) reporting systems that are developing in the US, Europe and many other countries.
(5) Developing programs that integrate monitoring of plankton using satellites for bloom detection. This could include data from animal-borne conductivity, temperature and depth sensors that are now being deployed on a variety of marine mammals, including cetaceans.

The Workshop concluded that there were many resources available online and that a list of contacts in the HAB community by country or region would be most useful. The HAB contacts could then be contacted by cetacean biologists who might require input during an unusual event that they may suspect is associated with exposure to HAB toxins as a causative agent. Two-way communication between stranding responders, oceanographers, and the ocean observing community was also suggested.

5.2 Health impacts of HABs and their toxins

Many of the compounding issues when investigating a human exposure to a HAB are also true for marine mammals. Often, little is known about the duration of the exposure, the toxicity of the bloom, overall health prior to the exposure, and concurrent exposures to other possible contaminants. Linking HABs and their toxins to cetacean impacts is difficult because of the multiple HAB species that may be involved, the varying oceanographic conditions and both HAB and cetacean biology, and data availability and data quality at all levels.

The use of 'omics technologies (from genomics to metabolomics) to investigate toxin exposures and their impact on individual animal health has been limited, but these methods hold promise for the development of biomarkers that can inform us of the role of biotoxins in unexplained mortality events or the extent of chronic exposures within marine mammal populations. Whilst the acute, chronic and latent effects of the biotoxin domoic acid (DA) on marine mammals is now well documented, the impact of chronic low-level exposure and the impact of other HAB toxins is less well known. In particular, given the well-documented exposure and effects of domoic acid in foetal sea lions, the effects of HABs and their toxins on the developing foetus and fecundity in exposed cetaceans needs to be considered and further studies in this area would be encouraged.

5.3 Workshop conclusions and recommendations

The Workshop recommended cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR[5], and other HAB groups. This could be done through the ICES and PICES working group communities. For example, ICES has a Marine Mammal Ecology Working Group and a Working Group on Harmful Algal Bloom Dynamics and PICES a Committee on HABs.

The Workshop recommended that more communication and active information exchange could be facilitated through these groups and their respective agendas.

[5]GlobalHAB - Global Ecology and Oceanography of Harmful Algal Blooms (*http://www.geohab.info/*); ICES - International Council for the Exploration of the Sea (*http://www.ices.dk/Pages/default.aspx*); PICES - North Pacific Marine Science Organization (*http://www.ices.dk/Pages/default.aspx*); SCOR - Scientific Committee on Oceanic Research (*http://www.scor-int.org/*).

The Workshop noted the rapid global expansion of aquaculture systems that enrich nutrients into these environments that can be a source of HABs themselves and can alter coastal habitats. The Workshop suggested that countries ensure development of this industry is in line with best management practices. The Workshop therefore recommended that countries using open aquaculture and pond systems consider the ecosystem changes that could negatively impact cetacean health.

While development of dose-response relationships may be infeasible for any cetacean species, data could be synthesised from multiple sources including laboratory experiments of other species as well as measured concentrations from marine mammals with confirmed acute toxicosis (both cetaceans and pinnipeds), as well as control cases without evidence of HAB-related disease. The Workshop recommended such datasets be identified or developed and synthesis approaches be pursued as a priority.

The Workshop recommended that toxins in prey species be included in surveillance and research studies as well as toxins in tissues as these samples may prove to be more valuable in determining exposure due to the very short half-life of many hydrophilic toxins in tissues and excreta.

The Workshop recommended sampling on a temporal and spatial scale that is relevant to both human health and coastal cetacean health.

The Workshop recommended that the development of biomarkers in relevant (and obtainable) tissues, both of exposure and of effects, be pursued as a priority.

In relation to current surveillance, approaches using the ELISA approach for DA and saxitoxin needs to be confirmed by mass spectroscopy and standardisation of methods is recommended. The Workshop recommended that appropriate limits of detection and limits of quantification with appropriate uncertainty levels be developed for each approach being used.

The SWG noted that increasing HAB events worldwide are influenced by a variety of factors, including changes in climate and temperature, as well as human activities that result in exponentially increasing input of nitrogen and phosphorus into the environment.

The SWG **agreed to** the recommendations of the HAB Workshop as follows:

- that cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR and other HAB groups to facilitate information exchange;
- that efforts to investigate data that could improve dose-response function be pursued;
- that toxins in cetacean prey be monitored; and
- that HAB toxin detection methods be standardised and research into appropriate biomarkers of exposure and response be pursued by researchers in the field.

The timeline for these actions are not specified.

The SWG noted that although global warming cannot be addressed in the short term, nutrient input can be controlled and therefore **recommended** that efforts to reduce the global use of nitrogen and phosphorus be enacted by member countries. Recognising that human habitation and population growth is putting increasing pressure on the global coastal zone especially evident in aquaculture industry expansion, the SWG **recommended** that governments support best sustainable aquacultural practices (for example, standards set out by the Best Aquaculture Practices Certification scheme (*https://bapcertification.org/*). In addition, the SWG **recommended** that member countries comply with the relevant International agreements, initiatives and standards set out by the Food and Agricultural Organisation of the United Nations (FAO), Fisheries and Aquaculture Department.

The SWG discussed that as HABs increase in frequency in many regions of the world, the effects of HABs on cetacean health, both at an individual and population-level, are not fully understood. The SWG noted the example of the 1997 die-off of Mediterranean monk seals (*Monachus monachus*) which occurred during an annual HAB event but no lesions were identified because it was not possible to collect tissues and samples., Often the ability to assign the cases to a particular cause is hampered by logistics, weather conditions and resources, and HAB-related mortalities currently being documented are likely to be only the tip of the iceberg. In addition, the technical expertise necessary to perform post-mortem examinations on cetaceans and to collect appropriate samples is still lacking in many regions of the world.

Noting that there are many regions of the world where there is no information or data about the impact of HABs on cetaceans, the SWG **recommended** that Governments, member countries, regional organisations and NGOs support research on this topic, and encourages member countries to prioritise HAB impacts in their monitoring and research plans. In addition, the SWG **recommended** that these member countries also prioritise capacity building for stranding response and post-mortem investigation of unusual cetacean events. These recommendations are ongoing.

The SWG commended Hall and the Workshop participants for their accomplishments during the Workshop.

6. MARINE DEBRIS

6.1 Brief update on intersessional progress and plans for 2018

Simmonds highlighted that a paper has been accepted for publication (Fossi *et al.*, 2017) which investigates the co-occurrence of fin whales and marine debris in the Mediterranean, a topic that had been previously encouraged by the SWG. The issue of plastic pollution and marine debris is also going to be considered at the Convention on the Conservation of Migratory Species (the Bonn Convention) and it will be a topic at the forthcoming Conference of Parties in October 2017. The SWG looks forward to a report from this meeting next year (SC/67b).

The SWG thanked Simmonds for the update and **agreed** that the intersessional working group should proceed with plans for a future Workshop priority topic on marine litter and plastics.

7. DISEASES OF CONCERN

7.1 Progress on website and communications (including quarterly CDoC updates) and plans for 2018

SC/67a/E07rev1 reported the progress made by the IWC Intersessional Working Group on Cetacean Diseases of Concern (CDoC) between May 2016 and April 2017. During IWC SC/66b, the Commission endorsed a recommendation to continue the work associated with refining the website and making it operational as soon as possible. The CDoC website can be found at *https://cdoc.iwc.int*. The main page is open to the public, but disease information pages require login information.

Changes suggested by the SWG last year (SC/66b) and incorporated over the past year include: (1) refinement of disease content for improved user accessibility; (2) revision of website sections, to include areas for *Hot Topics, News, Laboratory List, and Diseases Discussion portal*; (3) updating of landing page with new, more relevant photos; (4) uploading of reference lists; (5) restructuring of disease information by *Causes/Agents* and *Clinical Presentations*; and (6) linking to existing disease content on the IWC website.

Concerns were raised by SWG about the time investment versus possible use of the website. The SWG recognised the need to identify a mechanism for keeping CDoC website material current and requested that the Intersessional steering group develop a path for addressing these concerns.

The SWG recognised the importance of the content on the CDoC website, and noted the potential synergy between CDoC and the Strandings Initiative, in particular with the Hot Topics, Laboratory List, and reporting portal.

The SWG **recommended** that CDoC intersessional steering group include members of the Strandings Initiative to evaluate tasks that overlap that may more efficiently achieve the goals of both efforts.

The SWG **recommended** that the current content of the CDoC site undergo review by topic experts within the intersessional steering group, and that content be made available to users as soon as possible.

Furthermore, the SWG **recommended** that HAB experts review the relevant site content, and that the list of international HAB organisations be shared on the CDoC site.

The SWG noted the benefit of the quarterly CDoC updates and **recommended** that, if possible the Intersessional Steering Group suggest a means to continue to provide relevant disease information to interested parties on a quarterly basis. These recommendations will be progressed during the intersessional period and will be reported at SC/67b.

The SWG thanked Simeone for her efforts in improving the design of the CDoC website and updating the website content.

7.2 New information

New information about the small (300-500) endangered Okhotsk Sea Bowhead (OSB) whale subpopulation, which is exempt from aboriginal-subsistence whaling and has not been well studied, was presented in SC/67a/E01. To better understand natural causes of morbidity and mortality, a subset of photographic images (*n*=110; 2011-13) were analysed for signs of acute and chronic injuries, parasites, and various skin conditions in the western Okhotsk Sea. Findings from the OSB whales were compared to available data from the Bering-Chukchi-Beaufort Sea (B-C-B) bowhead whale stock, which has been well studied. Based on this limited image analysis, OSB and B-C-B bowheads are both exposed to fishing line entanglement and killer whale predation. Killer whale injuries were more severe in the OSB whales and included amputations of flukes and flipper tips. Moult-related skin conditions were observed only in the OSB, as was a greater body burden of whale lice. These differences could possibly reflect the different marine habitat that the OSB whales occupy (i.e. water temperature, salinity, turbidity, anthropogenic and mining run-off). These preliminary findings will be revisited with the completion of a comprehensive image analysis of OSB whales. The available images of OSB whales that use the Western Sea of Okhotsk will serve as a foundation for a much-needed photo-identification catalogue in support of future health assessment and population research on Okhotsk bowhead whales.

The SWG thanked the authors for this information on skin conditions in endangered bowheads and encouraged the continued collaborative work on the lesser-studied Okhotsk population of bowhead whales. This work is ongoing.

8. STRANDINGS AND MORTALITY EVENTS

8.1 Short review on intersessional progress and plans for 2018

At its 66th meeting in 2016, the Commission endorsed the recommendations of the Whale Killing Methods and Welfare Issues Working Group (WKM&WI WG) and the Scientific Committee on Strandings, including the establishment of a Strandings Expert Panel and Coordinator post. Following discussion in the WKM&WI WG, the issue of funding for the Strandings Coordinator was referred to the Finance and Administration Committee (F&A). The F&A Committee noted that funding was not allocated to this initiative and that costs might have to be met through voluntary contributions at least initially.

SC/67a/E06 summarised the work carried out by the IWC Intersessional Steering Group on Strandings between May 2016 and April 2017. The Intersessional Steering Group on Strandings was tasked during SC/66b with selecting the Expert Panel, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate. Nominations were solicited, taking into account the Terms of Reference recommended during SC/66b that the Expert Panel should include representation and areas of expertise from: (1) regional experts in stranding response; (2) diverse agencies and organisations; and (3) multi-disciplinary expertise. Selection of Expert Panelists was achieved through an online voting process, however there is under-representation on the panel from Asia and Africa.

The Intersessional Steering Group worked with the Secretariat to develop a draft governance structure for the IWC Initiative on Strandings which included a stranding coordinator position description. The structure proposed a transition from the Intersessional Steering Group to a permanent Steering Group made up of members of the Scientific Committee, Conservation Committee, and the WKM&WI WG to enhance communication between the Expert Panel and these bodies.

After discussion, the SWG noted a critical need to have an emergency response fund that could assist member countries in responses to unusual strandings and **agreed** on a reporting structure for the Expert Panel, Stranding Coordinator, and the Steering Group (Fig. 1) with the Intersessional Steering Group maintaining the operations until such time as the Commission approves the final governance structure.

The SWG **recommended** the establishment of a Steering Group, comprised of members of Scientific Committee, Conservation Committee, and Whale Killing Methods and Welfare Issues Working Group.

The SWG **agreed** that the Intersessional Steering Group remain and proceed with the development of the Stranding Initiative until the Commission appoints the Steering Group. In the interim, the SWG **recommended** inviting the Chair of the Conservation Committee (or his/her appointee) and the Chair of the Whale Killing Methods and Welfare Issues Working Group (or his/her appointee) to join the Intersessional Steering Group.

The SWG **recommended** that the Intersessional Steering Group finalise the Expert Panel and select representatives from Asia and Africa from the existing list of nominees.

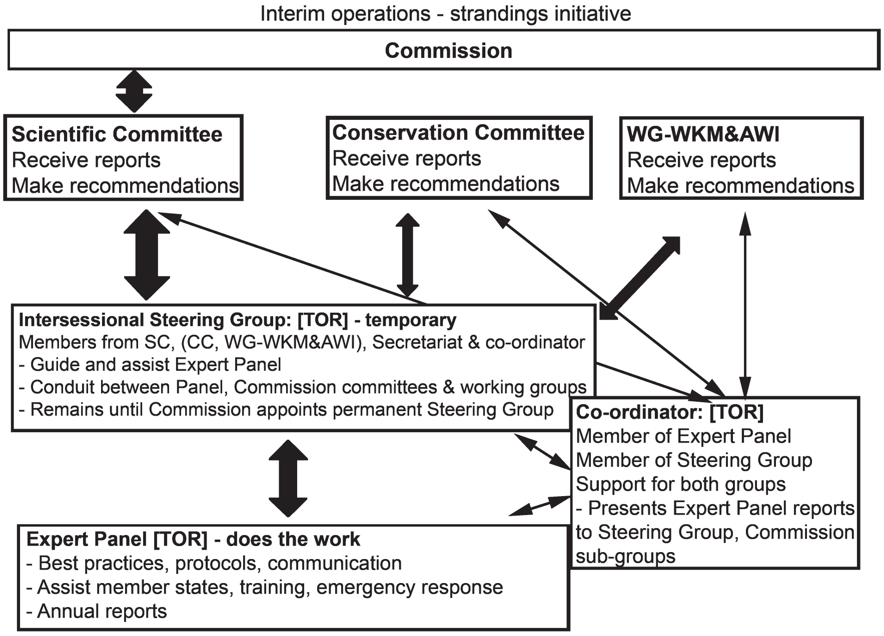

Fig. 1. Interim reporting structure (above).

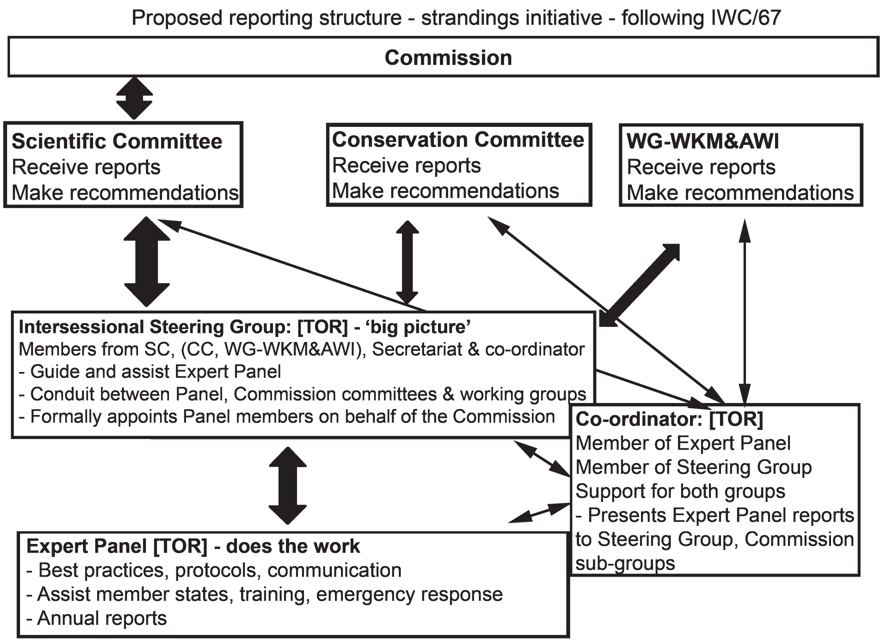

Fig. 2. Proposed reporting structure following Commission approval (above).

The SWG **recommended** that as a priority: (a) the Secretariat initiate the process to recruit a Stranding Coordinator as soon as possible; (b) the Expert Panel, once finalised, elect a chair, and work intersessionally and virtually; (c) the Intersessional Steering Group with the Expert Panel and in consultation with the Secretariat will develop a job description and person specification for the Stranding Coordinator and some members of the Expert Panel and Intersessional Steering Group will sit on the interview panel; (d) that the ISG develop a costed workplan for year 1; and (e) the ISG with the Secretariat develop a funding mechanism for emergency stranding response.

The SWG **agreed** that all five of these priorities are important and **recommended** that they be pursued con-currently.

As recommended previously at SC/66b, the SWG **agreed** that the Expert Panel and the Intersessional Steering Group should also work with intergovernmental organisations such as the IUCN Wildlife Health Specialist Group and member countries to develop a procedure for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations. These recommendations are being undertaken during the intersessional period and progress will be reported next year (SC/67b).

The SWG thanked Simeone for presenting this update on the progress made by the Intersessional Steering Group on Strandings.

8.2 New information

SC/67a/HIM02 described a pilot study that tested the ability of Very High Resolution satellite imagery to identify and count stranded whales during the Chilean sei whale (*Balaenoptera borealis*) stranding event that took place along the mid-Patagonian coast between February to May 2015. This event was the largest recorded stranding of baleen whales, but due to its extremely remote location the whales were not identified and counted until 3-5 months after the strandings occurred. A single 17x17km archival image from the WorldView2 satellite with a spatial resolution of 50cm per pixel taken on 24 March 2015 was compared to the aerial survey acquired on 24 June 2015. Images were counted manually and initial experiments on an automated analysis routine based on the spectral colouration of the whales was tested.

Whales were easily seen and counted; 23 whale were identified compared to 30 in the aerial survey. This discrepancy may be a result of more carcasses washing up after the satellite imagery was taken. All whale-like objects on the satellite imagery were in the approximate area where the aerial survey recorded stranded whales (the slight differences in location are thought to be due to re-floatation). Automated detection was less successful due to the extremely heterogeneous colour of the stranded whales which were in different body positions and had differing levels of decomposition. We conclude that VHR imagery could be an important future tool for detecting stranding events of baleen whales in remote areas.

During discussion, the SWG noted that, despite questions of cost and access to images, this method shows promise in areas where clear satellite images can be obtained (e.g. satellite images will not work for areas where carcasses will be obscured such as mangroves). Serial images would further illuminate issues with the timing of whale deposition especially in remote locations where carcasses persistence is unknown.

The SWG thanked the authors for their work on using Very High Resolution satellite imagery to evaluate large whale carcass deposition in remote locations and **recommended** continued refinement of this method. This work is ongoing.

Rowles summarised a humpback whale unusual mortality event that occurred along the US Atlantic Coast in which forty-three whales stranded from 1 January 2016 through 5 May 2017. Of the 22 cases examined, 10 cases had evidence of blunt force trauma or pre-mortem propeller wounds indicative of vessel strike and is well above the 16-year average plus 2 standard deviation rate for vessel strikes of 2.5 whales (1.5±1.0). During discussion, the SWG noted that there may not have been changes in vessel traffic, but that the whales feeding behaviour may have changed causing a possible overlap with some shipping lanes.

The SWG **agreed** that ongoing studies to investigate the reasons for this increase in vessel strikes to humpback whales on the US Atlantic coast should continue. In addition, risk assessment and possible mitigation strategies should proceed. This work is ongoing.

Carretta *et al.* (2016) estimated the fraction of carcasses recovered for a population of coastal bottlenose dolphins (*Tursiops truncatus*) using abundance and survival rate data from field studies to estimate annual deaths in the population. Observed stranding numbers were compared to expected deaths to estimate the fraction of carcasses recovered. For the California coastal population of bottlenose dolphins, the estimate of the fraction of carcasses recovered was 0.25 (95%CI=0.20-0.33). During a 12-year period (1995-2006), 327 animals (95%CI=253-413) were expected to have died and been available for recovery, but only 83 carcasses attributed to this population were documented. The relatively low estimates of carcass recovery for an extremely coastal dolphin population suggests that observed anthropogenic mortality values of dolphins in this region derived from strandings should be corrected to account for unobserved mortality. This assumes that the probability of stranding is equal for natural and human-caused deaths. These estimates are of additional value in developing carcass recovery correction factors for other more pelagic dolphin species in the region that might be less likely to strand.

During discussion, the SWG noted that, although this study did not distinguish between natural and human caused mortality, the correction factor provides a starting place for modelling human-caused effects in subsequent studies. Additionally, inclusion of other environmental factors might inform on what to expect during a specific ocean regime. Because stranding network effort affects the ability to generate this kind of carcass correction factor, this study also emphasises the importance of increasing and maintaining stranding response capacity.

The SWG welcomed the information provided by Weller and stressed the importance of understanding carcass recovery and how it can be scaled up to the whole population (e.g. it has practical applications for assessing oil spill damage).

9. NOISE

9.1 Update on national and international ocean noise strategies

Cholewiak presented an update on ongoing efforts by the US and international bodies developing strategies for addressing ocean noise issues. NOAA's Ocean Noise Strategy Roadmap was released in September 2016 (*http://cetsound.noaa.gov/road-map*). The Roadmap establishes NOAA's 10-year vision for ocean noise management, which broadens the agency's approach to focus both on the effects of noise on protected species, as well as on acoustic habitats. NOAA is actively pursuing many of the recommendations that emerged during the development of the ONS Roadmap. For example, NOAA has deployed a network of 12 Noise Reference Stations throughout US waters; this multi-year effort will provide standardised, calibrated data on trends in low-frequency noise. A pilot project with the National Center for Environmental Information will archive these data and make them publicly accessible, once the data are retrieved and initial analyses have been completed. Two chapters of the Roadmap have been published in peer-reviewed journals (Hatch *et al.*, 2016; Redfern *et al.*, 2017).

This past year, the IUCN also released a resource guide for managers on geophysical and other imaging surveys; this guide outlines the processes for increasing consistency in the systematic evaluation of survey activities and potential impacts (Nowacek and Southall, 2016). Also, Canada released their Oceans Protection Plan, which includes taking action to address the cumulative effects of shipping on marine mammals, including noise issues.

The development of two new acoustic standards via the Acoustical Society of America's ANSI standards process is underway. The first, 'Towed Array Passive Acoustic Operations for Bioacoustics Applications', led by Aaron Thode (SIO), will provide expert recommendations on standardising PAM operations as they relate to industry activities. The second, 'Acoustic Metadata for Passive Acoustic Monitoring', led by Marie Roch (SDSU) will provide guidance on metadata associated with the collection and analysis of passive acoustic data.

9.2 Update on intersessional cooperation with the IUCN WGWAP Noise Task Force and ocean noise recommendations

Last year, Committee members suggested that recommendations from the Acoustics Masking Workshop (IWC, 2016b) be shared with colleagues of the IUCN WGWAP Noise Task Force. Discussions were initiated with the Chair and two members of the WGWAP Noise Task Force in early 2017. A table was prepared using five measures listed in Nowacek *et al.* (2015) as a framework to emphasise commonalities among recommendations from four sources:

(1) IWC Masking Workshop;
(2) IUCN Planning Strategies for Managing Risk associated with Geophysical Surveys;
(3) NOAA's Ocean Noise Strategy; and
(4) guidelines for Marine Noise-generating Activities from the Convention on Migratory Species.

The IWC Masking Workshop additionally recommended connecting IWC recommendations on ocean noise with the UN Sustainable Development Goals (SDG14) process to 'Conserve and sustainably use the oceans, seas, and marine resources for sustainable development'. Rosenbaum reported on a side event on ocean noise, shipping and whale conservation that occurred prior to the UN Oceans Conference (February 2017) to discuss implementation of SDG14. A compilation of recommendations from the Working Group on Global Shipping and Whale Conservation from the February 2017 UN preparatory meeting side event and the table developed through the IUCN WGWAP Noise Task Force discussions are provided in Appendix 3.

The SWG welcomed the update on international efforts to develop noise guidelines and acoustic standards, and encouraged expanded international coordination regarding assessment and protection of acoustic habitat quality. The SWG also recognised the commonalities identified among recommendations from recent ocean noise Workshops and planning documents (e.g. Appendix 3) and **recommended** that the SWG continue to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise. This work is ongoing.

9.3 New international and national guidelines and advice (e.g. IMO)

9.3.1 Updates in seismic guidelines

In Reyes Reyes *et al.* (2016), legislation applied to seismic surveys to mitigate effects on marine mammals in 20 Latin American countries was reviewed. Currently, only Brazil and Peru have enacted mandatory guidelines. Some countries and companies have voluntarily adopted mitigation measures set in legislations of other countries. Seismic survey mitigation remains unlegislated in most Latin American countries where these activities proceed without robust environmental impact assessments and effective mitigation plans to minimise impacts on marine life. There is an urgency to increase awareness among Latin American countries and urge regulators to enact and enforce proper legislation for marine seismic survey activities. In addition, the SWG noted that the New Zealand Department of Conservation Guidelines (Department of Conservation, 2005) for minimising acoustic disturbance from seismic survey operations is being revised. The SWG looks forward to an update after the release of these guidelines.

Concerns regarding the effects of anthropogenic noise on cetaceans have been discussed since 2004 (IWC SC/56), and the Committee has repeatedly expressed concern regarding the potential impacts on cetaceans (IWC SC/57, IWC SC/58, IWC SC/59, IWC SC/62, IWC SC/66).

In 2006, a two-day pre-meeting was convened to specifically review impacts of seismic survey activities (IWC SC/58). Subsequently, the Committee made a series of recommendations regarding seismic survey mitigation and monitoring programmes, and recommended that member governments permitting seismic surveys should: (1) implement appropriate recommended monitoring programmes; (2) develop and/or evaluate nationally relevant mitigation procedures; and (3) identify and facilitate research, monitoring, and mitigation procedures that address the recommendations detailed in the Workshop report. However, Reyes Reyes *et al.* (2016) reports that few Latin American countries have instituted a process whereby marine mammal monitoring and mitigation measures are implemented during oil and gas exploration activities.

The SWG reiterated its previous **recommendations** on seismic survey noise reduction guidelines since 2004. The SWG also recognised the recommendations from Reyes Reyes *et al.* (2016)[6], and **agreed** that they should be addressed by international guidelines.

The SWG also **agreed** that member countries should collaborate regarding implementation of best available practices for minimising the negative impacts of seismic survey exploration on marine mammals and their acoustic habitats, and to promote collaborative efforts among industry partners to reduce the need for multiple surveys within the same habitats. This work should be progressed as a matter of urgency.

In discussion, the SWG noted that New Zealand is currently revising its guidelines regarding seismic surveys. The SWG looks forward to a presentation on the finalised guidelines next year.

9.3.2 Updates in shipping

In 2016, the Committee recommended a paper for submission to the IMO Marine Environment Protection Committee (MEPC), providing an update of recent information related to the extent and impacts of underwater noise from shipping. Submission of such a paper would assist the broader recommendations for enhanced cooperation between IWC and IMO and follows a similar update on ship strikes which was well received by IMO MEPC. The next MEPC meeting, MEPC 71 will be held in July 2017. At least one paper related to underwater noise from shipping has been tabled at that meeting, and when this is discussed IWC could offer to develop a technical paper on the issue for MEPC 72 (expected in early 2018).

The SWG **recommended** that an intersessional working group be formed to provide the Secretariat with a summary of the relevant material and discussions within the IMO Marine Environment Protection Committee (MEPC) on shipping noise, particularly from IWC (2016b) in the form of a paper that could be presented to MEPC 72. The paper would explain the background to the Committee recommendations made in 2016. The SWG also **recommended** that the Secretariat or an expert from the Scientific Committee attend the MEPC 71 to offer a technical paper for MEPC 72. This work would be completed by March 2018.

The SWG thanked all of the presenters for their updates on noise-related issues.

10. CLIMATE CHANGE

10.1 Brief update on the intersessional progress

Simmonds drew attention to a new report on the consequences of global warming that had been produced

[6]*http://asa.scitation.org/doi/abs/10.1121/2.0000285.*

under the auspices of the IUCN, launched at the IUCN World Congress in September 2016 (Laffoley and Baxter, 2016). One chapter (Simmonds, 2016), outlined the consequences for marine mammals. These include shifts in feeding and breeding grounds; movement of mobile species into new areas resulting in further conflicts with human activities; mismatches between peak productivity and cetacean migration timings; declines in species with restricted habitats and changes in the balance of species with increasing occurrences of invasive species.

Simmonds also noted the significant increase in publications linking climate change to effects in marine mammal populations and the paucity of studies in some regions, especially in the tropics.

The SWG thanked Simmonds for this update.

10.2 Reconsideration of this agenda item in light of agenda Item 11 and SM agenda Item 5 (river dolphins)

The SWG also had a discussion about how the topic of climate change could be better integrated into the work of the Scientific Committee. As this topic cuts across all agenda items dealt with by Environmental Concerns, as well as many other topics covered by the various sub-committees and working groups of the Scientific Committee, it was agreed that it is important that the impact of climate change is considered in an integrated manner. It should be highlighted where it is a specific driver within the topics being covered.

Simmonds noted consensus resolution and gave a brief history of work on this topic to date by the SWG, which has included several Workshops, the first in 1995 and which have been effective mechanisms to distil information and from which recommendations had flowed. He also noted the steering group meeting in 2014, which had been charged with making some recommendations to help direct future considerations on this topic by the Committee and its report (IWC, 2016a). The suggestions for future foci included:

- identification of potential focal species and locations which may be useful in studying the effects of climate change on cetaceans, including consideration of species in vulnerable, restricted habitats such as riverine sites, the Black Sea, Adriatic Sea, Bay of Bengal and Gulf of California;
- further synthesis and meta-analysis applications on existing data sets to investigate plausible climate change scenarios; and
- identification and investigation of long term datasets.

Simmonds emphasised that these and the other suggestions of the intersessional correspondence group were still relevant and, given the past informative Workshops, encouraged the development of a further Workshop sometime in the next few years to consider at least some of these points and take stock of the latest information.

The SWG **recommended** that the Climate Change intersessional correspondence group refine ideas for a future Workshop and identify relevant climate change issues. This work is ongoing.

11. ARCTIC ISSUES

11.1 Progress on priority topics including cooperation with other bodies

Moore provided information on the four priority topics to guide the SWG's approach to Arctic Issues that the Scientific Committee endorsed at SC/66b (Annex K: Item 13.1). The Arctic Intersessional Correspondence Group undertook the task of reviewing recent activities under each topic, with the outcome summarised (Appendix 4). Ten peer-reviewed papers were listed under priority topic one, with brief presentations provided for four of five papers in the Pacific Arctic sector and two of five papers for the Atlantic sector. In the Pacific Arctic, it was noted that while sea ice extent has declined, bowhead and gray whales in the eastern Chukchi Sea have not changed their distributions appreciably over a 34-year sampling period. Biogeographic details regarding the seasonal habitats of five stocks of beluga offshore Alaska are now available through telemetry studies. Notably, seasonally migrant species of baleen whale are now commonly seen north of Bering Strait, in what appears to be a more productive Pacific Arctic.

In Haug *et al.* (2017), a review of possibilities and constraints in the future harvest of living resources in a changing northeast Atlantic Arctic Ocean was presented. Global warming drives changes in oceanographic conditions in the Arctic Ocean and the adjacent continental slopes which may result in favourable conditions for increased biological production in waters at the northern continental shelves. However, production in the central Arctic Ocean will continue to be limited by the amount of light and by vertical stratification reducing nutrient availability. Upwelling conditions due to topography and inflowing warm and nutrient rich Atlantic Water may result in high production in areas along the shelf breaks. This may particularly influence distribution and abundance of sea mammals, as can be seen from analysis of historical records of hunting.

Boreal whale species, such as blue, fin, humpback and minke whales, are regular seasonal migrants to the Northeast Atlantic side of the Arctic Ocean where they take advantage of the summer peak in productivity as the sea-ice recedes northward. Furthermore, during the spring to autumn period, most harp seals on the Northeast Atlantic side of the Arctic are found in the central and northern parts of the Barents Sea where sea-ice edge is a platform from which they make foraging trips into open waters. Both migrant cetaceans and harp seals are likely to follow any further receding of the sea-ice edge, if sufficient food resources become available in the region. Such northward expansions of more boreal marine mammal species are likely to cause competitive pressure on some endemic Arctic species (bowhead whales, white whales, narwhals), as well as putting them at risk of predation and diseases.

Haug also presented information from Vacquié-Garcia *et al.* (2017), which described recent late summer distribution of whales in high Arctic Norwegian waters. The study explored the distribution and abundance of the narwhals, bowhead and white whales, in the marginal ice zone and into the sea ice north of the Svalbard Archipelago. Based on line-transect surveys were conducted in August 2015, bowhead whales were predominantly seen close to the ice-edge, whereas narwhals were located deeper into the ice. No white whales were observed during these surveys. To contextualise these results within the broader Svalbard cetacean community, opportunistic sightings from the period of the survey also were mapped to compare general distributions. These sightings included numerous cetacean species, especially seasonally occurring ones, however, the resident white whales dominated in terms of the numbers of individuals reported. The results suggest little spatial overlap between seasonally occurring whales and the narwhals, bowhead and white whales. Bowhead whales and narwhals were tightly associated with sea ice, and white whales were tightly coastal. In contrast, the seasonally occurring species (primarily blue, fin, humpback and minke whales) were found over the shelf and along its edges.

Priority topics 2-4 focused on aspects of integrating the work of E with various of the working groups of Arctic Council. Topics where synergies may be found include activities related to the Arctic Marine Shipping Assessment (AMSA) and the International Maritime Organization (IMO) Polar Code and Voyage Planning activities; in this regard, the Bering Strait Port Access Route Study and the Arctic Waterways Safety Committee were noted. With regard to ecosystem assessment activities, the Circumpolar Biodiversity Monitoring Program (CBMP), the State of the Arctic Marine Biodiversity Report (SAMBR), the Ecosystem Approach (EA) to Management, and the Arctic Council Emergency Prevention Preparedness and Response (EPPR) reports seemed the most relevant to the work of the SWG.

Possible changes to the structure of the SWG agenda were discussed after presentation of updates on the Arctic Issues priority topics. A short summary of the recommended changes include: (1) standing items are considered by SWG each year, with reference to all ocean regions, including the Arctic – so 'Arctic Issues' drops out as a stand-alone SWG agenda item; (2) focus topics, such as Cumulative Impacts, Marine Litter and Noise, are considered on a rotational basis; and (3) if 'Arctic Issues' is to be maintained as a stand-alone topic, consideration should be given to moving it to the NH Subcommittee Agenda and specific guidance be provided about what topics (e.g. population status of cetaceans, habitat use, etc.) will be addressed. See Appendix 4 for details.

The overarching goal of the suggested changes is to better integrate information flow on impacts to cetaceans of environmental variability associated with climate change, in the Arctic and elsewhere, among the sub-committees and working groups of the SC.

Based on the discussion in Items 10 and 11, the SWG **agreed** that the thematic and focus topics of the SWG are all occurring in the context of climate change, as are all other topics considered in several other SC subcommittees (e.g. SM, EM). Therefore, the SWG **recommended** that work on climate change be better integrated in the work of the full Scientific Committee. The SWG **agreed** that Arctic issues will no longer be a standing topic and papers would be addressed as appropriate under the most appropriate standing items for the issue being presented. This action was implemented at SC/67a.

The SWG thanked the presenters for their updates.

12. STATE OF THE CETACEAN ENVIRONMENT REPORT – SOCER

The State of the Cetacean Environment Report was the result of several resolutions of the International Whaling Commission, including Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), which directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 (IWC, 2001) welcomed the concept of SOCER and requested the annual submission of this report to the Commission. The first full SOCER (Stachowitsch *et al.*, 2003) was submitted in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Mediterranean and Black Seas, Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2017 SOCER (Appendix 5) focuses on the Indian Ocean, summarising key papers and articles published from about 2015 through 2017 to date. Next year (SC/67b) will focus on the Mediterranean and Black Seas.

For the high seas, the 'Ocean Health Index' (University of California) rates the Western Indian Ocean with a good score (79 of 100 points), but the Eastern Indian Ocean receives a poor value of 55. The evaluation of coastal waters and EEZs vary by country from a low of 51 (Pakistan) to a high of 85 (Seychelles). Another major evaluation, the 'First Global Integrated Marine Assessment' conducted by the UN identified the key threats as bycatch, habitat degradation and loss, and pollution including marine debris. Importantly, it outlined the lack of information available on the state of the Indian Ocean and stresses research gaps such as analyses of the biology and ecology of whales, and impacts of fishing on whales. Five major gill-netting countries take an estimated 60,000 small cetaceans as bycatch each year. Another paper reported that more than 17,000 dolphins were by-caught in another country (Pakistan). Plastic marine debris is identified as a major issue: in a Southern Hemisphere comparison, the Indian Ocean gyre apparently contains more floating debris than both the Southern Pacific and Southern Atlantic gyres combined. Other papers highlighted harmful algal blooms (HABs) as a problem (81 events between 1976 and 2009 in the Sea of Oman alone, with significant correlations between oxygen depletion, algal blooms and fish kills, whereby a considerable temperature increase in surface waters and catastrophic sewage treatment failures also play a role). In the Persian/Arabian Gulf, the status of the region is exemplified by an over 70% loss of historic reefs. Another report states that most of the over 100,000 tons of DDT still being used every year in India reaches the sea. In one item already identified by the Scientific Committee, shifting the current Traffic Separation Scheme off Sri Lanka only 15n.miles further offshore has the potential to reduce ship collisions with blue whales by 95%. Finally, several papers pointed to the threats facing endangered river dolphins in India, Pakistan and Nepal due to various modifications of waterways, including for inland navigation.

In terms of 'global' environmental issues, the problem of climate change predominated. Unprecedented levels of carbon dioxide in the atmosphere (410 ppm) have been recorded, and it is predicted we will soon reach global temperatures that have not been experienced in 420 million years. Also, 2016 was officially the hottest year on record with global temperatures 1.2°C above the average temperatures during the late 19th/early 20th centuries (1881-1910). The maximum Arctic sea ice coverage in the winter of 2016/17 was the lowest level ever recorded and air temperatures over the Arctic Ocean ranged from 2°C to 6°C above average in nearly every region. Moreover, massive amounts of meltwater in Antarctica has resulted in abnormal, huge lakes of meltwater up to 80km long. This meltwater is exacerbating ice loss in Antarctica. For example, large cracks have appeared in the Larsen C ice sheet, suggesting its imminent collapse. Finally, an increase of extent and duration of Harmful Algal Blooms is predicted because of climate change.

In terms of underwater noise, on a positive side several studies looked at better ways to investigate the impacts of noise. However, studies showed decreases in foraging in sperm whales and humpback whales in response to military sonar and major overlaps between fin whales and blue whales and seismic survey noise, which could lead to extensive call masking. Pilot whales also showed a response to echosounders – a type of noise producing device that has received little attention, but which are in wide use. In addition, modelling studies are starting to estimate the energetic effects of cetacean disturbance from underwater noise, for example, a beaked whale exposed to naval sonar faces a 30.5% increase in metabolic rate for more than 90 min after the exposure to noise.

Energetic costs have also been estimated for whale entanglement in fishing gear – the amount of energy expended by an entangled whale is roughly equivalent to a reproductive or migration event and the energetic costs will likely reduce reproductive rates and increase mortality rates. This is particularly important as half of all humpback whales showed signs of having been entangled, as did 83% of North Atlantic right whales.

Finally, further studies on cetaceans exposed to the *Deepwater Horizon* oil spill demonstrate clear population impacts including long-term deterioration of cetacean health, a decrease in in reproductive rates and increase in mortality rates in bottlenose dolphins exposed to oil. In total, 15 species of cetacean were reported as having been exposed to the *Deepwater Horizon* oil spill, thus it is likely that more species that bottlenose dolphins might have been impacted by this spill in the Gulf of Mexico. The studies also highlight that oil spills are a much bigger threat to cetaceans than previously thought.

In discussion, the SWG noted that the annual SOCER can be downloaded from the IWC website and also as an appendix in the Environmental Concerns Annex. Although infectious diseases were not included in the SOCER this year due to the lack of peer-reviewed publications in the focus region, this subject matter has been included in SOCER in previous years. The SWG thanked the editors of SOCER for their report and commended them on compiling this information.

13. WORK PLAN

The SWG has a number of topics on its agenda and it has sometimes been difficult to cover all these areas in sufficient detail with sufficient expertise during the scientific committee meetings. In order to address this issue, a proposed work plan was prepared (illustrated in Appendix 6) which summarises a way forward for the SWG. The proposal was to have three main 'standing' items (Pollution, Diseases of Concern and Strandings), three items that are dealt with in more detail on a cyclical basis (Noise, Cumulative Impacts and Marine Litter) and an Emerging Issues item. Overarching these topics would be SOCER and Climate Change. It was recognised by the SWG that climate change is a factor that is now affecting all of the topics listed above and was also a concern and interacting topic for the work of other sub-committees (for example ecosystem modelling, Northern and Southern Hemisphere). As such the effect of climate change would be highlighted during each of the topics and the Intersessional Correspondence Group would ensure the climate change aspect of the work of the Scientific Committee remains a key issue, with a view to organising a Workshop at an appropriate time in future.

The SWG **agreed** that the work plan and work flow summarised in Appendix 6 should be adopted with the caveat that emerging issues should be dealt with and a recognition that priorities may change if particular topics require attention because of developments during the year including receiving specific requests from the Commission.

14. ADOPTION OF REPORT

The report was adopted at 14:27 on 17 May 2017. The SWG thanked Rowles and Hall for their guidance during discussions and Greig, Simeone and Ylitalo for their rapporteuring.

REFERENCES

Andrianov, V.V., Lebedev, A.A., Neverozva, N.V., Lukin, L.P., Vorobyeva, T.Y., Sobko, E.I., Kobelev, E.A., Lisitsina, T.Y., Samokhina, L.A. and Klimov, S.I. 2016. Long-Term Environmental Impact of an Oil Spill in the Southern Part of Onega Bay, the White Sea. *Russ. J. Mar. Biol.* 42(3): 205-15.

Anon. 2016. Approaches to understanding the cumulative effects of stressors on marine mammals. National Academies of Sciences.

Arctic Council. 2017. Fairbanks Declaration 2017, on the occassion of the Tenth Ministerial Meeting of the Arctic Council. 8pp. [Available at: *https://www.state.gov/e/oes/rls/other/2017/270802.htm*].

Berdalet, E., Fleming, L.E., Gowen, R., Davidson, K., Hess, P., Backer, L.C., Moore, S.K., Hoagland, P. and Enevoldson, H. 2015. Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century. *J. Mar. Biol. Assoc. UK.*: 1-31. [Available at: doi:10.1017/S0025315001733].

Carretta, J.V., Danil, K., Chivers, S.J., Weller, D.W., Janiger, D.S., Berman-Kowalewski, M., Hernandez, K.M., Harvey, J.T., Dunkin, R.C., Casper, D.R., Stoudt, S., Flannery, M., Wilkinson, K., Huggins, J. and Lambourn, D.M. 2016. Recovery rates of bottlenose dolphins (*Tursiops truncatus*) carcasses estimated from stranding and survival rate data. *Mar. Mamm. Sci.* 32(1): 349-62.

Citta, J.J., Richard, P., Lowry, L.F., O'Corry-Crowe, G., Marcoux, M., Suydam, R., Quakenbush, L.T., Hobbs, R.C., Litovka, D.I., Frost, K.J., Gray, T., Orr, J., Tinker, B., Aderman, H. and Druckenmiller, M.L. 2017. Satellite telemetry reveals population specific winter ranges of beluga whales in the Bering Sea. *Mar. Mam. Sci.* 33: 236–50.

Clarke, J.T., Kennedy, A.S. and Ferguson, M.C. 2016. Bowhead and Gray Whale Distributions, Sighting Rates, and Habitat Associations in the Eastern Chukchi Sea, Summer and Fall 2009–15, with a Retrospective Comparison to 1982–91. *Arctic* 69(4): 359-77.

Dehn, L.A., Follman, E., Rosa, C., Duffy, L.K., Thomas, D.L., Bratton, G.R., Taylor, R.J. and O'Hara, T.M. 2006. Stable isotope and trace element status of subsistence hunted bowhead (*Balaena mysticetus*) and beluga whales (*Delphinapterus leucas*) in Alaska and gray whales (*Eschrichtius robustus*) in Chukotka. *Mar. Poll. Bull.* 52: 301-19. [Available on web].

Department of Conservation. 2005. Guidelines for minimising acoustic disturbance to marine mammals from seismic survey operations. Wellington, New Zealand: Department of Conservation; 2005.

Fossi, M.C., Romeo, T., Panti, C., Baini, M., Marsili, L., Campani, T., Canese, S., Galgani, F., Druon, J., Airoldi, S., Taddei, S., Fattorini, M., Brandini, C. and Lapucci, C. 2017. Plastic Debris Occurrence, Convergence Areas and Fin Whales Feeding Ground in the Mediterranean Marine Protected Area Pelagos Sanctuary: A Modeling Approach. *Mar. Sci.* (31 May 2017). Available from: *https://doi.org/10.3389/fmars.2017.00167*.

Genov, T., Angelini, V., Hace, A., Palmisano, G., Petelin, B., Malačič, V., Pari, S. and Mazzariol, S. 2016. Mid-distance re-sighting of a common bottlenose dolphin in the northern Adriatic Sea: insight into regional movement patterns. *J. Mar. Biol. Assoc. UK* 96: 909-14.

Genov, T., Kotnjek, P., Lesjak, J. and Hace, A. 2008. Bottlenose dolphins (*Tursiops truncatus*) in Slovenian and adjacent waters (northern Adriatic sea). *Annales, Series Historia Naturalis* 18(2): 227-44.

Gilbert, P.M. and Burford, M.A. 2017. Globally changing nutrient loads and harmful algal blooms. *Oceanography* 30(1): 58-69. [Available at: *https://doi.org/10.5670/oceanog.2017.110*].

Hall, A., Ylitalo, G.M., Greig, D., Gulland, F., Calambokidis, J., Huggins, J. and Rowles, T. 2016. The gestational transfer of polychlorinated biophenyls (PCBs) in harbour porpoise (*Phocoena phocoena*). Paper SC/66b/E03rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 16pp. [Paper available from the Office of this Journal].

Hatch, L., Wahle, C.M., Gedamke, J., Harrison, J., Laws, B., Moore, S.E., Stadler, J.H. and Van Parijs, S.M. 2016. Can you hear me here? Managing acoustic habitat in US waters. *Endang. Species Res.* 30: 171-86.

Haug, T., Bogstad, B., Chierici, M., Gjter, H., Hallfredsson, E.H., Hoslashines, A.S., Haringkon Hoel, A., Ingvaldsen, R.B., Lindal Jorgensen, L., Knutsen, T., Loeng, H., Naustvoll, L.J., Rottingen, I. and Sunnanring, K. 2017. Future harvest of living resources in the Arctic Ocean north of the Nordic and Barents Seas: A review of possibilities and constraints. *Fish. Res.* 188: 38-57.

Hauser, D.D.W., Laidre, K.L., Stern, H.L., Moore, S.E., Suydam, R.S. and Richard, P.R. 2017. Habitat selection by two beluga whale populations in the Chukchi and Beaufort seas. *PLoS ONE* 12(2): e0172755.

Helle, E., Olsson, M. and Jensen, S. 1976. PCB levels correlated with pathological changes in seal uteri. *Ambio* 5(5-6): 261-63.

International Whaling Commission. 1998. Chairman's Report of the Forty-Ninth Annual Meeting. Appendix 7. IWC Resolution 1997-7. Resolution on environmental change and cetaceans. *Rep. int. Whal. Commn.* 48:48-49.

International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whal. Comm.* 1998:43-44.

International Whaling Commission. 2001. Chairman's Report of the Fifty-Second Annual Meeting. Appendix 1. Resolutions adopted during the 52nd annual meeting. IWC Resolution 2000-7. Resolution on environmental change and cetaceans. *Ann. Rep. Int. Whal. Comm.* 2000:56-57.
International Whaling Commission. 2006. Report of the IWC Scientific Committee Workshop on Habitat Degradation, 12-15 November 2004, Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 8:313-35.
International Whaling Commission. 2008. Report of the Scientific Committee. Annex K. Report of the standing working group on environmental concerns. *J. Cetacean Res. Manage. (Suppl.)* 10:247-92.
International Whaling Commission. 2016a. Report of the IWC Climate Change Steering Group Meeting, 19 August 2014, Glasgow, UK. *J. Cetacean Res. Manage. (Suppl.)* 17:555-64.
International Whaling Commission. 2016b. Report of the Workshop on Acoustic Masking and Whale Population Dynamics, 4-5 June 2016, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 18:615-27.
International Whaling Commission. 2017. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. *J. Cetacean Res. Manage. (Suppl.)* 18:295-329.
Jepson, P.D., Deaville, R., Barber, J., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, B., Barnett, J., Berrow, S., Cunningham, A., Davison, N., Esteban, R., Ferreira, M., Foote, A., Genov, T., Gimenez, J., Loveridge, J., Llavona, A., Martin, V., Maxwell, D., Papachlimitzou, A., Penrose, R., Perkins, M., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A. and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.* 6: Article number: 18573. doi:10.1038/srep73.
Kannan, K., Blankenship, A.L., Jones, P.D. and Giesy, J.P. 2000. Toxicity reference values for the toxic effects of polychlorinated biphenyls to aquatic mammals. *Human and Ecological Risk Assessment* 6(1): 181-201.
Kodavanti, P.R.S., Coburn, C.G., Moser, V.C., MacPhail, R.C., Fenton, S.E., Stoker, T.E., Rayner, J.L., Kannan, K. and Birnbaum, L.S. 2010. Developmental exposure to a commercial PBDE mixture, DE-71: Neurobehavioral, hormonal, and reproductive effects. *Toxicol. Sci.* 116: 297-312.
Laffoley, D. and Baxter, J.M. 2016. Explaining ocean warming: Causes, scale, effects and consequences. 456pp. Gland, Switzerland, Gland, Switzerland. IUCN [Available at: *DOI: 10.2305/IUCN.CH.2016.08.en*].
Law, R.J. and Jepson, P.D. 2017. Europe's insufficient pollutant remediation. *Science* 356(6334): 148.
Lefebvre, K.A., Kendrick, P.S., Ladiges, W., Hiolski, E.M., Ferriss, B.E., Smith, D.R. and Marcinek, D.J. 2017. Chronic low-level exposure to the common seafood toxin domoic acid causes cognitive deficits in mice. *Harmful Algae* 64: 20-9.
McCabe, R.M., Hickey, B.M., Kudela, R.M., Lefebvre, K.A., Adams, N.G., Bill, B.D., Gulland, F.M.D., Thomson, R.E., Cochlan, W.P. and Trainer, V.L. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. *Geophysical Res. Lett.* 43. [Available at: 10.1002/2016GL070023].
Moore, S.E. 2016. Is it boom times for Baleen whales in the Pacific Arctic region? *Biol. Lett.* 12: 20160251.
Nowacek, D.P., Clark, C.W., Mann, D., Miller, P.J.O., Rosenbaum, H.C., Golden, J.S., Jasny, M., Kraska, J. and Southall, B.L. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. *Front. Ecol. Environ.* 13(7): 378-86.
Nowacek, D.P. and Southall, B.L. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys: a resource guide for managers. Gland, Switzerland: IUCN, 42pp. ISBN: 978-2-8317-1805-7.
Otten, T.G. and Paerl, H.W. 2015. Health effects of toxic cyanobacteria in U.S drinking and recreational waters: Our current understabding and proposed direction. *Curr. Envir. Health Rpt.* (2): 75-84.
Paerl, H.W. and Otten, T.G. 2013. Harmful cyanobacterial blooms: causes, consequences and controls. *Microb. Ecol.* 65: 995-1,010.
Redfern, J.V., Moore, T.J., Fiedler, P.C., De Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23: 394-408. [Available at: *http://wileyonlinelibrary.com*].
Reyes Reyes, M.V., Iniguez Bessega, M.A. and Dolman, S.J. 2016. Review of legislation applied to seismic surveys to mitigate effects on marine mammals in Latin America. 27(032002). Proceedings of meetings on accoustics.
Simmonds, M.P. 2016. Impacts and effects of ocean warming on marine mammals. pp.303-20. *In*: Laffoley, D. and Baxter, J.M. (eds). *Explaining ocean warming: Causes, scale, effects and consequences. Full report*. IUCN, Gland, Switzerland. Available here: *https://portals.iucn.org/library/node/46254*.
Stachowitsch, M., Rose, N.A. and Parsons, E.C.M. 2003. State of the cetacean environment report (SOCER) 2003: Second draft. Paper SC/55/E7 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 13pp. [Paper available from the Office of this Journal].
Starr, M., Lair, S., Michaud, S., Scarratt, M., Quilliam, M. and Lefaivre, D. 2017. Multispecies mass mortality of marine fauna linked to a toxic dinoflagellate bloom. *PLoS ONE* 12(5): e0176299. [Available at: *https://doi.org/10.1371/journal.pone.0176299*].
Tilbury, K.L., Stein, J.E., Krone, C.A., Brownell, R.L., Blokhin, A., Bolton, J.L. and Ernest, D.W. 2002. Chemical contaminants in juvenile gray whales (*Eschrichtius robustus*) from a subsistence harvest in the Arctic feeding grounds. *Chemosphere* 47: 555-64.
Vacquié-Garcia, J., Lydersen, C., Marques, T.A., Aars, J., Ahonen, H., Skern-Mauritzen, M., Øien, N. and Kovacs, K.M. 2017. Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endang. Spec. Res.* 32: 59-70. [Available at: DOI: 10.3354/esr00791].
Varanasi, U., Stein, J.E., Tilbury, K.L., Meador, J.P., Sloan, C.A., Clark, R.C. and Chan, S.L. 1994. Chemical contaminants in gray whales (*Eschrichtius robustus*) stranded along the west coast of North America. *Sci. Tot. Environ.* 145(1-2): 29-53.

Appendix 1

AGENDA

1. Introduction
   - 1.1 Opening remarks
   - 1.2 Election of Chairs
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of agenda
   - 1.5 Review of available documents
2. Pollution 2020
   - 2.1 Review on intersessional progress persistent organic pollutants
   - 2.2 Review on mercury in cetaceans
3. Oil spill impacts
   - 3.1 Development of information resource and communication strategy
   - 3.2 New information on oil spill risks
4. Cumulative impacts
   - 4.1 Brief update on intersessional progress and plans for 2018
5. Harmful algal blooms
   - 5.1 Bloom dynamics and drivers
   - 5.2 Health impacts of HABs and their toxins
   - 5.3 Workshop conclusions and recommendations
6. Marine debris
   - 6.1 Brief update on intersessional progress and plans for 2018
7. Diseases of concern
   - 7.1 Progress on website and communications (incl. quarterly CDoC updates) and plans for 2018
   - 7.2 New information
8. Strandings and mortality events
   - 8.1 Short review on intersessional progress and plans for 2018
   - 8.2 New information
9. Noise
   - 9.1 Update on national and international ocean noise strategies
   - 9.2 Update on intersessional co-operation with the IUCN WGWAP Noise Task Force and ocean noise recommendations
   - 9.3 New international and national guidelines and advice (e.g. IMO)
     - 9.3.1 Updates in seismic guidelines
     - 9.3.2 Updates in shipping
10. Climate change
    - 10.1 Brief update on intersessional progress
    - 10.2 Reconsiderations of this agenda item in light of agenda item 11 and SM agenda item 5 (river dolphins)
11. Arctic issues
    - 11.1 Progress on priority topics including cooperation with other bodies
12. State of the Cetacean Environment Report – SOCER
13. Work plan

Appendix 2

POLLUTION 2020: PROGRESS REPORT

Background: SC/66b – Pollution 2020 work plan (Table 17, IWC (2017)).

This progress report summarises the intersessional work that has been carried out under the Pollution 2020 initiative and following the workplan agreed at SC/66b, under three main activities:

(a) Continue modelling of contaminants, including potential addition of PBDEs

The individual based model (EffectS of Pollutants On Cetacean populations, SPOC) has continued to be developed and refined during the intersessional period. The R code used to construct the model has been improved and made more efficient which has helped to speed up the model simulations. A manuscript has been submitted for publication in the peer reviewed literature (Environmental Pollution) and is currently in review. The code has been prepared for uploading to an open source software development website known as GitHub. This will be completed when the paper has been accepted for publication, to ensure that any issues picked up during the review process are dealt with. Finally, problems with hosting the web-based version of the model on the University of St Andrews server whilst allowing public access through the University's firewall has been resolved through the use of a very short registration requirement (i.e. supply an email address and a terms and conditions box tick agreement). This will also help us find out who is using the model and enable us to give some limited support, if necessary.

Two further aspects have also now been included in the model or are being actively explored for the future:

(1) The additional uncertainty around the *in utero* transfer parameter, based on the data from harbour porpoise (*Phocoena phocoena*) female foetus pairs presented at SC/66b in Hall *et al.* (2016) has now been included. This has the expected effect of increasing the uncertainty in the overall simulated population growth rates under the different exposure scenarios. Whilst this additional source of data variation therefore increases the variability in the overall results, it does reflect more of the overall uncertainty in the various model parameters. However, additional data from beluga whales (*Delphinapterus leucas*) now also available (Desforges *et al.*, 2012) and will be used to further refine this model parameter in future.

(2) Adding the effect of PBDEs on calf survival or reproduction into the model has been problematic as tissue-related concentration response functions, that could be directly substituted for the PCB functions currently embedded in the model, have not yet been

identified. In future integration of a toxicological energetic mink (Desforges *et al.*, 2017) and/or a physiologically based pharmacokinetic cetacean model (Weijs *et al.*, 2014) will again be investigated. Earlier attempts to do this failed due to a lack of information for many of the cetacean-specific physiological parameters. However, that hurdle seems to have now been overcome to some extent. Integrating these approaches would allow oral dose response functions to be used in the SPOC risk assessment framework, making use then of the published toxicological data for PBDEs and impacts on reproduction and offspring survival (Kodavanti *et al.*, 2010).

In addition, we have identified two studies (Fair *et al.*, 2012; Martin *et al.*, 2007) in which the effects of PBDEs (as a commercial mixture) on the immune system of mink and mice respectively were evaluated. There was sufficient detail in these papers for immune concentration response functions to be constructed and to be included in the SPOC model for exploring effects of PBDEs on immunity. This is focus of the current model modifications and will be implemented in the model following the inclusion PBDE effects on calf survival or fecundity.

(b) National and international progress on risk and mitigation for PCBs

Intersessional Correspondence Group (Hall (Convenor), Donovan, Greig, Herr, Holm, Jepson, Rowles, Ryeng, Schwacke, Simmonds, Ylitalo)

The intersessional email group on risk and mitigation for PCBs has not been hugely active. However, a number of news items reporting high levels of PCBs in killer whales[7] and a general call for countries to adhere to the Stockholm Convention on Persistent Organic Pollutants (an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants) on the basis of the high PCB levels in killer whales and other European cetaceans published by Jepson *et al.* (2016) and reported at SC/66b have been released[8].

At a more local level, members of the intersessional email group reported the following example activities in the US and Europe.

(i) There are ongoing efforts to reduce PCBs in San Francisco Bay. There is a PCB TMDL for wastewater (and treatment to remove particulates that are high in PCB like dirt from the streets) and there is active monitoring in some areas in the bay that routinely have higher levels of PCBs than others (suspected to be ongoing sources of PCBs). More recently, there are now permits required when buildings are being demolished to prevent the caulk from these activities entering the bay (probably implemented in 2015). And there is monitoring to evaluate trends and see if there are any reductions. The footnoted links give more details on these initiatives[9].

(ii) One item related to POPs reduction into marine waters is that, in Puget Sound, Washington USA, a new theory has emerged on POPs in the marine food web[10]. Scientists from the Washington State Department of Fish and Wildlife, NMFS, and other entities have been monitoring POPs and metals in various abiotic and biotic species in Puget Sound (including phytoplankton, zooplankton, flat fish, forage fish, salmonids, killer whales (*Orcinus orca*) over a number of years. Puget Sound is a deep fjord in which marine water flushing rates are quite low. Although previous mitigation efforts to reduce POPs into Puget Sound, such as removing (dredging) or capping contaminated sediments, have helped reduce the POPs concentrations in biota, recent data indicate that the concentrations of PCBs measured in sediments do not correlate with levels found in biota collected from the same area. The new theory is that low trophic level biota, such as plankton, are likely taking up the PCBs before they have a chance to reach sediments and that these lipophilic compounds are biomagnified through the pelagic food web of Puget Sound. If this hypothesis is correct, then preventing new inputs of POPs into the region via storm water and atmospheric deposition is very important so as to not increase the risk to pelagic biota in the region.

(iii) Regarding the marine environment in the EU waters, the SEA and EU Marine Strategy Framework Directive (MSFD) have made progress towards 'safe, clean and healthy seas' around Europe but without definite outcomes, regarding POPs so far. Many items are currently in discussion and some measures have been put into action regarding marine litter, e.g. MSFD Competence Centre (MCC) for marine litter and more recently a ban on light-weight plastic sacs[11].

(c) Data integration and mapping

Work on the contaminant mapping tool presented at SC/67b has been progressing. The demonstration given then used simulated data to show the concept and obtain feedback from the Scientific Committee. The suggestions and comments provided by the Committee members were welcomed and improvements to the tool have (and are) being implemented.

The most progress under this Agenda item has been in synthesising the data for the map. We now have a database comprising >500 records for three main species (harbour porpoise, bottlenose dolphin (*Tursiops truncates*) and beluga whale) from all parts of the world where studies have been carried out. Plus, additional data for bowhead (*Balaena mysticetus*), humpback (*Megaptera novaeangliae*), gray (*Eschrichtius robustus*), long finned pilot (*Globicephala melas*), melon-headed (*Peponocephala electra*) and killer whale; common (*Delphinus capensis*), rough-toothed (*Steno bredanensis*), striped (*Stenella coeruleoalba*), spinner (*Stenella longirostris*), humpback (*Sousa chinensis*) and Guiana dolphin (*Sotalia guianensis*) as well as finless (*Neophocaena phocaenoides*) and Dall's porpoise (*Phocoenoides dalli*) have been entered into the database ready for mapping. These data comprise mainly PCBs and DDTs with some more recent data on PBDEs, with trends spanning from the 1970s. However, most comparable data is from the 1990s to the 2010s. We have concentrated on the adult males only where possible but some data for juveniles has also been included. The map tool selection boxes mean

[7]e.g. *http://www.bbc.com/news/science-environment-39738582.*

[8]*http://www.wcl.org.uk/docs/Link%20IWC%20PCB%20briefing.pdf.*

[9]*http://www.sfestuary.org/taking-action-for-clean-water-pcbs-in-caulk-project/; http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaypcbstmdl.shtml; http://www.sfestuary.org/wp-content/uploads/2013/03/FactSheetPCBTMDLFINAL012313.pdf.*

[10]see *https://www.eopugetsound.org/magazine/pcb-theory.*

[11]*http://ec.europa.eu/environment/waste/packaging/legis.htm.*

the user can chose which age/sex classes to visualise. Where possible data have been entered on a geometric mean, lipid weight basis and again additional data not in this format can be included if it is in the database but at the user's discretion. The data has been obtained from over 70 peer reviewed publications and grey literature where raw data and sufficient detail was reported and these references will also be included on the web pages. This will shortly be available through the web.

REFERENCES

Desforges, J.-P.W., Sonne, C. and Dietz, R. 2017. Using energy budgets to combine ecology and toxicology in a mammalian sentinel species. *Sci. Rep.* 7: 46267.

Desforges, J.P.W., Ross, P.S. and Loseto, L.L. 2012. Transplacental transfer of polychlorinated biphenyls and polybrominated diphenyl ethers in arctic beluga whales (*Delphinapterus leucas*). *Environ. Toxicol. Chem.* 31: 296-300.

Fair, P.A., Stavros, H.C., Mollenhauer, M.A.M., DeWitt, J.C., Henry, N., Kannan, K., Yun, S.H., Bossart, G.D., Keil, D.E. and Peden-Adams, M.M. 2012. Immune function in female B6C3F1 mice is modulated by DE-71, a commercial polybrominated diphenyl ether mixture. *J. Immunotoxicol.* 9: 96-107.

Hall, A., Ylitalo, G.M., Greig, D., Gulland, F., Calambokidis, J., Huggins, J. and Rowles, T. 2016. The gestational transfer of polychlorinated biophenyls (PCBs) in harbour porpoise (*Phocoena phocoena*). Paper SC/66b/E03rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 16pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2017. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. *J. Cetacean Res. Manage. (Suppl.)* 18:295-329.

Jepson, P.D., Deaville, R., Barber, J., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, B., Barnett, J., Berrow, S., Cunningham, A., Davison, N., Esteban, R., Ferreira, M., Foote, A., Genov, T., Gimenez, J., Loveridge, J., Llavona, A., Martin, V., Maxwell, D., Papachlimitzou, A., Penrose, R., Perkins, M., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A. and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.* 6: Article number: 18573. doi:10.1038/srep73.

Kodavanti, P.R.S., Coburn, C.G., Moser, V.C., MacPhail, R.C., Fenton, S.E., Stoker, T.E., Rayner, J.L., Kannan, K. and Birnbaum, L.S. 2010. Developmental exposure to a commercial PBDE mixture, DE-71: Neurobehavioral, hormonal, and reproductive effects. *Toxicol. Sci.* 116: 297-312.

Martin, P.A., Mayne, G.J., Bursian, S.J., Tomy, G., Palace, V., Pekarik, C. and Smits, J. 2007. Immunotoxicity of the commercial polybrominated diphenyl ether mixture DE-71 in ranch mink (*Mustela vison*). *Environ. Toxicol. Chem.* 26: 988-97.

Weijs, L., Roach, A.C., Yang, R.S.H., McDougall, R., Lyons, M., Housand, C., Tibax, D., Manning, T., Chapman, J., Edge, K., Covaci, A. and Blust, R. 2014. Lifetime PCB 153 bioaccumulation and pharmacokinetics in pilot whales: Bayesian population PBPK modeling and Markov chain Monte Carlo simulations. *Chemosphere* 94: 91-96.

Appendix 3

WORKING GROUP, GLOBAL SHIPPING AND WHALE CONSERVATION, UN FEB 2017 PREP. COMM.

Howard Rosenbaum and Brandon Southall, co-Chairs
Sue Moore, Ocean Noise Compilation of Recommendations

Background

Commercial shipping is one of the most widespread industrial activities in our oceans, transporting more than 90% of the world's goods and energy. By its very nature its routes are often highly concentrated within shipping lanes and near ports. Shipping vessel operations, both individually and in aggregate, have a range of potential impacts on marine species and ecosystems - such as direct injury or mortality from ship strikes, and sub-lethal behavioral effects of underwater noise pollution (including interference with communication, foraging, and navigation of marine species). While these issues differ in a number of ways, the relative risk of each increases where higher spatial and temporal overlap occurs between shipping density and the presence of susceptible species engaged in biologically important activities occurs. In other words, the potential impacts from both are far greater when a high concentration of shipping activity intersects with the migratory pathways or critical feeding or reproductive habitat of vulnerable species.

Both ship-strike probability and ocean noise pollution can be monitored and impacts reduced by integrating widely available remote-sensing and tracking technologies with knowledge of animal presence and behavior and managing impacts accordingly. Noise quieting technologies may also effectively mitigate noise pollution at the source, leading to an overall reduction in levels of shipping noise.

There is considerable scientific, conservation, government, and industry interest in understanding and mitigating the impacts of ship-strikes and ocean noise pollution from commercial shipping and other marine traffic on marine life. This interest has resulted in some specific measures, including ship-routing and speed-control schemes and passive acoustic and ship-monitoring networks in several jurisdictions, and the development of vessel-quieting guidelines within the International Maritime Organization (IMO). However, additional and sustained international collaboration and partnerships, leading to specific actions, are needed to limit and reduce the impacts of vessel operations on marine life.

Recommendations

The June 2017 UN Ocean Conference enables UN Member States to reverse the state of decline of our oceans and meet SDG14 targets by 2030. Given the global scale of shipping and the documented impacts of direct mortality and acoustic habitat loss on endangered and protected marine species, it is critical to incorporate these issues into the framework for delivery of the SDG14 targets. We recommend including the following specific measures in the Call for Action issued by the UN Ocean Conference.

- Recognise both acute (ship-strike mortality) and chronic (elevation of marine ambient noise at a global scale) impacts on marine species as inter-related threats that must be addressed for successful implementation of SDG14.
- Further develop and integrate national and international acoustic monitoring and ship-tracking programs.
- Use the results of integrated monitoring to evaluate risks from ship strikes and ocean noise pollution and then develop appropriate regulatory strategies.
- Use existing knowledge, technological advances, and public-private partnerships to develop and implement global best practices to address both ship-strike and ocean noise pollution issues (see supplementary document with additional considerations and references to recent related efforts).

Table 1

Suggestions and recommendations from four recent workshops cross-referenced to the five measures listed in Nowacek *et al*. (2015).

Nowacek *et al*. (2015) - paraphrased	IUCN planning strategies	IWC masking Workshop	CMS Guidelines	NOAA ONS
Empirically based restrictions on the duration and/or area of activities in known biologically important habitat.	-	Section 11 – Site selection of Important Marine Mammal Areas for protection should integrate information on anthropogenic noise.	-	Development of national guidance for acoustic impact thresholds and other management tools.
Sustained monitoring of acoustic habitat indicators, with limitations and targets based on the cumulative noise contributions of human activities.	Practice no. 3 – Implement mitigation and monitoring of operations.	Section 11 – Increase research on and management consideration of acoustic habitat in cetacean conservation efforts.	Section I.2 – Professional sound propagation modeling. Section I.3 – Cumulative sound exposure level (SELcum) as key metric.	Improved management to protect acoustic habitat and achieve species- or habitat-focused goals through incorporation of place-based authorities.
Preconditions for developing and implementing practices to reduce acoustic footprints of noise-generating activities.	Practice no. 1 – Assess and evaluate the environment in the context of the proposed actions.	Section 11 – Ships that contribute disproportionately to ocean noise levels should be a priority for replacement or application of ship-quieting technology.	Section I.1 – Operational mitigation procedures. Sections I.4-I.11 – EIA guidelines for specific noise sources.	Expansion of existing international partnerships with regulatory agencies and industries to promote use of quieter technologies.
Creation of an intergovernmental science organization to coordinate and advance efforts to improve the environmental assessment of acoustic impacts.	-	Section 11 – Member states should undertake management efforts to keep quiet areas quiet and make noisy areas quieter.	Section G – Related intergovernmental decisions.	Development of NOAA capacity for predictive sound field and sound exposure modeling.
Requirements for preparation of EIAs and strategic or programmatic environmental assessments to include analysis of potential for cumulative effects.	Practice no. 2 – Evaluate risk and develop plans accordingly. Practice no. 4 – Evaluate and improve.	Section 11 – Integrate consideration of ocean noise into efforts under the United Nations Sustainable Development Goal 14 and the Convention on Biological Diversity (Aichi Targets 7 and 11).	Section H.2 – Basic principles of EIAs. Section I – Framework for EIA guidelines for marine noise- generating activities.	Enacting monitoring requirements for compliance processes that reflect comprehensive science goals.

- For ship-strikes, best practices should include the temporal and spatial separation of shipping lanes and large whale habitat, where possible, as well as encouraging slow steaming practices and consideration of speed reductions in high-risk areas.
- Ship-noise monitoring and mitigation efforts should involve shipping industry and government partnerships aimed at addressing these issues from strategically different perspectives, including:
  - reducing noise exposure within new or existing marine protected areas (Target 14.5) or Important Marine Mammal Areas, especially for those with resident or predictably-present acoustically sensitive and vocally-active species;
  - implementing quieting techniques in accordance with the IMO voluntary vessel-quieting guidelines to directly reduce shipping contributions to noise pollution (Target 14.1); and
  - evaluating noise benefits of holistic 'green ship' designs aimed at increased fuel efficiency and reduced emissions; and providing financial incentives to encourage the adoption of ship-quieting technology.

Ocean Noise: an abbreviated compilation of recommendations from recent work by IUCN(Nowacek and Southall, 2016), IWC (IWC, 2016), CMS (Prideaux, 2016) and NOAA (Gedamke, 2016) focused on impacts of anthropogenic noise on marine life

This brief summary of suggestions and recommendations from recent publications on the topic of impacts of anthropogenic noise on marine life is meant to support discussions of international policy for reducing those impacts. The table below is only a subset of what was presented in each publication – selected here to reinforce particular goals and to emphasise points of agreement among many specialists in the field of ocean noise and its impacts. Numerous other reports and peer-reviewed publications on this topic exist, but those mentioned in the table provide an introductory window on the key issues.

Nowacek *et al.* (2015) state, 'a responsible path forward should focus on the creation of legally binding international commitments' to reduce the impacts of anthropogenic noise on marine life. They list five measures that provide an initial framework for a 'new conversation' regarding ocean noise. Two options they suggest are that: (1) member states of the IMO pursue an annex to MARPOL 1973/78 through the Marine Environmental Protection Committee or, because MARPOL applies solely to ships; and (2) member states negotiate a new convention to regulate all non-military sources of underwater noise. Either of these approaches, or others, will require agreement among nations on overarching goals.

REFERENCES

Gedamke, J. 2016. NOAA Ocean Noise Strategy Roadmap (*http://cetsound.noaa.gov/road-map*).

International Whaling Commission. 2016. Report of the Workshop on Acoustic Masking and Whale Population Dynamics, 4-5 June 2016, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 18:615-27.

Nowacek, D.P., Clark, C.W., Mann, D., Miller, P.J.O., Rosenbaum, H.C., Golden, J.S., Jasny, M., Kraska, J. and Southall, B.L. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. *Front. Ecol. Environ.* 13(7): 378-86.

Nowacek, D.P. and Southall, B.L. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys: a resource guide for managers. Gland, Switzerland: IUCN, 42 pp. ISBN: 978-2-8317-1805-7.

Prideaux, G. 2016. CMS Family Environmental Impact Assessment Guidelines for Marine Noise-generating Activities. Convention on Migratory Species (CMS) of Wild Animals, Bonn.

Appendix 4

PRIORITY WORK TOPICS

The Scientific Committee endorsed four priority topics to guide the work of E with regard to Arctic issues at SC/66b; the complete wording for each topic can be found in Annex K (Item 13.1). The updates provided here are listed under abbreviated headings for each priority topic.

Priority Topic 1. Updates on cetacean species that routinely occur in the Arctic, with a priority on endemic species:
Short list of recent peer-reviewed papers; brief presentations were provided for some (8) of the papers. Full references are given at the end of Appendix.

Pacific Arctic sector
- Citta *et al.* (2017): beluga winter ranges in the Bering Sea*.
- Clarke *et al.* (2016): bowhead and gray whale habitat selection in NE Chukchi Sea*.
- Hauser *et al.* (2017): beluga habitats in Chukchi and Beaufort seas*.
- Lefebvre *et al.* (2017): algal toxin prevalence in Alaskan marine mammals.
- Moore (2016): baleen whale 'seasonal migrants' in the SE Chukchi*.

Atlantic Arctic sector
- Breed *et al.* (2017): killer whales disrupt narwhal habitat use.
- Frouin-Mouy *et al.* (2017): acoustic detection of marine mammals in Baffin and Melville Bays.
- Haug *et al.* (2017): future marine living resources in the Nordic and Barents Sea*.
- Kuznetsova *et al.* (2016): beluga winter distribution in the White Sea.
- Vacquié-Garcia *et al.* (2017): bowhead, beluga and narwhale distribution North Svalbard*.

Priority Topic 2. Integrate arctic related SWG work with SC sub-committees, Arctic Council Working Groups, the IMO, NGOs and other stakeholders
Arctic Council-PAME WG (http://www.pame.is/): AMSA and Polar Code
Fulfilling one of the primary and long-standing recommendations of the Arctic Council's 2009 Arctic Marine Shipping Assessment (AMSA) that the Arctic States cooperatively support efforts at the IMO to strengthen harmonise and regularly update international standards for vessels operating in the Arctic, the 'Polar Code' entered into force on 1 January 2017. The International Maritime Organization (IMO) has adopted the '*International Code for Ships Operating in Polar Waters*' (Polar Code) and related amendments to make it mandatory under both the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). This marks an historic milestone in the IMO's work to protect ships and people aboard them, both seafarers and passengers, in the harsh environment of the waters surrounding the two poles.

The Polar Code is intended to cover the full range of shipping-related matters relevant to navigation in waters surrounding the two poles – ship design, construction and equipment; operational and training concerns; search and rescue; and, equally important, the protection of the unique environment and eco-systems of the inhospitable waters surrounding the two poles. The Polar Code includes mandatory measures covering safety (part I-A) and pollution prevention (part II-A) and recommendatory provisions for both (parts I-B and II-B).

Section 11.3.6 of Chapter 11 on Voyage Planning includes the requirement that in considering routes through polar waters, masters shall take into account: 'current information and measures to be taken when marine mammals are encountered relating to known areas with densities of marine mammals, including seasonal migration areas' and 'current information on relevant ships' routing systems, speed recommendations and vessel traffic services relating to known areas with densities of marine mammals, including seasonal migration areas' These requirements are linked by footnote to a 2009 Guidance Document For Minimising The Risk Of Ship Strikes With Cetaceans (MEPC.1/Circ.674) which is 'to provide guidance to Member Governments in reducing and minimising the risk of ship strikes of cetaceans.' The document sets forth important general principles that should be taken into account and possible actions that may be taken to reduce such risk.

Note 1
The IWC SC may wish to discuss the possibility of providing advice to the IMO on areas within polar waters of 'known densities of marine mammals, including seasonal migration areas'; this discussion could be initiated in the HIM WG, to focus on ship strike mitigation, with issues related to shipping noise discussed in E.

Note 2
Bering Strait Port Access Route Study (PARS), Appendix D – Environmental Analysis and ATBA's (areas to be avoided); lists series of maps that illustrate wildlife use patterns for the Bering Sea region[12].

Note 3
The CAFF - State of the Arctic Marine Biodiversity Report (SAMBR) will provide broad-scale figures on marine mammal species richness and status in eight *Arctic Marine Areas* considered by the Circumpolar Biodiversity Monitoring Program (CBMP).

Note 4
See presentation on marine mammals (focused on Cetaceans) entitled, 'Approaches and considerations for understanding connectivity for marine mammals using various techniques,' at The Arctic Council's Protection of the Marine Environment's Workshop 'Science and Tools for Developing Arctic Marine Protected Area (MPA) Networks: Understanding Connectivity and Identifying Management Models,' Washington DC[13].

Note 5
An Arctic Waterways Safety Committee, aims to 'bring together local marine interests in the Alaskan Arctic in a single forum, and to act collectively on behalf of those interests to develop best practices to ensure a safe, efficient, and predictable operating environment for all current and future users of the waterways'[14].

Priority Topic 3. Work with Secretariat and SC members to identify colleagues active in Arctic Council and IUCN to develop common standards for pan-Arctic monitoring of Arctic-endemic cetacean populations
Arctic Council-CAFF WG (http://www.caff.is/): Circumpolar Biodiversity Monitoring Program (CBMP)-Marine Expert Networks
Each CBMP Marine Expert Network has provided contextually-important advice for its area of expertise

[12] *https://www.uscg.mil/hq/cg5/cg553/NAVStandards/PARS.asp.*
[13] *http://pame.is/index.php/projects/marine-protected-areas/mpa-Workshop-september-2016.*
[14] *http://www.arcticwaterways.org/home.html.*

to help Arctic biodiversity monitoring programs deliver policy-relevant information and provide robust advice. The Marine Mammal Expert Network (MMEN) has worked over several years to identify comparable monitoring parameters for marine mammal distribution, abundance and trends in the Arctic. This work is reflected in the Arctic Biodiversity assessment and Laidre *et al.* (2015) and now the forthcoming 2017 SAMBR report which has updated the ABA tables and included basic information on marine mammal harvest across the Arctic. The CBMP MMEN includes several current (and past) members of the Scientific Committee.

Future work of the MMEN will focus on integrating additional parameters into arctic-wide monitoring programs such as on health, passive acoustics, habitat changes, and telemetry tracking studies, while continuing to keep those parameters already incorporated into the database supporting the ABA and SAMBR up-to-date. [The MMEN also plays a role in implementing existing international monitoring plans for arctic pinnipeds and the polar bear.]

CAFF - State of the Arctic Marine Biodiversity Report (SAMBR)

Drawing on members of CAFF's Marine Expert Networks, the final SAMBR report will be presented to the Arctic Council Ministerial for its approval on 11 May 2017 (there may be a link to it on day 4 of SC/67a). This report is the first integrated reporting outcome from the CBMP Marine Plan. Where possible, the SAMBR:

- describes current and/or historical baseline status of identified Focal Ecosystem Components [including beluga whales, narwhals and bowhead whales];
- evaluates historical and contemporary trends;
- considers how changes in biodiversity may be linked to stressors;
- describes differences that have occurred within the Arctic Marine Areas;
- describes status of Arctic biodiversity monitoring; and
- identifies research priorities, knowledge gaps; and provides advice for monitoring and management.

PAME and CAFF – Ecosystem Approach EA) to Management

See especially 'Roles for Arctic Council in EA Implementation section[15].

IUCN

- Cetacean Specialist Group[16].
- Joint SSC/WCPA Marine Mammal Protected Areas Task Force[17].
- Western Gray Whale Advisory Panel[18].
- Natural Marine World Heritage in the Arctic Ocean – describes seven areas in the Arctic Ocean that may be of Outstanding Universal Value (OUV).

NAMMCO

Global Review of Monodontids Workshop conducted in Hillerød, Denmark, 13-16 March 2017. Workshop report in production, to be available on NAMMCO website later in 2017[19].

Priority Topic 4. Contribute to the development of Arctic disaster response plans (e.g. EPPR)

Arctic Council-Emergency Prevention Preparedness and Response (EPPR) Working Group

The EPPR Field Guide for Oil Spill Response in Arctic Waters, originally published in 1998, is being updated. The new, re-organised guide, which will be available electronically in 2017, will have new or expanded chapters on Health and Human Safety, Logistics, and Wildlife. The EPPR has also created the Arctic Spill Response Database Query Tool and User Guide, both of which become available electronically in 2017. The User Guide will be augmented by a visualisation tool developed by NOAA's Office of Response and Restoration[20].

The Emergency Prevention, Preparedness and Response (EPPR) Work Plan (2015-17) outlines a series of further projects and deliverables in this arena[21].

Draft Arctic Marine Mammal Disaster Response Guidelines

NOAA Fisheries has developed draft guidelines for marine mammal response in northern Alaska, including the Bering Strait, Northwest Alaska, and the North Slope of Alaska. The purpose is to increase preparedness for wildlife response, as directed under the Oil Pollution Act of 1990.

REFERENCES

Breed, G.A., Matthews, C.J., Marcoux, M., Higdon, J.W., LeBlanc, B., Petersen, S.D., Orr, J., Reinhart, N. and Ferguson, S.H. 2017. Sustained disruption of narwhal habitat use and behavior in the presence of Arctic killer whales. *Proc. Natl. Acad. Sci. U.S.A.* 114(10): 2,628-33.

Citta, J.J., Richard, P., Lowry, L.F., O'Corry-Crowe, G., Marcoux, M., Suydam, R., Quakenbush, L.T., Hobbs, R.C., Litovka, D.I., Frost, K.J., Gray, T., Orr, J., Tinker, B., Aderman, H. and Druckenmiller, M.L. 2017. Satellite telemetry reveals population specific winter ranges of beluga whales in the Bering Sea. *Mar. Mamm. Sci.* 33: 236–50.

Clarke, J.T., Kennedy, A.S. and Ferguson, M.C. 2016. Bowhead and Gray Whale Distributions, Sighting Rates, and Habitat Associations in the Eastern Chukchi Sea, Summer and Fall 2009, 15, with a Retrospective Comparison to 1982–91. *Arctic* 69(4): 359-77.

Frouin-Mouy, H., Kowarski, K., Martin, B. and Bröker, K. 2017. Seasonal Trends in Acoustic Detection of Marine Mammals in Baffin Bay and Melville Bay, Northwest Greenland. *Arctic* 70(1): 59-76.

Haug, T., Bogstad, B., Chierici, M., Gjter, H., Hallfredsson, E.H., Hoslashines, A.S., Haringkon Hoel, A., Ingvaldsen, R.B., Lindal Jorgensen, L., Knutsen, T., Loeng, H., Naustvoll, L.J., Rottingen, I. and Sunnanring, K. 2017. Future harvest of living resources in the Arctic Ocean north of the Nordic and Barents Seas: A review of possibilities and constraints. *Fish. Res.* 188: 38-57.

Hauser, D.D.W., Laidre, K.L., Stern, H.L., Moore, S.E., Suydam, R.S. and Richard, P.R. 2017. Habitat selection by two beluga whale populations in the Chukchi and Beaufort seas. *PLoS ONE* 12(2): e0172755.

Kuznetsova, D.M., Glazov, D.M., Shpak, O.V. and Rozhnov, V.V. 2016. Winter distribution and migrations of beluga whales (*Delphinapterus leucas*) in the White Sea based on satellite tracking data. *Biol. Bull.* 43(8): 914-17.

Laidre, K.L., Stern, H., Kovacs, K.M., Lowry, L., Moore, S.E., Regehr, E.V., Ferguson, S.H., Wiig, Ø., Boveng, P., Angliss, R.P., Born, E.W., Litovka, D., Quakenbush, L., Lydersen, C., Vongraven, D. and Ugarte, F. 2015. Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. *Cons. Biol.* 2015: 15pp.

Lefebvre, K.A., Kendrick, P.S., Ladiges, W., Hiolski, E.M., Ferriss, B.E., Smith, D.R. and Marcinek, D.J. 2017. Chronic low-level exposure to the common seafood toxin domoic acid causes cognitive deficits in mice. *Harmful Algae* 64: 20-9.

Moore, S.E. 2016. Is it boom times for Baleen whales in the Pacific Arctic region? *Biol. Lett.* 12: 20160251.

Vacquié-Garcia, J., Lydersen, C., Marques, T.A., Aars, J., Ahonen, H., Skern-Mauritzen, M., Øien, N. and Kovacs, K.M. 2017. Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endang. Spec. Res.* 32: 59-70.

[15]*http://www.pame.is/index.php/projects/ecosystem-approach.*
[16]*http://www.iucn-csg.org/.*
[17]*https://www.iucn.org/theme/protected-areas/wcpa/what-we-do/marine-mammal-protected-areas.*
[18]*https://www.iucn.org/western-gray-whale-advisory-panel.*
[19]*http://nammco.wpengine.com/topics/global-review-of-monodontids/.*
[20]*http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html.*
[21]*http://arctic-council.org/eppr/wp-content/uploads/2010/04/EPPR_Work_Plan_2015-2017.pdf.*

Appendix 5

STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2017

Editors: M. Stachowitsch*, N.A. Rose¥ and E.C.M. Parsons+

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 (IWC, 2001) welcomed the concept of the State of the Cetacean Environment Report (SOCER) and requested the annual submission of this report to the Commission. The first full SOCER (Stachowitsch *et al.*, 2003) was submitted in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Mediterranean and Black Seas, Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2017 SOCER focuses on the **Indian Ocean,** summarising key papers and articles published from *ca* 2015 through 2017 to date.

INDIAN OCEAN

General

FIRST CONFIRMED FIELD OBSERVATIONS ON NEWLY DESCRIBED OMURA'S WHALE AND HABITAT IMPLICATIONS

The status of the cetacean environment is particularly important in populations restricted to particular habitats. Omura's whale in northwest Madagascar may be such a small, resident and isolated (sub-) population with low genetic diversity. The range of the species is exclusively restricted to tropical waters, which is rare among baleen whales: it is probably non-migratory, showing no segregation of feeding and breeding habitat. This paper extends its known range into the western Indian Ocean. The authors consider that the ongoing and planned future expansion of hydrocarbon exploration and production within its documented range off Madagascar is a significant conservation concern. Two MPAs (Ankivonjy and Ankarea) that partially overlap this (sub-) population's habitat received permanent status in 2015, offering some protection within relatively small core areas where oil industry activities are restricted. The authors argue for the inclusion of Omura's whales off the northwest coast of Madagascar on the IUCN Red List.

(SOURCE: Cerchio, S., Andrianantenaina, B., Lindsay, A., Rekdahl, M., Andrianarivelo, N., and Rasoloarijao, T. 2015. Omura's whales (*Balaenoptera omurai*) off northwest Madagascar: ecology, behaviour and conservation needs. *R. Soc. Open Sci.* 2: 150301. *http://dx.doi.org/10.1098/rsos.150301*).

THE STATE OF THE ARABIAN GULF: KUWAIT AS A CASE STUDY

The waters of Kuwait are threatened by local and more distant anthropogenic impacts. The latter include upstream dam construction, which has increased the salinity from 36 ppt in 1981 to 44 ppt in recent years. This decline in the environmental status of the region is reflected in an over 70% loss of historic reefs across the Gulf, with an additional 27% near critical stages. Kuwaiti waters are experiencing significant decreases in major commercial fish and crustacean species due to overfishing and severe deficiencies in sewage treatment. The authors conclude by stating that 'the threats to the coastal and marine environments of Kuwait, and the wider Gulf, are both evident and increasing, and the status of many aspects of the region's unique biodiversity are at record low levels'.

(SOURCES: Devlin, M.J., Le Quesne, W.L.F., and Lyons, B.P. 2015. Editorial: The marine environment of Kuwait—emerging issues in a rapidly changing environment. *Mar. Pollut. Bull.* 100: 593-596; Sheppard, C. 2015. Coral reefs in the Gulf are mostly dead now, but can we do anything about it? *Mar. Pollut. Bull. http://dx.doi.org/10.1016/J.marpolbul.2015.09.031*).

PAN-INDIAN OCEAN COOPERATION SOUGHT ON SUSTAINABLE WHALEWATCHING

The IWC, in cooperation with the Indian Ocean Rim Association (IORA) and supported by Australia, met in February 2016 to discuss a region-wide whalewatching tourism network. Representatives of 15 nations in the Indian Ocean region attended and several recommendations were made. The IWC's 5 Year Whalewatching Strategy, combined with the upcoming online 'Whalewatching Guidelines', will provide the Indian Ocean rim (and other regions) with a best-practice framework and tools to develop an industry that promotes economic growth and benefits the marine environment.

(SOURCE: *https://iwc.int/sustainable-whalewatching-on-the-agenda-in-the-ind*).

FIRST GLOBAL INTEGRATED MARINE ASSESSMENT: INDIAN OCEAN

This major overview of the world's oceans by the United Nations found that the Indian Ocean region contains 31 species of marine mammals. The authors point to numerous threats, such as bycatch (in gillnets, seine nets, beach seines and drift nets), habitat degradation and loss, and pollution, including marine debris. The report tends to underline a lack of information. Accordingly, it identifies five research gaps related to marine mammals: (a) the need to train and equip local scientists; (b) coordinated long-term monitoring; and (c) genetic studies. The final two gaps pertain specifically to whales: (d) analyses of the biology and ecology of whales; and (e) impacts of fishing on whales.

(SOURCE: Inniss, L. and Simcock, A. (Joint coordinators); Rice, J. (Lead member of 12 contributors). 2016. The first global integrated marine assessment: World ocean assessment I. *United Nations, Chapter 36E:* 28pp. *http://www.un.org/Depts/los/woa*).

IMPORTANT ONGOING WORK ON THREATS TO CETACEANS IN THE ARABIAN SEA

The Arabian Sea Whale Network (ASWN) has been working on recommendations made by the IWC's Scientific Committee (Committee). A satellite tracking survey revealed whales ranging along a 1,150km corridor along the southern coast of Oman and northern Yemen, with a hotspot in the Gulf of Masirah, a habitat that overlaps with emerging industrial activity. Of particular concern are humpback whales; mitigation initiatives are being taken by the port of Duqm (Oman), which 'will have strong bearing on other port developments in the Arabian Sea'. Container ships (3-fold increase in traffic from 2004-14) are considered to pose the highest risk to whales, indicating a need for immediate risk

*Department of Limnology and Bio-Oceanography, Faculty of Life Sciences, University of Vienna, Austria.
¥Animal Welfare Institute, Washington, DC, USA.
+University Marine Biological Station Millport (University of London), Great Cumbrae, Scotland and Department of Environmental Science and Policy, George Mason University, Fairfax, Virginia, USA.

assessment work (i.e., addressing humpback whales and ship occurrence in Oman) and a wider assessment to determine priority areas for study. At SC/66b, the Committee reiterated its serious concern about the status of this population and noted that progress toward developing a Conservation Management Plan for Endangered Arabian Sea Humpback Whales had stalled, pending endorsement from range states.

(SOURCES: Willson, A., Baldwin, R., Cerchio, S., Collins, T., Findlay, K., Gray, H., Godley, B.J., Al-Harthi, S., Kennedy, A., Minton, G., Sucunza, F., Zerbini, A., and Witt, M.J. 2016. Research update on satellite tagging studies of the Arabian Sea humpback whales in the Sultanate of Oman. Paper presented to the Scientific Committee of the IWC, SC/66b/SH28, *J. Cetacean Res. Manage.* 18 (Suppl.), p.41; *Arabian Sea Whale Network Newsletter.* 2016. Paper presented to the Scientific Committee of the IWC, SC/66b/SH12; Willson, A., Kowalik, J., Godley, B.J., Baldwin, R., Struck, A., Nawaz, R., Witt, M.J. Priorities for addressing whale and ship co-occurrence off the coast of Oman and the wider North Indian Ocean. 2016. Paper presented to the Scientific Committee of the IWC, SC/66b/HIM10).

OCEAN HEALTH INDEX RATES INDIAN OCEAN

The Ocean Health Index, compiled by the University of California at Santa Barbara, has released its third annual update. It is based on 10 ecological, economic and societal categories or 'goals', each of which is measured and scored based on four dimensions: status, trend, pressures, and resilience. For the high seas (i.e., beyond national jurisdictions), the western Indian Ocean receives a good overall score (79 out of 100), which ranks it first out of 15 FAO major fishing areas. This value is high compared to the overall health of the earth's oceans (69 out of 100). The eastern Indian Ocean, however, receives a score of only 55, which ranks it very low, namely number 13 among these 15 fishing areas. On a country and EEZ basis, the overall Ocean Health Index score ranks India at 130 of 221 EEZs (score 66), Pakistan 208 (score 51), Indonesia 145 (score 65), Madagascar 162 (score 62), Seychelles 7 (score 85), and Maldives 33 (score 77).

(SOURCES: *http://www.oceanhealthindex.org; http://www.oceanhealthindex.org/region-scores/high-seas:-indian-ocean-western; http://www.oceanhealthindex.org/region-scores/high-seas:-indian-ocean-eastern*).

Habitat degradation

General

GANGES RIVER DOLPHINS POTENTIALLY THREATENED BY WATERWAY PLANS IN INDIA

South Asian or Ganges river dolphins face an additional, serious threat (beyond bycatch and altered and declining river flows) involving a plan under the National Waterways Act, 2016, to convert 111 river reaches into waterways for inland navigation and goods transport. Moreover, the Indus subspecies in Pakistan is also under potential threat from a recently proposed commercial waterway on the Indus River. The IWC's Scientific Committee (Committee) expressed serious concern at SC/66b for the survival of river dolphins in India given this new information. It agreed that the situation facing South Asian river dolphins is a matter of grave concern and requires immediate attention. Accordingly, the Ganges and other river dolphins will be considered as a potential priority topic at a future meeting.

(SOURCE: IWC/66/17. 2016. Short overview of the work of the Scientific Committee at its 2015 and 2016 Annual Meetings).

ENDANGERED GANGES RIVER DOLPHIN IN INDIA: MULTIPLE THREATS

The Ganges River dolphin is one of the most endangered cetaceans in the world and the second rarest freshwater dolphin (<2,000 individuals in Nepal, India and Bangladesh). An assessment was done on the various threats facing these dolphins in the Kulsi River, a tributary of the Brahmaputra in Assam, India. Less than 30 dolphins are estimated to remain in the river system. Numerous potential threats were identified and site visits conducted at various parts of the river system to assess whether and where these threats occurred. Directly observed threats included: river bank erosion, receding water levels, fishery bycatch, sand mining, overfishing and pesticide use in riparian areas and boat traffic. Other potential threats to the dolphins included dams and barrages, invasive species, siltation of habitat and poaching. The researchers concluded that the 'need of the hour now is to come up with a conservation plan to stop or at least decrease the magnitude of the effects of these threats'.

(SOURCE: Jelil, S.N. 2015. Conservation threats of the Gangetic dolphin *Platanista gangetica gangetica* in River Kulsi, a tributary of Brahmaputra, Assam, India. *NE J. Contemp. Res.* 2: 6-11).

ENDANGERED GANGES RIVER DOLPHIN IN NEPAL: MULTIPLE THREATS

Only an estimated 37-42 Ganges river dolphins inhabit the rivers of Nepal. Deep pools best predicted dolphin use in three river systems examined (Karnali, Sapta Koshi, Narayani). These pools are river and season specific, so that the authors 'strongly recommend site and season-specific conservation actions'. In one of these three rivers (Karnali), a major natural flood in 2010 caused the river channel to shift from a protected area (restricted fishing) to an unprotected area. In response to this shift, the dolphins moved to the unprotected area, which the authors refer to as an 'ecological trap'. This is because irrigation demands affect water depth: fishing posed a threat when water levels dropped but not in deeper water. The dolphin distribution here shifted downstream, and the population declined from 11 in 2012 to 6 in 2015. To avoid extinction, the authors call on the Government of Nepal to 'prioritise ecologically adequate river flow regimes for implementing efficient irrigation schemes and adaptive fisheries regulations in the Karnali basin'. Nepalese fishermen recognised that fisheries posed a risk but believed water pollution and dam/irrigation developments were the greatest threats. This situation underlines that human activities can compound habitat-related problems after unforeseen natural events have already put pressure on a cetacean population.

(SOURCES: Paudel, S., Levesque, J.C., Saavedra, C., Pita, C., Pal, P. 2016. Characterisation of the artisanal fishing communities in Nepal and potential implications for the conservation and management of Ganges River Dolphin (*Platanista gangetica gangetica*). *PeerJ 4:e1563;* doi: 10.7717/peerj.1563; Paudel, S., Pal, P., Cove, M.V., Jnawali S.R., Abel, G., Koprowski, J.L., and Ranabhat, R. 2015. The Endangered Ganges River dolphin *Platanista gangetica gangetica* in Nepal: abundance, habitat and conservation threats. *Endang Species Res* 29: 59-68; Khanal, G., Suryawanshi, K.R., Awasthi, K.D., Dhakal, M., Subedi. N., Nath, D., Kandel, R.C., and Kelkar, N. 2016. Irrigation demands aggravate fishing threats to river dolphins in Nepal 2016. *Biol. Conserv.* 204: 386-393).

Fisheries interactions

CETACEAN BYCATCH IN TUNA FISHERIES IN WESTERN AND CENTRAL INDIAN OCEAN

The average annual catch of tuna from the western and central Indian Ocean is 1.1 million tons, mainly involving gillnets (40%), purse seine (26%), longline (12%), handline and troll (11%) and pole-and-line (9%). The major gillnet fishing nations include Iran, India, Sri Lanka, Oman and Yemen, with an estimated 60,000 small cetaceans taken as bycatch each year. Although large-scale gill-netting (> 2.5 km length) is banned by UN convention and IOTC resolution, it continues to be 'carried out by Iran, Pakistan and possibly also other countries'. Purse seining is dominated by French and Spanish fleets. This has previously involved setting on cetaceans (baleen whales and mostly spotted dolphins and spinner dolphins), which has recently been banned by EU regulation (2007) and IOTC (2013). The author concludes by noting that there has been 'a widespread failure to monitor and manage cetacean bycatch in Indian Ocean tuna fisheries, and to develop and implement mitigation measures'. The 'enormous, and still growing, gillnet capacity in the region should be of particular concern'.

(SOURCE: Anderson, R.C. 2014. *Cetaceans and Tuna Fisheries in the Western and Central Indian Ocean*. IPNLF Technical Report 2, International Pole and Line Foundation, London. 133 pages).

SUGGESTIONS TO REDUCE DOLPHIN ENTANGLEMENT IN SHARK NETS

Gillnets are used on South African beaches to protect human bathers from sharks, but also take a substantive toll on cetaceans through bycatch. Researchers investigated factors that might affect bycatch of Indian Ocean humpback dolphins in Richards Bay, South Africa. Using photo-identification, they found dolphins have a low level of residency but long-term site fidelity, with dolphins paying short, but repeated, visits to the bay, before moving on. The researchers suggested that Richards Bay is important habitat for the dolphins. However, at least 8% of catalogued individuals were found in shark nets, while most bycaught dolphins in Richards Bay were uncatalogued adolescents. There was a notably higher proportion of entangled males than females. Results indicated lower familiarity with nets did not increase bycatch rates. The researchers suggested bycatch might be reduced by removing nets/closing beaches to swimmers in the winter, reducing the number of nets, adding pingers to the nets, or introducing bait and hooks to catch sharks in the bay. Non-lethal suggestions to reduce shark presence included chemical or electrical deterrents and/or observers who can warn bathers about shark presence. The authors concluded that 'bycatch of Indian Ocean humpback dolphins in shark nets at Richards Bay may be negatively affecting the wider population, and continued efforts to mitigate the loss are vital'.

(SOURCE: Atkins, S., Cantor, M., Pillay, N., Cliff, G., Keith, M., and Parra, G. 2016. Net loss of endangered humpback dolphins: integrating residency, site fidelity, and bycatch in shark nets. *Mar. Ecol. Prog. Ser.* 555: 249-260).

BYCATCH IN THE TUNA GILLNET FISHERIES OF PAKISTAN

The ca. 700 gillnet vessels operating off Pakistan incidentally capture a large number of sharks, sea turtles and cetaceans. During the 2013-2015 period, four gillnet vessels reported 208 dolphins and whales as bycatch. A total of 10,150 dolphins were reported killed in tuna gillnet operations in 2014. Along the entire coast of Pakistan in 2015, 17,200 dolphins were killed. The most common bycatch species were Indo-Pacific bottlenose dolphins, common bottlenose dolphins, and spinner dolphins. During a 4-year period since the WWF-Pakistan observer program was initiated, entangled dolphins were successfully released on only three occasions. Whale entanglements were very rare (six species in four years). The authors state that 'High catches of protected species, including cetaceans, sharks and marine turtles, poses serious threats to sustainability of the oceans'. In 2016, the Governments of Sindh and Balochistan enacted laws for the protection of these species. WWF-Pakistan has initiated a program for safe release of entangled animals that has so far released 32 whale sharks, 14 mobulids, one beaked whale, one guitarfish, two bottlenose dolphins and thousands of sea turtles.

(SOURCES: Sharid, U., Khan, M.M., Nawaz, R., Razzaq, S.A., and Ayub, S. 2016. Bycatch analysis of tuna gillnet fisheries of Pakistan: An analysis of bycatch data from 2013-2016. World Wide Fund for Nature, Karachi, Pakistan, Report for IOTC Meeting; Nawaz, R. and Moazzam, M. 2014. An assessment of cetacean mortality in the tuna fisheries of Pakistan. *IOTC-2014-WPEB 10-INF25*).

DOLPHIN ENTANGLEMENT RISK IN BAY OF BENGAL, BANGLADESH, AND NEW MPA

A survey in the Bay of Bengal, Bangladesh, revealed that 28% of photo-identified Indo-Pacific bottlenose and 15% of Indo-Pacific humpback dolphins exhibited injuries related to entanglements with fishing gear. The authors state that this 'implies a strong potential for fatal interactions that could jeopardise the conservation status of both dolphin populations which otherwise appear favorable'. Ninety gillnetting trips between 2013 and 2015, in the framework of an initiative to protect small coastal cetaceans and to improve safety at sea, documented one fatal entanglement of a humpback dolphin and two fatal entanglements of Indo-Pacific bottlenose dolphins. A new MPA (Swatch of No-Ground: SoNG), covering 1,738km² and ranging from a submarine canyon to coastal waters offshore of the Sundabarans mangrove forest, was signed into law in 2014. It provides priority habitats for these two species, as well as other cetaceans at conservation risk, and was designed more generally 'to safeguard dolphins, whales, sea turtles, sharks, and other oceanic species'.

(SOURCE: Smith, B.D., Mansur, R., Strindberg, S., Redfern, J., and Moore, T. 2015. Population demographics, habitat selection, and spatial and photographic analysis of bycatch risk of Indo-Pacific humpback dolphins *Sousa chinensis* and bottlenose dolphins *Tursiops aduncus* in the northern Bay of Bengal, Bangladesh. 2015. Paper presented to the Scientific Committee of the Int Whal Commn, SC/66a/SM19).

Marine debris

MARINE DEBRIS ON REMOTE INDIAN OCEAN ISLANDS

A 1km stretch of beach on remote Alphonse Island in the western Indian Ocean yielded 4,763 items weighing 142kg. Most of the items had land origins thousands of kilometres away. Surface current models pointed to South East Asia, Somalia, India/Sri Lanka and potentially Madagascar as sources. The authors identified inadequate waste management as the cause. A second study found a daily mean abundance of 35 plastic particles per m² on a small coral island used only for research and environmental education. Although the values were generally lower than on highly contaminated beaches in Mumbai (10-180 particles/m²), the abundance on such a remote island 'is a worrying sign for the global distribution of plastic debris'. The values would probably have been much higher if particles < 1 mm had been considered. The authors believe the sources could be nearby inhabited islands, tourist islands within the atoll, or debris blown into the sea from 'garbage islands' used for landfilling.

(SOURCE: Duhec, A.V., Jeanne, R.F., Maximenko, N., and Hafner, J. 2015. Composition and potential origin of marine debris stranded in the Western Indian Ocean on remote Alphonse Island, Seychelles. *Mar. Pollut. Bull.* 96: 76-86; Imhof, H.K., Sigl, R., Brauer, E., Feyl, S., Giesemann, P., Klink, S., Leupolz, K. Löder, M.G.J., *et al.* 2017. Spatial and temporal variation of macro-, meso- and microplastic abundance on a remote coral island of the Maldives, Indian Ocean. *Mar. Pollut. Bull.* 116: 340-347).

INDIAN OCEAN GYRE MAY HAVE GREATEST MARINE DEBRIS LOAD IN THE SOUTHERN HEMISPHERE

In a modelling-based effort, the amount of floating plastic in the five subtropical gyres was estimated at 5 trillion pieces, or 264,000 tons. Unexpectedly, the southern hemisphere showed values as high as those in the northern hemisphere, where inputs are considered to be substantially larger. The Indian Ocean contains one of these gyres and, within the Southern Hemisphere, it showed a greater particle count and weight of plastic debris than the South Atlantic and South Pacific Oceans combined. The authors attributed this to a possible between-hemisphere redistribution of wastes, as well as previously unaccounted-for pollution sources such as the Bay of Bengal. The authors underlined that the values they presented were minimum estimates, considering only known inputs into the sea: floating material makes up only a fraction of this material, with the location of the remainder largely unknown, but including 'on shorelines, on the seabed, suspended in the water column, and within organisms'.

(SOURCE: Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryba, P.G., and Reissner, J. 2014. Plastic pollution in the world's oceans: More than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. *PLoS ONE* 9(12): e111913. doi.org/10.1371/journal.pone.0111913).

PLASTIC DEBRIS IN THE PERSIAN GULF

This first assessment of microplastics in the Persian Gulf (Arabian Sea), which is biologically part of the northwest Indian Ocean, found levels in the range of several European sites. The microplastic levels (highest value: 1,258 particles/kg) reflected the relative proximity to industrial and urban activities. The likely sources include beach debris, discarded fishing gear, and urban and industrial outflows. Fibres were the most common microplastic type identified, followed by films and fragments. A second study, conducted near the Iranian city of Bandar Abbas, northern Persian Gulf, attributed the larger marine debris items found on beaches primarily to tourism and recreational activities. Both large plastic items and microplastics have been shown to impact ecosystem health, as well as the health of cetaceans, with the problem being clearly as prevalent in the Persian Gulf as in other oceans.

(SOURCES: Naji, A., Esmaili, Z. and Khan, F.R. 2017. Plastic debris and microplastics along beaches of the Strait of Hormuz, Persian Gulf. *Mar. Pollut. Bull.* 114: 1057-1062; Sarafraz, J., Rajabizadeh, M. and Kamrani, E. 2016. The preliminary assessment of abundance and composition of marine beach debris in the northern Persian Gulf, Bandar Abbas City. *J. Mar. Biol. Assoc UK* 96: 131-135).

Ship strikes

BLUE WHALE SHIP STRIKES OFF SRI LANKA: AN AVERTABLE PROBLEM

The southern coast of Sri Lanka hosts high densities of endangered blue whales and is also one of the world's busiest shipping lanes. This overlap means a high risk of ship strikes, and numerous stranded animals with injuries attributable to ship collisions (e.g. blunt force trauma, propeller wounds) have been recorded. The reliable predictability of the distribution of northern Indian Ocean blue whales, even in such a data-poor ecosystem, suggests that shifting the current Traffic Separation Scheme only 15n.miles further offshore would reduce the risk by 95%. The Committee agreed that 'the combined results of these studies is sufficiently consistent to support a proposal to IMO to move the shipping lanes should Sri Lanka so wish'.

(SOURCES: Redfern, J.V., Moore, T.J., Fiedler, P.C., de Vos, A., Brownell Jr., R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions on data-poor marine ecosystems. *Divers. Distrib.* 1-15, doi: 10.1111/ddi.12537; Priyadarshana, T., Randage, S.M., Alling, A., Calderan, S., Gordon, J. Leaper, R. and Porter, L. 2016. Distribution patterns of blue whale (*Balaenoptera musculus*) and shipping off southern Sri Lanka. *Reg. Stud. Mar. Sci.* 3: 181-188; IWC. 2016. *J. Cetacean Res. Manage 18 (Suppl.)* p. 19).

Chemical pollution

HEAVY METAL CONTAMINATION IN NORTHERN PART OF PERSIAN GULF

The concentrations of the heavy metals Cu, Zn, Pb and Cd in the coastal sediments of the Hormuz Strait, northern Persian Gulf, were higher than in other coastal sediments. The values in mullet were so high that human consumption 'should be of very high concern for public health'. Due to bioaccumulation, the high values in the sediment and in fish point to potentially even higher values in species further up the food chain, such as cetaceans.

(SOURCE: Bastami, K.D., Afkhami, M., Mohammadizadeh, M., Ehsanpour, M., Chambari, S., Aghaei, S., Esmaeilzadeh, M., Neyestani, M.R., Lagzaee, F., and Baniaman, M. 2015. Bioaccumulation and ecological risk assessment of heavy metals in the sediments and mullet *Liza klunzingeri* in the northern part of the Persian Gulf. *Mar. Pollut. Bull.* 94: 329-334).

FEEDING AREA IN ANTARCTIC WATERS DETERMINES POLLUTANT LEVELS IN HUMPBACK WHALES BREEDING IN INDIAN OCEAN

There are four humpback whale stocks breeding in the Indian Ocean and feeding in Antarctic waters. In one of these (Réunion Island; C/C4), HCB and DDTs predominated amongst the seven POPs in the whales, with DDE being the major organohalogenated pollutant. This reflects its long-term accumulation in humpback whales. DDE is the most persistent metabolite of DDT and bioaccumulates in Antarctic krill. The Antarctic environment still receives DDE input. The sources are redistribution of previously deposited DDT in soil and snow/ice and ongoing DDT use in parts of the southern hemisphere. Based on blubber contaminant levels, gender and seasonal differences, the authors concluded that there are significant differences in feeding ground exposure. This is in agreement with data from other Antarctic aquatic species such as krill, fish and penguins. It underlines the importance of individually examining whale stocks and their habitats (in the present case mainly Area III, one of six putative feeding areas around the Antarctic) to determine potential exposure and cetacean health threats.

(SOURCE: Das, K., Malarvannan, G., Dirtu, A., Dulau, V., Dumont, M., Lepoint, G., Mongin, P., and Covaci, A. 2017. Linking pollutant exposure of humpback whales breeding in the Indian Ocean to their feeding habits and feeding areas off Antarctica. *Environ. Poll.* 220: 1090-1099, *http://dx.doi.org/10.1016/j.envpol.2016.11.032*).

SLIGHT HABITAT DIFFERENCES DETERMINE POLLUTANT LEVELS IN SYMPATRIC DOLPHINS IN THE INDIAN OCEAN

At least 10 cetacean species are regularly observed in the waters off La Réunion in the southwest tropical Indian Ocean. Spinner and Indo-Pacific bottlenose dolphins are the most common species, found year-round. Despite their spatial and temporal overlap, the two species are differently exposed to contaminants. For PCBs, HCHs and T-Hg, concentrations were significantly higher in the more coastal bottlenose than in the spinners. MeO-PBDEs (reportedly of natural origin) were the dominant compounds (55% of the total POPs) in spinners, while PCBs dominated (50% contribution) in bottlenose. The authors attributed this to dietary and foraging habitat preferences (more coastal vs more offshore). Other contaminants showed similar profiles for the two species. The levels of each contaminant class were significantly higher in males than females. Interestingly, the higher T-Hg concentrations in the coastal dolphins reflect the volcanic activity of La Réunion, not anthropogenic sources. Again, this underlines the importance of individually examining species regarding feeding area, dietary preferences, gender, potential tissue-related differences, and natural versus anthropogenic contaminant sources to help determine the state of the cetacean environment as it pertains to specific populations.

(SOURCE: Dirtu, A.C., Malarvannan, G., Das, K., Dulau-Drouot, V., Kiszka, J.J., Lepoint, G., Mongin, P., and Covaci, A. 2016. Contrasted accumulation patterns of persistent organic pollutants and mercury in sympatric tropical dolphins from the south-western Indian Ocean. *Environ. Res.* 146: 263-273, *http://dx.doi.org/10.1016/j.envres.2016.01.006*).

PESTICIDE RELEASE CONTINUES TO BE AN ISSUE IN THE INDIAN OCEAN

In India, an estimated 380,000 tons of pesticides and other halogenated hydrocarbons are used each year (DDT: 107,000 tons). The corresponding values in Pakistan are

11,000 tons, Bangladesh 3,000 tons, and Sri Lanka 28,000 tons. A large proportion of pesticides reaches the sea via the atmosphere and rivers in India. This study found that the values detected in an estuarine creek entering the sea in Mumbai exceeded several international guidelines. The authors called for sensitising and educating end users on the appropriate management of pesticides. DDT and other OCPs are persistent in the environment and accumulate along the food chain, affecting long-lived predators such as cetaceans.

(SOURCE: Rekadwad, B.N. and Khobragade, C.N. 2015. A case study on effects of oil spills and tar-ball pollution on beaches of Goa (India). *Mar. Pollut. Bull.* 100: 567-570).

Disease and mortality events

UPDATE ON RECENT WHALE STRANDINGS ALONG THE WEST COAST OF INDIA

Along the west coast of India from 2015-16, a total of 11 baleen whales stranded, including two blue whales (one of which was rescued) and two (possibly three) Bryde's whales. The dead blue whale was emaciated and had one large and several smaller wounds. The authors emphasised 'the importance of seafaring communities in providing secondary data on whale sightings'. In 2016, awareness material, including identification guides for stranded animals, was developed and widely disseminated. An earlier report covering three states of the west coast of India during the period 2000-15 documented 19 stranded Bryde's and blue whales.

(SOURCES: Sutaria, D., Sule, M., Jog, K., Bopardikar, I., Panicker, D., and Jamalabad, A. 2016. Baleen whale records from the Arabian Sea, India from June 2015 to May 2016. Paper presented to the Scientific Committee of the IWC, SC/66b/SH34; Sutaria, D., Sule, M., Bopardikar, I., and Panicker, D. 2015. Recent baleen whale records from the Arabian Sea, India. Paper presented to the Scientific Committee of the IWC, SC/66a/SH17).

Harmful Algal Blooms (HABs)

HARMFUL ALGAL BLOOMS, LOW OXYGEN AND FISH KILLS AN ISSUE IN THE NORTHWEST INDIAN OCEAN

In the last decade, previously unreported phytoplankton (dinoflagellate) species have become the dominant agents causing harmful algal blooms (HABs) in the Sea of Oman. Beyond being directly toxic to marine life, such blooms have an impact on the marine ecosystem through the interplay between bloom degradation, oxygen depletion and fish kills. From 1976 to 2009, 81 HAB events were recorded in the Sea of Oman, of which 10 caused fish kills. There was a significant correlation between oxygen depletion, algal blooms and fish kills from 1988-2011. Warming of surface waters by 1.2°C in the last 50 years has resulted in increased stratification, exacerbating this problem. The authors argued that a better understanding of this phenomenon is important because Oman plans to increase its coastal aquaculture industry, which could both contribute to the problem by releasing nutrients into the sea, while at the same time suffering from the blooms and their effects. Beyond causing general deterioration of the marine environment, HABs have been implicated in mass mortalities of cetacean species.

(SOURCE: Harrison, P.J., Piontkovski, S. and Al-Hashmi, K. 2017. Understanding how physical-biological coupling influences harmful algal blooms, low oxygen and fish kills in the Sea of Oman and the Western Arabian Sea. *Mar. Pollut. Bull.* 114: 25-34).

RETHINKING AQUACULTURE IN THE INDIAN OCEAN

A global alliance has been created to develop novel solutions for environmental problems related to aquaculture in the Indian Ocean. Launched by Australia's Department of Foreign Affairs and Trade, in cooperation with the World Wildlife Fund and others, the global alliance seeks to rethink the future of aquaculture in the region. The focus will be on the feeds being used, aquaculture system redesigns and creating new ocean products to achieve a 'Blue Revolution'. Aquaculture can harm the marine environment by damaging or removing habitats (e.g., mangrove forests), introducing or spreading invasive species and pathogens, and polluting surrounding ecosystems, especially with nutrients (eutrophication). Beyond directly affecting the habitat of coastal cetaceans, the aquaculture industry produces nearly half of all the fish eaten worldwide, thus playing a role in determining the status of food chains in the marine environment in general.

(SOURCE: NEWS. 2016. *Mar. Pollut. Bull.* 106: 5-6).

Oil spills

OIL SPILLS AND TAR-BALL POLLUTION AN ONGOING PROBLEM IN THE STATE OF GOA (INDIA)

Goa comprises about 105km of India's total coastline length of 8,100km. The marine ecosystem here is stressed by, *inter alia*, overfishing, destructive fishing practices and contaminants. In addition, large amounts of tar are deposited here every month by high tides and from June to October during monsoon season, posing a problem for the marine environment and for the tourism-based economy. This pollution reflects leakages and oil tanker washes, i.e., normal ship operations, rather than oil tanker accidents. Cetaceans can be affected by continuous contact with floating oil when surfacing to breathe, by the chemical composition of oil components in the water and by consuming contaminated prey.

(SOURCE: Singare, P.U. 2015. Persistent organic pesticide residues in sediments of Vasai Creek near Mumbai: Assessment of sources and potential ecological risk. *Mar. Pollut. Bull.* 100: 464-475).

GLOBAL

Habitat degradation

Fisheries interactions

GHOST GEAR ENTANGLEMENT OF CETACEANS WORLDWIDE

This review examined 76 publications dating from 1997-2015 and reports on 5400 individuals of 40 different species being recorded as entangled. Marine mammals accounted for 70% of all cases, the most common taxon being cetaceans. Humpback whales were the most recorded species (670 entangled individuals), followed closely by North Atlantic right whales (648). One study reported that half of all humpback whales showed signs of prior entanglement, another that 83% of North Atlantic right whales from the east coast of the USA and Canada showed such evidence. Many observations involved scarred tails. Juvenile cetaceans are apparently most at risk of dying due to entanglement. The review specifically points to a deficit of information from the Indian Ocean (as well as Southern and Arctic Oceans).

(SOURCE: Stelfox, M., Hudgins, J. and Sweet, M. 2016. A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs. *Mar. Pollut. Bull.* 111: 6-17).

THE ENERGETIC COSTS OF ENTANGLEMENT CAUSE POPULATION-LEVEL IMPACTS

Entanglement in fishing gear causes significant drag and buoyancy effects on whales. It was estimated that the force on North Atlantic right whales exerted by gear entanglement, for 10 sets of gear investigated or removed from whales in US Atlantic coast waters, ranged from 11-275 Newtons. Entangled whales were tagged during disentanglement efforts to examine the effects of entanglement on swimming. Fluke strokes were significantly shorter and more variable in shape, and 'gliding' behaviour was less frequent. The amount of thrust the whales produced decreased and swimming was generally less efficient. After disentanglement, whales needed 1.2-1.8 times less power to swim. Researchers also compared the blubber thicknesses of entangled and normal

North Atlantic right whales and estimated that between entanglement and eventual death the whales will consume $7.4\times\ 0_{10}$ J-1.2×10^{11} J of energy. Whales have to expend 3.95×10^{9}-4.08×10^{10} J more energy to swim due to the drag from entangling gear. This extra expenditure of energy is roughly equivalent to a reproductive or migration event, in terms of its scale. The greater the drag, the higher the likelihood of mortality. Entanglement therefore inflicts a major energetic cost on right whales; even if the animal is disentangled, the energetic cost could, in females, lead to delay in, or failure of, reproduction. The researchers stated that '[r]ecovery from such physiological stress and disturbance may limit an individual's future reproductive success, making entanglement a potential contributor to fluctuations in population growth' (Van Der Hoop *et al.*, 2017c). They also stated that whale conservation efforts should focus not only on lethal impacts from anthropogenic activities, but also on sub-lethal effects, as energetic costs could lead to a reduction in health and certainly a reduction in, or even cessation of, reproduction, which ultimately could deplete populations.

(SOURCES: Van der Hoop, J., Corkeron, P., Henry, A.G., Knowlton, A.R. and Moore, M.J. 2017a. Predicting lethal entanglements as a consequence of drag from fishing gear. *Mar. Pollut. Bull.* 115: 91-104; Van der Hoop, J., Nowacek, D.P., Moore, M.J. and Triantafyllou, M.S. 2017b. Swimming kinematics and efficiency of entangled North Atlantic right whales. *Endang. Species Res.* 32: 1-17; Van der Hoop, J., Corkeron, P. and Moore, M. 2017c. Entanglement is a costly life-history stage in large whales. *Ecol. Evol.* 7: 92-106).

Marine debris

TIRE ABRASION AND SYNTHETIC CLOTHING IDENTIFIED AS MAJOR SOURCES OF MICROPLASTIC POLLUTION IN THE WORLD'S OCEANS

According to an IUCN report, tire particles and the fibres from clothing made of synthetic materials may contribute up to 31% of the 9.5 million tons of plastic that enter the ocean every year. Tire waste generated by abrasion during road use is the main source of primary microplastics in the Americas, Europe and Central Asia, with synthetic textile products as the main offenders in India and Southeast Asia. Microplastics can accumulate in the food web, have been found in most marine animals, including baleen whales, and pose a potential threat to human health.

(SOURCE: NEWS. 2017. *Mar. Pollut. Bull.* 117: 1).

Disease and mortality events

Harmful Algal Blooms (HABs)

HARMFUL ALGAL BLOOMS AND CLIMATE CHANGE: AN EMERGING ISSUE

Of the 4,000 known species of marine phytoplankton, about 300 have properties that make them harmful to humans (e.g. causing neurological disorders) and the marine environment (e.g. causing oxygen crises, fish kills). In a project sponsored by SCOR and IOC of UNESCO, experts are seeking to improve our understanding of, and promote cooperation/partnerships on, the issue of HABs and the role climate change may be playing. This project (GlobalHAB) will help coordinate research and promote communication between scientists and society. HABs have been identified as a threat to cetaceans by the Committee and are the topic of a pre-meeting at SC/67a.

(SOURCE: NEWS, 2016. *Mar. Pollut. Bull.* 106: 7).

Oil spills

DEEPWATER HORIZON (DWH) OIL SPILL: AN UPDATE

Several studies were published since 2016 on the impacts of the DWH oil spill. Dias *et al.* (2017) noted 11 cases where dolphins were seen swimming through oil, where oil adhered to their skins, the sheen often persisting for some time afterward. The researchers concluded that 'during oil spills in cetacean habitat, direct exposure of whales and dolphins to petroleum products will likely occur' because dolphins cannot detect - and thus cannot avoid - oil spills.

Colegrove *et al.* (2016) investigated perinatal mortality linked to spill exposure. Common bottlenose dolphins exposed to the spill were found to be significantly more likely to: die in the womb or very soon after birth; show signs of lung collapse; have foetal distress (oxygen deprivation in the womb); and develop pneumonia. Also, there was a higher prevalence of perinates with *Brucella* sp. infections (compared to stranding in Mississippi and Alabama). The researchers concluded that bottlenose dolphins exposed to the DWH oil spill 'were particularly susceptible to late-term pregnancy failures and development of *in utero* infections including brucellosis'.

Kellar *et al.* (2017) investigated longer-term reproductive success, using hormone analysis from blubber biopsies, or ultrasound scans taken when animals were collected as part of a capture-release research programme. Animals were followed for a year after the detection of pregnancy; the percentage of successful births in oil-exposed animals was substantially lower (19%) than in other dolphin populations (Sarasota Bay, Florida and South Carolina: 65%). A number of factors were compared (e.g., levels of progesterone, cortisol, thyroid hormone) but only white blood cell counts were correlated with reproductive success. The researchers concluded that the 'high reproductive failure rates [in spill-exposed animals] are consistent with mammalian literature that shows a link between petroleum exposure and reproductive abnormalities and failures'.

Capture-release animals were also assessed for lung health. Smith *et al.* (2017) found that four years after the occurrence of the spill, some improvements in lung health had occurred; however, levels of moderate to severe lung disease remained elevated. The researchers 'confirmed that dolphins living in areas affected by the [DWH] spill were more likely to be ill; however, some improvement in population health has occurred over time'.

These studies show distinct and substantial population-level impacts from the DWH oil spill on common bottlenose dolphins alone. Aerial/vessel surveys and other reports documented over 1,100 cetaceans from at least 10 species in thick surface oil or the surface oil sheen from the DWH spill (between April-September 2010), which together with strandings of oiled animals gives a total of 15 species of cetacean recorded as exposed to the oil spill. The impact of the spill on multiple populations of cetacean species, including great whales, in the Gulf of Mexico and adjacent areas, is likely to be substantial.

(SOURCES: Aichinger Dias, L., *et al.* 2017. Exposure of cetaceans to petroleum products following the *Deepwater Horizon* oil spill in the Gulf of Mexico. *Endang. Species Res.* 33: 119-125; Colegrove, K.M., *et al.* 2016. Fetal distress and *in utero* pneumonia in perinatal dolphins during the Northern Gulf of Mexico= unusual mortality event. *Dis. Aquatic Org*. 119: 1-16; Kellar, N.M., *et al.* 2017. Low reproductive success rates of common bottlenose dolphins *Tursiops truncatus* in the northern Gulf of Mexico following the *Deepwater Horizon* disaster (2010-2015). *Endang. Species Res.* 33: 143-158; Smith, C.R., *et al.* 2017. Slow recovery of Barataria Bay dolphin health following the *Deepwater Horizon* oil spill (2013−2014), with evidence of persistent lung disease and impaired stress response. *Endang. Species Res.* 33: 127-142; Takeshita, R., *et al.* 2017. The *Deepwater Horizon* oil spill marine mammal injury assessment. *Endang. Species Res.* 33: 95-106; Wilkin, S.M., *et al.* 2017. Marine mammal response operations during the *Deepwater Horizon* oil spill. *Endang. Species Res.* 33: 107-118).

Climate change

TEMPERATURE INCREASES COULD REACH LEVELS NOT SEEN FOR 420 MILLION YEARS

Over the past 420 million years, there has been a slow increase in solar radiance (energy meeting the Earth's surface;

a net increase of ~9 Wm^{-2} of radiative forcing), but from a global warming perspective, this has been counteracted and effectively negated by a simultaneous decline in atmospheric CO2 levels (probably due to an expansion of carbon dioxide-absorbing plants and geological factors). However, today atmospheric CO2 has reached levels not seen since the early Eocene (50 million years ago). Researchers analysing the interaction of this increase with solar radiance concluded that if 'CO2 continues to rise further into the twenty-third century, then the associated large increase in radiative forcing, and how the Earth system would respond, would likely be without geological precedent in the last half a billion years'.

(SOURCE: Foster, G.L., Royer, D.L. and Lunt, D.J. 2017. Future climate forcing potentially without precedent in the last 420 million years. *Nature Comm.* 8: art. 14845. doi:10.1038/nature22049).

CLIMATE CHANGE EXACERBATING HARMFUL ALGAL BLOOMS

Researchers investigated the prevalence of HABs in the North Atlantic and North Pacific Oceans and whether these were linked to climate change-induced warming. They specifically looked at the HAB-producing species *Alexandrium fundyense* and *Dinophysis acuminate* and built predictive models of occurrence. They discovered numerous sites where HABs had not occurred before, but where they could occur as a result of warming. They also discovered higher potential growth rates of such blooms, and longer bloom seasons (particularly on the Atlantic and Alaskan coasts, which is important cetacean habitat).

(Source: Gobler, C.J., Doherty, O.M., Hattenrath-Lehmann, T.K., Griffith, A.W., Kang, Y. And Litaker, R.W. 2017. Ocean Warming Since 1982 Has Expanded The Niche Of Toxic Algal Blooms In The North Atlantic And North Pacific Oceans. *Proc. Natl Acad. Sci. Usa, Online Early*. Doi: 10.1073/Pnas.1619575114).

RECORD LEVELS OF CARBON DIOXIDE RECORDED

In 2017, the Mauna Loa Observatory in Hawaii recorded a carbon dioxide level exceeding 410ppm for the first time. When the observatory started recording carbon dioxide levels in 1958, they were 280ppm. In 2013, they passed 400ppm for the first time. Carbon dioxide levels were last at this level 50 million years ago in the Eocene, a period when the world was 10°C warmer than it is today.

(SOURCE: Khan, B. 2017. We just breached the 410 ppm threshold for CO2. *Scient. Amer.* 21 April 2017. *https://www.scientificamerican.com/article/we-just-breached-the-410-ppm-threshold-for-co2/*).

DISCOVERY OF MASSIVE MELTWATER RIVERS IN ANTARCTICA INCREASES CONCERN ABOUT ICE SHELF BREAK UP

The current prediction for sea level rise this century, as the result of Antarctic ice sheet meltwater having an impact on the breakup of ice sheets, is one metre. However, researchers analysing satellite images (from 1973 onwards) and aerial photographs (from 1947 onwards) of the surface of Antarctica warn that there is substantial movement of water across the surface of Antarctica, as the result of melting ice, that has not been factored into this prediction. The researchers found rivers of meltwater on the surface of Antarctica as far south as 85°S and as high in elevation as 1,300m above sea level. These meltwater rivers are up to 120km long and feed 'vast melt ponds up to 80 kilometres long'. The researchers raised concerns that this rapidly increasing water flow, whilst being a physical representation of the extent of melting, could exacerbate the breaking up of ice sheets and lead to positive feedback loops that could accelerate the loss of ice around Antarctica.

(SOURCES: Kingslake, J., Ely, J.C., Das, I. and Bell, R.E. 2017. Widespread movement of meltwater onto and across Antarctic ice shelves. *Nature* 544: 349-352; DeConto, R. M. and Pollard, D. 2016. Contribution of Antarctica to past and future sea-level rise. *Nature* 531: 591-597).

ARCTIC SEA ICE COVERAGE REACHES A RECORD LOW

The maximum Arctic sea ice coverage in the winter of 2016/17 was the lowest level ever recorded. The previous record low was in winter 2015/2016. The maximum extent for 2016/17 was 14.43 million km^2. This was 1.17 million km^2 below the average during 1981-2010. The rate of decline in ice coverage has been 42,700km^2 per year, or 2.74% per decade. Air temperatures over the Arctic Ocean ranged from 2°C to 6°C above average in nearly every region.

(SOURCE: National Snow and Ice Data Center. http://nsidc.org/arcticseaicenews/).

2016 WAS THE HOTTEST YEAR ON RECORD

NASA and NOAA jointly declared that 2016 was the hottest year globally since comprehensive recording was initiated 137 years ago. The hottest year on record previously was 2015, and 2014 before that, marking three years in a row of record-breaking global temperatures. Of the 17 hottest years on record, 16 have occurred in the 21st century (the exception being the strong El Niño year of 1998). To compare how elevated the temperatures were, 2016 was almost 0.9° C warmer than 1998. Temperatures in 2016 were 1.2°C above the average temperatures during the late 19th/early 20th centuries (1881-1910).

(Source: Thompson, A. 2017. 2016 Was The Hottest Year On Record. *Scient. Amer*., 18 January 2017, *Https://Www.Scientificamerican.Com/Article/2016-Was-The-Hottest-Year-On-Record/*).

LARSEN C ICE SHELF SHOWS SIGNS OF IMMINENT COLLAPSE

A large (175km), expanding crack appeared in the Larsen C ice shelf, which suggests that the shelf may be unstable and collapse in the near future. The Larsen C shelf covers 50,000km^2 and contains ice up to 350m thick. After the Larsen A and B shelves broke up, it led to an eightfold increase in glacier ice flow into the ocean. Intact ice shelves effectively act as 'fences', preventing ice on land from flowing into the sea via glaciers. If the Larsen C shelf were to break up, the glacier ice that would flow into the ocean would provide enough additional water to raise global sea level by one centimetre. At present, sea level is rising by 3mm a year, and one-third of this rise is attributable to land-based ice in Greenland and Antarctica flowing into the oceans via glaciers (265 GT/year for Greenland and 95±50 GT/year for Antarctica, which is contributing 0.72 and 0.26 mm/year to global sea level rise, respectively).

(SOURCES: Tollefson, J. 2017. Giant crack in Antarctic ice shelf spotlights advances in glaciology. *Nature* 452: 202.403; Forsberg, R., Sørensen, L.S., and Simonsen, S. B. 2017. Greenland and Antarctica ice sheet mass changes and effects on global sea level. *Surv. Geophys.* 38: 89-104).

Noise impacts

SPERM WHALES STOP RESTING AND FEEDING WHEN EXPOSED TO MILITARY SONAR

Several studies have investigated the effects of sonar on beaked whales, but there is scant information on other deep-diving species. Two recent studies on sperm whales exposed to sonar reported avoidance behaviour, interruption of foraging and/or resting behaviour, and an increase in social sound production in response to 1-2 kHz (mid-frequency) active sonar. The sperm whales stopped foraging at a cumulative received sound exposure level (SEL) of 135 to 145 dB re 1 μPa. They also displayed avoidance and social call changes in response to 6-7 kHz (high frequency) sonar, although the responses were less pronounced.

(SOURCES: Curé, C., Isojunno, S., Visser, F., Wensveen, P. J., Sivle, L. D., Kvadsheim, P. H., Lam, F. P. A., and Miller, P.J.O. 2016. Biological significance of sperm whale responses to sonar: Comparison with anti-predator responses. *Endang. Spec. Res.* 31: 89-102; Isojunno, S., Curé, C., Kvadsheim, P. K., Lam, F. P. A., Tyack, P. L., Wensveen, P., and Miller, P.J.O. 2016. Sperm whales reduce foraging effort during exposure to 1-2 kHz sonar and killer whale sounds. *Ecol. Appl.* 26: 77-93).

A QUIETER ALTERNATIVE TO SEISMIC SURVEY AIRGUNS?

Vibroseis is a method used to conduct seismic surveys where, instead of an explosion, a longer duration vibration is used to gather geological data. This method could be used in the marine environment, potentially as a way to reduce noise-based impacts on cetaceans. Sound levels were modelled from a vibroseis array and an airgun array and compared under different marine scenarios: shallow water, deep water and an underwater slope. At a distance of 100m, the vibroseis array was 20dB lower in peak-to-peak SPL vs the airgun array, and 12dB lower at 5km. At 100km the SELs were a total of 8dB lower. In general, the vibroseis array produced lower sound levels than the airgun array, and could be a promising mitigation measure to reduce impacts on cetaceans from seismic surveys.

(SOURCES: Duncan, A.J., Weilgart, L.S., Leaper, R., Jasny, M and Livermore, S. 2017. A modelling comparison between received sound levels produced by a marine Vibroseis array and those from an airgun array for some typical seismic survey scenarios. *Mar. Pollut. Bull.*, in press).

SMALL RESTRICTED POPULATIONS MAY BE MORE VULNERABLE TO DISTURBANCE

Many mitigation measures assume that as noise levels increase, cetaceans will simply move to another location to avoid harm. However, some species have habitats that are very restricted. If they move away from this habitat, they may face even greater impacts. Displacement may increase stress and result in reduced ability to forage for species such as Cuvier's beaked whales or Maui's dolphins. Species such as western gray whales, however, may be so reliant upon foraging in their restricted feeding grounds that they stay within this habitat, despite being exposed to disturbance and noise, and potentially suffer health-reducing levels of disturbance. Mitigation measures should recognise that small, restricted populations may literally have 'nowhere to go without experiencing harm' when it comes to disturbance. The authors also highlighted that mitigation measures often do not take into account that some species are more difficult to detect and that noise producers might assume their activities are not having an effect, because they are unable to detect the animals that are suffering impacts. The authors therefore suggested that '[m]itigation and monitoring plans should explicitly include estimation of cetacean detection probabilities, to ensure that as many animals as possible are detected and that true risks of harming animals that may never be seen are understood'.

(SOURCE: Forney, K.A., Southall, B.L., Slooten, E., Dawson, S., Read, A.J., Baird, R.W., Brownell, R.L Jr. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. *Endang. Species Res*. 32: 391-413).

OVERLAP OF BLUE AND FIN WHALES WITH SEISMIC SURVEY NOISE IN CETACEAN SOUNDSCAPES

An analysis was conducted on three soundscapes in the Atlantic Ocean, from the Arctic to the Antarctic, to document sound levels. The highest sound levels were found in the equatorial Atlantic, and this was attributed to high levels of seismic survey noise from oil and gas exploration - at the Ascension Island study site, seismic airgun signals were audible during almost every hour of the study period. Seismic surveys were also occurring in Fram Strait in the Arctic, primarily during the summer, for 10 out of 16 months of recording. During those 10 months, seismic survey noise was detected, on average, 17 hours per day (for a total duration of over 4,000 hours during the study period from August 2009 through December 2010). In August and September, the occurrence of blue and fin whales coincided with seismic survey noise in the Arctic site. At the Atlantic site, blue and fin whale calls were heard year round, meaning there was a year-round overlap (and potential masking) with seismic survey noise.

(SOURCE: Haver, S., Klinck, H., Miksis-Olds, J.L., Nieukirk, S.L., Matsumoto, H., and Dziak, R.P. 2017. The not-so-silent world: measuring Arctic, Equatorial, and Antarctic soundscapes in the Atlantic Ocean. *Deep-Sea Res. I* 122: 95-104).

A NEED TO STANDARDISE SOUND MEASUREMENTS FOR IMPACT POLICY PURPOSES

Studies that describe the impacts of noise, both in the terrestrial and aquatic environment, often portray sound levels in different ways. For example, sounds might be measured as: (1) SPL RMS - the 'average height' of the sound wave over a specified time period; and (2) 'peak-to-peak' (the difference between the highest and lowest pressure deviations in a given time interval). Depending on how noise is measured, a given sound level may actually vary in practical terms by up to 12dB. Most managers, environmental advocates and policy-makers are not trained in the physics of underwater sound and fail to realise that the decibel scale is not easily comparable for underwater versus above-water noise. (Editor's note: For example the 'loudness' of sound sources such as seismic survey air guns is often compared to the loudness of a Boeing 747 jet taking off, which is approximately 150dB (at 25m) in air. Importantly, however, this would be valued as 215.5dB (re 1μPa) underwater because of the difference of reference values and the physical nature of water.) A new review on this issue presented marine mammal case studies that highlighted such discrepancies. In one example, two levels were given the same decibel value, although there was actually a 45dB difference between them. The review called for standardising how sound levels are expressed, especially when dealing with noise impacts. In particular the frequency spectrum should be expressed (e.g. in a format such as '40dB SPL_{max} re 1μPa (10-200Hz)'). In the case study noted above, for example, the disparity was because measurements were made over different frequency ranges. (Editor's note: An analogy is trying to count the number of birds in a wood - although the number of birds remains the same, one gets a very different value if counting at midday versus at midnight. The observation 'window' needs to be standardised.) Because noise-related damage is often related to the maximum amount of noise in an event, it is important to note the maximum sound level (SPL_{max}), rather than averaging sound levels over a lengthier period. Sound-related damage may also increase as a result of continuous exposure, so that the cumulative sound exposure level (SEL) is also important, with information on the sound duration. The background noise level in an animal's habitat might also be an important value when measuring impacts. (Editor's note: For example, a dolphin that inhabits waters near a noisy harbour with a high level of background noise might be affected differently by a passing boat than a dolphin in a quiet bay. This is also an issue when the responses of animals kept in captive settings are used to predict responses of animals in quieter wild settings.) Finally, as noise exposure may cause stress responses, noting the duration of a noise exposure, as well as the duration of subsequent quiet 'recovery' periods, is also important. An intense sound that is shortly followed by another intense sound might be more stressful than a sound that is followed by a long quiet period. This calls for standardising how noise levels are expressed in papers and developing improved regulations in order to efficiently manage the impacts of sounds on cetaceans (and other species).

(SOURCE: McKenna, M.F., Shannon, G., and Fristrup, K. 2016. Characterizing anthropogenic noise to improve understanding and management of impacts to wildlife. *Endang. Species Res*. 31: 279-291).

NEW METHOD TO DETECT NOISE-RELATED INJURY IN THE INNER EARS OF CETACEANS

Because of decomposition of acoustic tissues, detecting hearing damage in stranded cetaceans can be difficult. A new method to examine the structure of the inner ear of stranded cetaceans was trialled on two stranded long-finned pilot whales. In one of the animals (a juvenile), many sensory cells in the inner ear were missing, suggesting overexposure to underwater noise, specifically lower frequency noise. The method allowed analysis of ear tissues for damage even 30 hours after death. This approach might be extremely valuable in evaluating the degree of noise-related injury in stranded cetaceans.

(SOURCE: Morell, M., Brownlow, A., McGovern, B., Raverty, S.A., Shadwick, R.E., and André, M. 2017. Implementation of a method to visualize noise-induced hearing loss in mass stranded cetaceans. *Sci. Rep.* 7: 41848; doi: 10.1038/srep41848).

SEISMIC SURVEY SOUNDS DRAMATICALLY REDUCE REEF FISH ABUNDANCE

The impacts of seismic surveys on cetaceans is an issue that is receiving increasing attention, but few studies have investigated the impacts of these intense sound-producing activities upon the habitats of cetaceans. A new study recorded videos of fish on a reef before and during a seismic survey, to assess the effect on fish abundance. During seismic surveying, reef-fish abundance declined by 78%. This shows that such surveys may not only impact cetaceans, but also their prey species. The researchers stated that '[t]he finding…goes well beyond detection of a startle response from individual fish, instead suggesting a multi-species response to airgun noise' and 'these research results augment and confirm issues raised by marine mammal experts and suggest that concerns associated with marine seismic surveys appear to be realistic and well-founded'. Therefore, seismic surveys could have substantial impacts on cetacean prey species, as well as on cetaceans themselves.

(SOURCE: Paxton, A.B., Taylor, J.C., Nowacek, D.P., Dale, J., Cole, E., Voss, C.M., and Peterson, C.H. 2017. Seismic survey noise disrupted fish use of a temperate reef. *Mar. Pol.* 78: 68-73).

SCIENTIFIC ECHO-SOUNDER ALTERS PILOT WHALE BEHAVIOUR

Mid- and low-frequency active military sonar has an impact on several cetacean species, but there is limited information on the impacts of other types of sonars. An experiment was conducted on the impacts of a scientific echo-sounder (EK60) on the behaviour of five short-finned pilot whales. Hidden Markov model analyses found that although foraging behaviour did not change, the animals frequently changed their swimming direction during exposure. This study showed an impact on cetacean behaviour from a sound-producing technology that is often not considered during impact assessments.

(SOURCE; Quick, N., Scott-Hayward, L., Sadykova, D., Nowacek, D., and Read, A. 2016. Effects of a scientific echo sounder on the behavior of short-finned pilot whales (*Globicephala macrorhynchus*). *Can. J. Fish. Aquat. Sci.*: in press).

A NEW METHOD TO ANALYSE BEHAVIOURAL CHANGES IN RESPONSE TO DISTURBANCE

A new method to measure subtle behavioural impacts from anthropogenic disturbance and noise was developed and trialled with killer whales as the test species. Fractal analysis was used to determine whether animals moved directly (with little deviation), or whether they deviated from their course and changed direction more frequently - a behavioural change that has been reported in response to anthropogenic disturbance. The method was viable for highlighting sometimes subtle and difficult to perceive, but statistically significant, behavioural responses to disturbance.

(SOURCE: Seuront, L. and Cribb, N. 2017. Fractal analysis provides new insights into the complexity of marine mammal behavior: A review, two methods, their application to diving and surfacing patterns, and their relevance to marine mammal welfare assessment. *Mar. Mamm. Sci.*, in press.)

FEEDING BEHAVIOUR OF HUMPBACK WHALES SIGNIFICANTLY REDUCED DURING SONAR EXPOSURE

The (lunge) feeding behaviour of humpback whales was examined during controlled exposure experiments to military low-frequency sonar (1.3-2.0 kHz with SPLs at the source of up to 160-180 dB re 1 μPa). The animals were fitted with acoustic- and motion-sensing devices, which allowed the distinctive actions of lunge feeding to be detected. The first exposure of 12 whales lead to a statistically significant 68% reduction in lunge feeding rates. During a second exposure, the feeding rate was 66% below pre-exposure levels. The researchers stated that 'Our results indicate that naval sonars operating near humpback whale feeding grounds may lead to reduced foraging and negative impacts on energy balance'.

(SOURCE: Sivle, L.D., Wensveen, P.J., Kvadsheim, P.H., Lam, F.P.A., Visser, F., Curé, C., Harris, C.M., Tyack, P.L., and Miller, P.J.O. 2016. Naval sonar disrupts foraging in humpback whales. *Mar. Ecol. Prog. Ser.* 562: 211-220).

THE ENERGETIC COST FOR BEAKED WHALES OF TRYING TO EVADE NAVAL SONAR

The respiration rate in bottlenose dolphins during swimming was used to calculate the energetic cost of fluke strokes (3.31±0.20 J kg^{-1} stroke^{-1}). This was then used to estimate the cost of high speed evasion responses in cetaceans of a variety of sizes. It was found that the larger the cetacean, the greater the relative cost of swimming became. Modelling the energetic cost for the response documented by beaked whales to naval sonar (increased fluking rates and longer bursts of powered swimming) showed a 30.5% increase in metabolic rate, with an elevated rate being maintained for more than 90 min after the exposure to noise. This demonstrates a clear energetic cost associated with the evasion response exhibited by beaked whales to navy sonar.

(SOURCE: Williams, T.E. *et al.* 2017. Swimming and diving energetics in dolphins: a stroke-by-stroke analysis for predicting the cost of flight responses in wild odontocetes. *J. Exp. Biol.* 220: 1135-1145).

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The editors once again thank David Janiger for providing his database of recently published marine mammal papers and for supplying .pdf copies of difficult-to-obtain papers. We thank Gianna Minton and Dipani Sutaria for submitting several entries for inclusion. The editors are especially grateful to the Government of Austria and the Animal Welfare Institute for providing support for SOCER preparation, as requested by Resolution 2000-7 (IWC, 2001). We also thank the IWC Secretariat for allotting funds for preparing SOCER 2017.

Appendix 1

GLOSSARY

Species glossary

Blue whale: *Balaenoptera musculus*
Bryde's whale: *Balaenoptera edeni*
Common bottlenose dolphin: *Tursiops truncatus*
Cuvier's beaked whale: *Ziphius cavirostris*
Fin whale: *Balaenoptera physalus*
Ganges river dolphin: *Platanista gangetica*
Gray whale: *Eschrichtius robustus*
Humpback whale: *Megaptera novaeangliae*
Indian Ocean humpback dolphin: *Sousa plumbea*
Indo-Pacific bottlenose dolphin: *Tursiops aduncus*
Indo-Pacific humpback dolphin: *Sousa chinensis*

Killer whale: *Orcinus orca*
Long-finned pilot whale: *Globicephala melas*
Maui's dolphin: *Cephalorhynchus hectori maui*
North Atlantic right whale: *Eubalaena glacialis*
Omura's whale: *Balaenoptera omurai*
Short-finned pilot whale: *Globicephala macrorhynchus*
Sperm whale: *Physeter macrocephalus*
Spinner dolphin: *Stenella longirostris*
Antarctic krill: *Euphausia superba*
Mullet: *Liza klunzingeri*

Heavy metals
Cd – Cadmium
Cu – Copper
Hg – Mercury
Pb – Lead
Zn – Zinc

Glossary of terms

Bioaccumulation: Increase in concentration of a pollutant within an organism compared to background levels in its diet.

Brucella: Various species of bacteria that cause the disease brucellosis.

dB: Decibel – a logarithmic measure of sound pressure level.

DDE: The organochlorine dichlorodiphenyldichloroethylene, a breakdown product of the pesticide DDT.

DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Dinoflagellate: A large group of unicellular algae belonging to the phytoplankton.

EEZ: Exclusive Economic Zone.

Estuarine: Related to estuaries or river mouths.

Eutrophication: Input of nutrients into an aquatic system, typically associated with excessive plant growth and oxygen depletion.

FAO: Food and Agriculture Organization, an intergovernmental organisation with 194 Member Nations.

Fractal: A rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole.

Gyre: Large system of rotating ocean currents.

HCB: Hexachlorobenzene, an organochloride compound.

HCH: Hexachlorocyclohexane, a polyhalogenated compound.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hertz).

IMO: International Maritime Organisation.

IOC: Intergovernmental Oceanographic Commission of UNESCO.

J: Joule

μPa: Micropascal, a unit of pressure.

MeO-PBDE: Methyloxidated polybrominated diphenyl ether.

Microplastics: Plastic particles 0.3-5mm in diameter, often the result of larger plastic pieces breaking down over time.

MPA: Marine Protected Area.

NASA: National Aeronautics and Space Agency of the US Government.

Newton: The International System of Units unit of force.

NOAA: National Oceanic and Atmospheric Administration of the US Government.

nm: Nautical mile.

OCP: Organochlorine pesticide.

Organochlorine: Organic compounds that contain chlorine. Many are toxic and used as pesticides. Most of these compounds persist in the environment (are not biodegradable) and also tend to accumulate in fatty tissue (e.g. blubber) of cetaceans and other marine organisms. See also organohalogen.

Organohalogen: Organic compounds that contain any halogen (i.e. fluorine, chlorine, bromine, or iodine).

PBDE: Polybrominated diphenyl ether.

PCB: Polychlorinated biphenyls.

Perinatal: The period ranging from one month before to one month after birth.

POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.

ppm: Parts per million

ppt: Parts per thousand

rms: Root-mean-square. A measurement of sound pressure.

SCOR: Scientific Committee on Ocean Research of UNESCO.

SEL: Sound exposure level.

Soundscape: The level of natural and anthropogenic sound in the environment.

SPL: Sound pressure level. SPL_{max} refers to maximum SPL.

Stratification: Layering of the water column due to different water densities, as induced for example by temperature or salinity differences.

Sympatric: Occurring in the same geographical area, used with animals and plants.

T-Hg: Total mercury.

UNESCO: United Nations Education, Scientific and Cultural Organization.

REFERENCES

International Whaling Commission. 1998. Chairman's Report of the Forty-Ninth Annual Meeting. Appendix 7. IWC Resolution 1997-7. Resolution on environmental change and cetaceans. *Rep. Int. Whal. Comm.* 48:48-49.

International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whal. Comm.* 1998:43-44.

International Whaling Commission. 2001. Chairman's Report of the Fifty-Second Annual Meeting. Appendix 1. Resolutions adopted during the 52nd annual meeting. IWC Resolution 2000-7. Resolution on environmental change and cetaceans. *Ann. Rep. Int. Whal. Comm.* 2000:56-57.

Stachowitsch, M., Rose, N.A. and Parsons, E.C.M. 2003. State of the cetacean environment report (SOCER) 2003: Second draft. Paper SC/55/E7 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 13pp. [Paper available from the Office of this Journal].

Appendix 6

WORK PLAN DIAGRAM

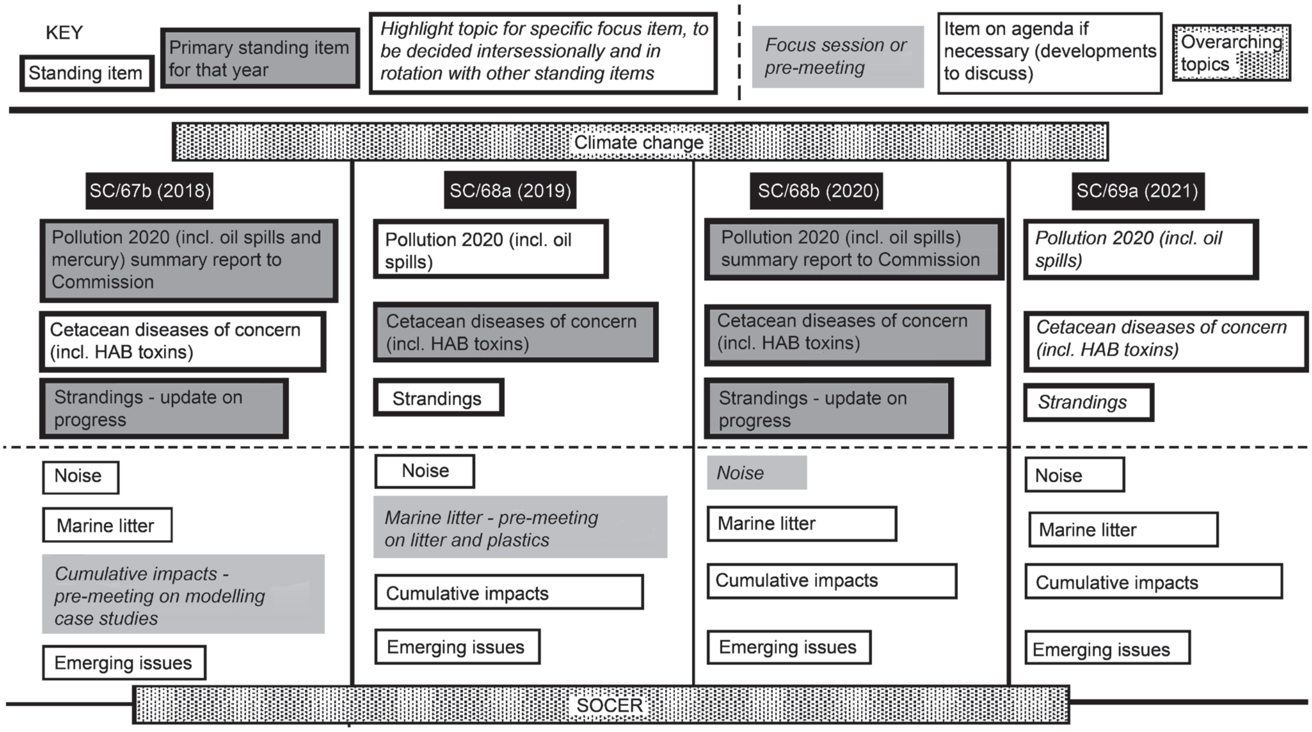

Fig. 1. The work plan has three long-standing items: pollution, diseases of concern and strandings, three items that are dealt with on a cyclic basis: noise, marine litter and cumulative impacts and an emerging issue. Overarching these topics are SOCER and climate change.

Annex L

Report of the Working Group on Ecosystem Modelling

Members: Kitakado (Convenor), Baba, Belchier, Bell, Burkhardt, Butterworth, Cañadas, Collins, Cooke, Cunen, Currey, de la Mare, de Moor, Diallo, Donovan, Double, Enmynkau, Fortuna, Frey, Friedlaender, Gunnlaugsson, Hakamada, Haug, Herr, Hielscher, Hinke, Hjort, Isoda, Ivashchenko, Kelkar, Konishi, Lang, Lee, Lundquist, Mate, Mallette, McKinlay, Moore, Morita, H., Morita, Y., Moronuki, Murase, Funahashi, New, Øien, Palka, Phay, Pierce, Punt, Redfern, Reeves, Reyes, Rogers, Santos, Simmonds, Skaug, Slugina, Solvang, Tamura, Tulloch, Víkingsson, Von Duyke, Wade, Walløe, Walters, Weinrich, Yasokawa, Yasunaga, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Kitakado welcomed the members of the Ecosystem Modelling Working Group (hereafter Working Group).

1.2 Election of Chair
Kitakado was elected Chair.

1.3 Appointment of Rapporteurs
Butterworth, McKinlay, New and Skaug were appointed as rapporteurs with assistance of the Chair.

1.4 Adoption of Agenda
The adopted Agenda is included as Appendix 1.

1.5 Documents available
The documents available to the Working Group were identified as SC/67a/EM01-16, Redfern *et al.* (2017), Solvang *et al.* (2017),Weinstein *et al.* (2017) and Mate *et al.* (2016).

2. BODY CONDITION ANALYSIS FOR THE ANTARCTIC MINKE WHALE

2.1 Review results of analyses
2.1.1 Review of analyses
Based on an analysis of length-weight relationships, SC/67a/EM02 reported on trends in minke whale body condition as determined from data collected during the JARPA sampling program, 1989-2005. Penalised regression splines were used to model total body weight as non-linear functions of body length, time within season, foetus length and long-term trend over year. Four discrete subsets of the JARPA data were examined after exploratory analyses revealed differences in the length-weight relationship between sexes and between those animals considered to have a high or low diatom load. For a majority of the data (83%, comprising all males, and females with low diatom load) the authors found no evidence for a decline in total body weight over the 17 years of the JARPA program. For females with high diatom load there existed some signal to indicate a decline in body weight, however the long-term trend was not linear, was not consistently in decline for all animals within the group, and was based on small sample sizes (average 37 samples/year). The authors concluded these results provided little evidence for a widespread decline in food availability.

De la Mare presented SC/67a/EM01, which sets out analyses on the subset of the data for whales with measured fat weight (measured for the first whale taken each day from 1988/89 onwards, although a substantial number of days were not sampled). Konishi and Walløe (2015) considered that fat weight is the most appropriate measure of body condition. The analyses in SC/67a/EM01 indicated that total body weight (also included in the JARPA data) was a more complete measure of body condition. The JARPA data showed that the seasonal gain in lean weight (total weight minus blubber weight) exceeded the seasonal gain in blubber weight. A range of models fitted to total weight data were not consistent with any significant long term decline in body condition. Analyses of fat weight with a fixed effects model resulted in an apparent decline significant with p=0.015, but this probability value overstated the significance by ignoring the effects of model selection, pseudo-replication and random effects. Their mixed effects models did not show a significant decline in fat weight. Systematic trends in the segment of the population being sampled was evidenced by changes in ages and sex ratios. Overall it difficult to determine whether the apparent changes in body condition in a subset of the models reflected real changes in the population, or whether they were an artefact due to variability in the segment of the population being sampled.

SC/67a/EM04 presented an analysis of the Antarctic minke whale data from the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). Six response variables were considered, which were all potential proxies for body condition: blubber thickness at two sites, half girth at two sites, fat weight, and an index based on total weight. A large, biologically plausible linear mixed effect model intended to incorporate all effects influencing body condition was proposed and analysed. Model selection was carried out by means of the focused information criterion (FIC) with the goal of increasing the precision of the estimate of the linear effect of year. Both parts of the analysis supported the conclusion that there had been a decrease in body condition over the 18 years under study. Five out of six proxies for body condition had clear, negative, significant estimates for the linear effect of year. Also, for these five responses the FIC procedure selected models with similar conclusions, while a baseline model without a linear effect of year was not favoured. With the last of these six proxies, an index based on total weight, the estimated effect of year was negative, but not significant. Also, in this case, the FIC procedure preferred a model not containing the linear effect of year. However, total weight was considered to be less clearly linked to body condition compared to the other responses.

SC/67a/EM03 was drafted as a response to the draft of SC/67a/EM04 that was circulated as part of the exchange of papers two months before the meeting. The paper provided a constructive critique of the analyses in SC/67a/EM02 including a number of suggestions or requests for clarification. Results were presented that show that on about 28% of days no whales were measured for fat and the proportion of the catch that was weighed changed over the JARPA period, which may add to bias in trends in fat weight.

SC/67a/EM07 addressed a question originating from the analyses of minke whale body condition data collected under the JARPA program. Two teams investigated the hypothesis of yearly decline in body condition and found somewhat conflicting results. A key disagreement concerned whether total weight (suitably standardised) was an equally good (or better) proxy for body condition than measures directly related to blubber (for example fat weight). Both teams found that the total weight of the minke whales appeared to be constant over the JARPA period, while other response variables (for example fat weight) seemed to experience significant decline. These results were considered paradoxical by the authors of SC/67a/EM03. SC/67a/EM07 aimed to explain that the seeming conflict of fat weight and total weight results was not necessarily a paradox. Some simplified examples and a small simulation study were provided to support the case that disagreeing results could be explained by the increased residual variance when using total weight compared to using fat weight. The potential causes of the large residual variance in the total weight were also briefly discussed.

SC/67a/EM08 addressed some issues originating from the analyses of minke whale body condition data collected under the JARPA program. Two teams investigated the hypothesis of yearly decline in body condition and found somewhat conflicting results (see SC/67a/EM01 and SC/67a/EM02 from the first team, and SC/67a/EM04 from the second). Both teams proposed several linear mixed effects models for the response variable fat weight, and this note investigated whether the conclusions in SC/67a/EM04 were affected by incorporating some of the variables and interaction terms suggested in SC/67a/EM01. A total of nine new models were considered and all the models had a significant, negative, linear effect of year, and achieved better AIC values than the winning linear mixed effect model in SC/67a/EM01. Using one of the new models as a new wide model, a full FIC (focused information criterion) analysis of a set of 27 candidate models was performed. The main conclusions in SC/67a/EM04 remained unchanged.

De la Mare explained that the paradox referred to in the commentary in SC/67a/EM03 was the proposition arising from the analyses in SC/67a/EM04 that a substantial decline in nutritive condition purportedly measured by indicators such as fat weight could be evidence for important changes in feeding conditions without there being a corresponding decline in body weight. The problem was not statistical but rather it was the biotic implications of the results in SC/67a/EM04 that were paradoxical. The main results presented in SC/67a/EM01 led to no paradox. The lowest AIC and BIC models for body weight did not include a year trend. However, the trend from the lowest AIC model that did include a year trend gave an estimated rate of change in total body weight (using only the data that include fat weights) of -0.0048 tonnes per year with a standard error of 0.012, t=-0.40, and was clearly not statistically significant. The corresponding estimate of mean body weight at the start of the 17-year JARPA period was 6.98 tonnes (both sexes combined). This estimated decline was -0.068 %/year, leading to a total decline on body weight over the 17-year period of 1.16%. Running the same model using all the body weights (not just those from animals who also had their fat weights measured) gave a trend of -0.0032 tonnes/year with a standard error of 0.0078, t=-0.4. In this case the percentage decline was -0.045 per year and a total 17-year decline of 0.77%. The results from the mixed effects model for fat weight was a trend of -0.0035 tonnes per year with a standard error of 0.00213, t=-1.66, and was shown to be not significant by bootstrap. The estimated mean fat weight for females in year 2 was 1.873 tonnes, giving a percentage decline per year of 0.189, and a total over 17 years of 3.23%. Thus there was no paradox in the main results of SC/67a/EM01; the point estimates of the rates of changes in body weight and fat weight are similar, and neither is statistically significant or substantial.

In response to SC/67a/EM01-03, SC/67a/EM16 argued that the basis of 'body weight is better proxy than fat weight or blubber thickness' used the data incorrectly. This suggested that it was reasonable that models with fat weight and blubber thickness showed significant yearly decline with no decline in total body weight, which was also confirmed by SC/67a/EM04 and SC/67a/EM07. These did not admit other factors exist such as sampling design. SC/67a/EM16 also explained unfavourable use of highly correlated close variables (fat weight and body weight; r=0.9 in JARPA data) for both response and independent variables in de la Mare's models. SC/67a/EM16 also argued that there was no need of data separation by diatom load level by SC/67a/EM02 by showing a correlation between foetus length and diatom load. SC/67a/EM02 finally concluded that the important declines of nutritional condition in minke whales over the JARPA period, which were significant at the 5% level, remained valid.

2.1.2 Discussion

Several participants argued against the use of total body weight as an indicator of body condition, because total weight was accumulated over many years. An additional problem was that bone weight increases with the age of individuals, and that lipid in bones can be replaced by water and lead to an increase in the total weight. It was argued that blubber thickness or total fat weight were the most appropriate indicators for detecting inter-annual changes in feeding conditions. The same conclusion had been reached for North Atlantic minke whales. Aguilar highlighted that, although indicative of body condition, variation in blubber thickness is not proportional to the evolution of body fat reserves and actually tends to underestimate changes if other morphometric and biochemical variables were not incorporated into the energetic model (Aguilar *et al.*, 2007). For this reason, the actual decline in body condition was likely to be more severe than the observed decline in blubber thickness.

Aguilar pointed out that the relationship between body weight and body length is not commonly considered a reliable proxy of body condition because it is affected by a number of biases: in females it is influenced by pregnancy, it requires incorporation of age in any condition determination because bone grows continuously along life, and it is strongly determined by muscle mass. The latter bias was particularly influential because protein incorporates large quantities of water and its energetic density is much lower than that of fat, so significant variation in muscle mass does not reflect parallel variation in condition. The assumption put forward by document SC/67a/EM01 that fat stores in bone and muscle were as important as those in blubber was inconsistent with previous results on cetacean bioenergetics, the reason being that the data used for the calculations were wrongly selected from the bibliography. Appendix 2 details more accurate values for lipid content that confirm blubber as the main body depot for lipid reserves in baleen whales. In response, the authors of SC/67a/EM01-03 referred to their results that show that fat weight and body weight, conditioned on suitable covariates, showed no substantial or significant declines over the period of JARPA. They also felt that, according to their analyses, the concordance between the two measures – fat weight and total weight – lent considerable support to the proposal that total weight was an appropriate measure of body condition.

The authors of SC/67a/EM04 were asked about the role played by the spatial covariates. In response, they said that spatial effects are modelled separately as a latitude effect, which is statistically significant and included in all models, and longitude effect (referred to as 'region'). The longitudinal covariate was not always selected by the FIC criterion, and did not seem to have a large effect on the estimated decline in blubber thickness.

The authors of SC/67a/EM04 were further asked about the method used to estimate the standard deviation in the estimated slope of decline, and in particular if the model selection process had been taken into account. They answered that a cross-validation method, which involved splitting the data into two parts, had been used to ensure the validity of results. Later discussions identified that this data splitting process, while done for generally desirable reasons (i.e. to test the best model selected on a hold-out set of data), as described, introduced a stochastic element to results of model selection that had not been described or summarised. Some members of the Working Group felt this introduced some doubt about the general validity of the results of model selection. The authors of SC/67a/EM04 answered that while the comments above may have somewhat influenced the results after model selection with FIC (the second half of SC/67a/EM04), they in no way influenced the first part of SC/67a/EM04, which contained no stochastic data-splitting, and thus in no way influenced the main conclusions of SC/67a/EM04. Some members of the Working Group thought it would be useful to consider an assessment of the relative stability of parameter confidence intervals in light the realised JARPA sample sizes and model complexity.

In relation to the estimation of standard deviations, the authors of SC/67a/EM04 explained that these had been evaluated under the selected model, rather than the more conservative approach of using the wide model, but it was expected that using the wide model instead would not make a huge difference. Additional analyses undertaken during the meeting confirmed this (see Appendix 3).

It was argued that in SC/67a/EM02 a substantial part of the data had been left out. The authors of SC/67a/EM02 replied that in response to some concerns expressed by Cunen, Walløe, and Hjort early in the collaboration, most of the data that was originally omitted (samples without measured stomach weight) were reintroduced to the analyses, with updated analyses presented in Appendix D of SC/67a/EM02. The results of the analysis using the more complete data were not appreciably different from the results from the analysis using the reduced data, which excluded cases missing stomach weight.

The Chair noted that it had previously been agreed that there had been a statistically significant decline in blubber thickness and fat weight. It was suggested that when viewed in the wider context of the Committee's interest, especially from a management perspective, significance at the 5% level is probably not the most important related issue. The Committee's interest would likely focus on the use of such information in multi-species models. Such use could take two forms: either qualitative confirmation (or otherwise) of trends suggested by a model fitted to other data, or as a component of the likelihood used in fitting such 'standardised' blubber thickness values to multi-species models. In either case, the inputs desired would be annual 'standardised' estimates for blubber thickness with associated coefficients of variation. For this, a demonstration of 5% statistical significance, although desirable, would not be essential; rather in the case, say, of fitting a model to information which included these estimates, the model would be the more influenced by those annual estimates with greater precision. The primary utility of variance estimates would be to ensure that they were no greater than the variance of the residuals for the model fit to the 'standardised' blubber estimates, to guard against an over-parametrised model overfitting to the information available.

The Working Group **agreed** that, thanks to the collaborative effort, considerable progress had been made in achieving convergence on the question of how to analyse for trends in body condition and/or blubber thickness in the JARPA data. Both teams and the Working Group **agreed** that the estimation of changes over time is more complex than had originally been assumed, because of the need to take account of additional components of variance which are partially confounded with the realised sampling design, and which had not been taken into account on the initial analysis.

2.1.2.1 POSITION OF DE LA MARE AND MCKINLAY (HEREAFTER DM)

DM's position was that the relevant accumulation of weight was not confined to the blubber and visceral fat, because the accumulation of lean weight (which also includes fat) within a season exceeds the accumulation of weight in blubber and visceral fat. This was consistent with the observations of Lockyer (1981), who in relation to blue and fin whales stated that '…the greatest observed increases in weight occur in the internal musculature …'. DM stated that while some details provided by Aguilar may be improvements, the general conclusion was not; all inferences drawn about fat weight and body weight in the analyses were drawn from the data, and the precise details of the illustration in SC/67a/EM01 were not critical to those results. SC/67a/EM01 and SC/67a/EM03 showed that the additions to both forms of weight (lean + fat weight) reflected feeding, and the analyses showed that there was no significant or substantial trend in total weight. Although DM consider that total weight was the appropriate measure of feeding success, the analyses in SC/67a/EM01 of fat weight also showed no substantial or significant trend (-0.2% per year). The results for blubber thickness (variable BT11) were also not significant. In SC/67a/EM03, DM noted several concerns regarding the FIC analyses that remained unaddressed. FIC results seemed to be single realisations of an approach to model selection that has some random elements. A comparison of the two analyses of fat weight in SC/67a/EM04 and SC/67a/EM08, which used different wide models, had different estimated coefficients, FIC values and confidence intervals, even though the selected final model was the same in both cases. If the coefficients and confidence intervals are instances from distributions of these statistics then those distributions will be necessary to understand the method. It was not clear why analyses that selected the same final model should have had such different results; for example, confidence regions of -0.0126, -0.0039 for SC/67a/EM04 versus -0.0141, -0.0002 for SC/67a/EM08. If the results in SC/67a/EM08 were driven primarily by using a different wide model (with more interaction terms) then the fat weight results in SC/67a/EM08 became consistent with the results of DM; the year trend was not significant because the confidence intervals in SC/67a/EM08 included zero when the wide model variance was used in the calculations in SC/67a/EM07. Finally, DM drew attention to the results in SC/67a/EM03 which showed that the FIC fat weight model in SC/67a/EM04 was a considerably poorer fit in terms of AIC and BIC compared to their 'best' models that do not include fixed year effects.

2.1.2.2 POSITION OF CUNEN, WALLØE, HJORT AND KONISHI (HEREAFTER CWHK)

The position of CWHK was the following. Despite the arguments from DM, CWHK remained convinced that fat weight, and the related blubber and girth measurements, were better proxies for body condition than total weight. On this point they agreed with the biological arguments made by Aguilar and pointed out that the total weight of any animal is clearly a function of many long-term variables, many of which were not measured (and may be impossible to measure). One example given was the weight of the skeleton, which is known to increase with age in many mammalian species. Using the total weight must thus be expected to obscure any pattern between fat weight and year (SC/67a/EM08). Their choices concerning the statistical modelling had been sound, reasonably robust and consistent with previous recommendations by this Working Group and by earlier recommendations by the authors of SC/67a/EM01 and SC/67a/EM02. The findings supported and confirmed the conclusions reached earlier by Konishi and Walløe (2015): for five of the six body condition proxies, there was a clearly significant linear decline over year. There was basic agreement with DM regarding parts of the basic statistical modelling and model fitting tools. However, CWHK did not agree on the necessity of splitting the data into four parts and then analysing these separately (as has been done in SC/67a/EM02). They claimed that potential differential patterns due to Sex or Diatom coverage could be taken care of by carefully chosen interaction terms. Concerning the claims made by DM in SC/67a/EM03 about the preferred model in terms of FIC having 'considerably poorer fit in terms of AIC and BIC' compared with their 'best' models, CWHK claimed this was solely a consequence of different size-controlling variables (BWt *vs* BLm), and that they demonstrated in SC/67a/EM08 that their wide model had a better AIC value than the 'best' model in SC/67a/EM02. Also, CWHK considered that the model selected by FIC based on that wide model would also have had a better AIC value than the 'best' model in SC/67a/EM02. The JARPA data set remains a rich source of biologically important information and there is scope for further statistical work of interest regarding some of the finer issues and details of the data. CWHK stood by the main conclusions they had reached regarding the decline in body condition over the JARPA time period.

2.1.3 Conclusion

The Scientific Committee agreed by consensus at its 2014 meeting that there had been a statistically significant (5% level) decline in blubber thickness and fat weight (IWC, 2015). In subsequent years, analyses challenging (as well as supporting) that agreement have been presented. In the Working Group, there was no consensus to recommend a change to the past agreement.

2.2 Review approached used in body condition analyses for other stocks

Solvang *et al.* (2017) presented a study of North Atlantic minke whales regarding the energy deposited at high productive arctic latitudes in summer. It was expected that the whales' body condition on the summer grounds would reflect food availability during their most intensive feeding period, and thus indicate how well the high-latitude ecosystems can support the populations. During the commercial catch operations on feeding grounds in Norwegian waters, body condition data (blubber thickness and girth) were collected from 10,556 common minke whales caught from 1993 to 2013. To investigate associations between condition and time/area, the authors applied the following three models: (1) multiple regression models with covariates, sex, year, latitude and longitude, to find significant coefficients of the covariate; (2) random effect models involving the random effects of variations by year or area and with sex as a fixed variable; (3) varying coefficient models, which were applied to investigate variation with year/area and to interpret covariate effects by visualisations. The significance of the estimated coefficients were assessed by the authors' proposed statistical tests. In conclusion, the total trend over the two decades of data available suggested a decrease in minke whale condition. However, this trend was most pronounced during the high summer season when the seasonal effect over the annual sampling periods from April to September was considered.

The results in Solvang *et al.* (2017) were of relevance to the *Implementation Review* of North Atlantic minke whales. It was noted that it would be interesting to include prey resources and competing species (cod and harp seals) as explanatory variables in the analyses. It was also suggested that date-of-capture be included as a covariate, in addition to 'season' which was already included. The authors indicated that they have included date-of-capture as a covariate to the model, and have considered day effect in the varying coefficients model in canonical correlation analysis (Yamamura *et al.*, 2016), which indicated a significant positive effect to body condition.

3. REVIEW ISSUES RELEVANT TO ECOSYSTEM MODELLIN WITHIN THE COMMITTEE

3.1 Individual-based energetic models

De la Mare indicated that work was on-going on the relevant models (SC/67a/RMP02), but that they did not yet include competition between species.

3.2 Effects of long-term environmental variability on whale populations

The issue of variability in baleen whale demographics was examined at a Workshop held in 2010 (IWC, 2011). Although data were limited, an average coefficient of variation of 0.40 for the inter-annual variability in the rate of successful reproduction was estimated for the stocks examined. There were insufficient data to estimate the long-term (for example decadal-scale) variability of reproduction. Cooke assessed the implications of this level of variability for trajectories of recovering baleen whale populations, with and without the assumption of additional variability at the decadal scale (see Appendix 4).

The simulations suggested that the trajectories of recovering stocks would be expected to show very little signal of environmental variability, and would be well approximated by deterministic models, until the stocks have recovered to about $0.5K$ (where K is carrying capacity) or more. The fact that many populations have shown smooth exponential increase as they have recovered from low levels, does not imply that they will continue to show smooth trends. Particularly in the case of the Southern Hemisphere, where for several decades baleen whale stocks had been recovering from low levels, higher variability might be expected from now onwards, as stocks recover above $0.5K$.

The Working Group took note of the predictions and agreed to keep the item on its agenda, to be discussed if new analyses are forthcoming. The Working Group suggested that efforts be made to include effects of environmental variability in population models, including the individual-based energetic models that are being developed.

3.3 Modelling of competition among baleen whales

Friedlaender presented results from three studies on the foraging ecology of humpback and Antarctic minke whales from satellite tagging studies in the waters off the western side of the Antarctic Peninsula. This research is part of the IWC-SORP supported research programme on the foraging ecology of baleen whales in the Antarctic. In the first paper (SC/67a/EM10), state-space models were employed to satellite tag data from both species to understand the influence of environmental parameters (e.g. sea ice) on the foraging behaviour of each species. Comparisons were also made to understand how the foraging ranges of each species was defined and affected by environmental variables. The authors found that humpback whales spent greater periods of time in area-restricted search and were less likely to switch behavioral states than minke whales, forage in open water and close to shore whereas minke whales were more tied to seasonal sea ice regardless of its location. There was overlap in the core foraging areas of humpback and minke whales, but minke whales had to search far broader areas in order to find suitable habitat for foraging and predator avoidance. There was no current indication that prey was limiting in this ecosystem, but the potential for competition may exist as climate-driven changes decrease the amount of available foraging habitat for minke whales while concurrently increasing open water for humpback whales in which to forage. The results provide the first quantitative estimates for the foraging behaviour of both krill predators in Antarctic waters and provide insights as to the potential effects of a rapidly changing environment on the structure and function of a polar ecosystem. In the other study (SC/67a/EM11) movement was partitioned into seasonal changes in geography, composition, and characteristics using a multi-state mixture movement model. Whales later in the austral fall spent more time in movements associated with foraging, travelled at lower speeds between foraging areas, and shifted their distribution northward and inshore. Seasonal changes in movement were likely due to a combination of sea ice advance and regional shifts in the primary prey source. This study presented an important step towards mechanistic models of movement in the marine environment at broad scales. In the final study (Weinstein *et al.*, 2017) the spatial distribution of satellite-tagged humpback whales and krill fishery effort were analysed within the small-scale management units defined by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). Using a Bayesian movement model to partition whale movement into traveling and area-restricted search states, it was found that both whale behaviour and krill catch effort were spatially clustered, with distinct hotspots of the whale activity in the Gerlache and southern Branfield Straits. These areas aligned with increases in krill fishing effort, and present potential areas of current and future conflict. The study recommended that the Antarctic West and Bransfield Strait West management units merit particular attention when setting fine-scale catch limits and, more broadly, consideration as critical areas for krill predator foraging.

A question was raised regarding the temporal scale over which the tagging took place. Friedlaender indicated that all minke whales were tagged on the same day, while all humpback whales were tagged within four days on either side of the minke whales. The acknowledged difficulty in tagging minke whales was overcome, in part, by approaching the whales when they are in groups and by assessing their behaviour to minimise the probability the minke whale will move away. Friedlaender offered to discuss the authors' approach with interested parties.

3.4 Stable isotope analyses

Aguilar presented SC/67a/EM05 and SC/67a/EM06, which both focused on the validation of stable isotope sampling techniques. SC/67a/EM05 addressed the reliability of using faecal material to assess short-term diet composition in baleen whales. It investigated whether stable isotope values of the prey were affected by digestive enzymes and bacteria during the passage along the digestive tract by analysing faeces from Icelandic fin whales and comparing results with those from krill and a variety of fish prey. Results showed that stable isotope values of krill remained unaltered. Also, the stable isotope values of faeces, which under visual inspection appeared to only contain fish remains, revealed that contribution of krill in the digested food was indeed substantial. This demonstrated that: (i) results from macroscopic gross analysis of faeces may be misleading because less digestible components, such as fish bones, may be overrepresented; and (ii) that faecal stable isotope values contribute significant information to the assessment of short-term diet.

SC/67a/EM06 focused on the use of baleen plates, which are composed of inert tissue that grows incrementally and that therefore archives in a sequential manner the stable isotopic values of the whale body pool during a time span of several years. Baleen plates differ in size and sometimes in coloration between different segments of the filtering row or between sides of the mouth, so concern has been raised on the effect of such variation on structural composition and growth rates of the plates that might be affecting the stable isotope values and their oscillations. The paper examined the replicability of patterns between baleen plates occupying different positions in the mouth of a fin whale. Results showed that all baleen plates, independently of their position in the filtering apparatus, size or coloration, grow at the same rate and display similar stable isotope values and oscillations. Therefore, position of sampling along the baleen plate row should not be a reason of concern when conducting stable isotope studies.

The discussion of SC/67a/EM05 focused on how long the intestine contents keep their isotopic concentration. The main conclusion was that, in principle, stable isotopes are not degraded and can be measured in decomposed material. However, there was some concern that in highly degraded tissue, microbial activity may change the composition, for example, the enrichment of nitrogen ranges. This was highlighted as an area in need of investigation.

A question was raised as to whether the results of SC/67a/EM06 could be extended to similar analyses for Antarctic minke whales, where the baleen is regularly sampled from a central position, as there was a desire to ensure that best sampling practice was being followed. The authors stated that their main conclusion was that any baleen plate will produce the same information, while the longest plate contains the most information because of the extended time period over which it has grown. Therefore, the authors concluded that if the samples were always being drawn from the same location, then the results of SC/67a/EM06 would also be applicable to minke whales.

3.5 Review 'regime shift' component of NEWREP-NP

Annex 17 of SC/67a/SCSP10 reported on the review of the 'regime shift' component of NEWREP-NP. In the original plan of NEWREP-NP, 'regime shift' issues were one of the secondary objectives. The original aim of this point was to contribute to the understanding of the implications of environmental change in terms of whale stock management, rather than detection of a major environment change itself. It is difficult to predict whether a major environmental change (categorised as a 'regime shift') would occur within twelve years of NEWREP-NP. These discussions during the Expert Panel's meeting led to the recognition that the original wording of this proposal, 'regime shift', may have been to specific. Hence, the proponents amended this wording as 'environmental change' in order to better reflect their intention. Because 'regime shift' has been identified as one of the types 'environmental changes', the amendment was consistent with the original proposal. Furthermore, given the Panel's recommendation, the original Secondary Objectives I(v) and II(v) were treated as Ancillary Objectives rather than Secondary Objectives in the revised plan. The proponents will monitor spatial distribution of whales, compositions of prey species and body conditions of target whales. They will then investigate potential influential factors, such as the availability of prey resources, which may explain temporal changes in the indexes mentioned above if observed. Such monitoring and investigation will contribute to future in-depth assessment of whales as in the case of Antarctic minke whales.

3.6 Others

Reyes presented SC/67a/EM13 which took note of IWC Resolution 2016-3 'Cetaceans and Their Contribution to Ecosystem Functioning'[1] highlighting the important role that whales play in cycling nutrients through the oceans, in the sequestration of carbon and in enhancing ecosystem productivity, as well as the importance of 'whale falls' as microhabitats in the deep sea. In the resolution, the Commission asked the Scientific Committee 'to screen the existing research studies on the contribution of cetaceans to ecosystem functioning to develop a gap analysis regarding research and to develop a plan for remaining research needs'. SC/67a/EM13 was intended to help this process and provided a comprehensive bibliography of relevant scientific publications to date and suggestions for further research to help fill knowledge gaps. Furthermore, the authors recommended holding an international workshop to further develop research into the roles of cetaceans as ecosystems engineers.

Discussion revolved around the testability of the interesting hypotheses laid out in SC/67a/EM13, especially given the potential complexity of the models that would ensue. The authors clarified that they had brought the item to EM for advice and guidance on the best way forward with regards to building their hypotheses into quantitative models that can be fit to data. Advice was offered regarding the use of tools such as EcoSim, as well as other papers and projects on animal movement and habitat use that speak to how and where animals can be part of ecosystem models using data, rather then simulations. The Working Group welcomed the presentation of SC/67a/EM13 and **agreed** that the sub-committee was the proper place to bring such work. In addition, the Working Group **encouraged** relevant submissions in the future, especially in light of Resolution 16.3.

[1]*https://archive.iwc.int/pages/search.php?search=%21collection72&k=.*

4. ECOSYSTEM MODELLING IN THE ANTARCTIC OCEAN

4.1 Review progress of modelling

SC/67a/EM14 presented a revision of the Mori and Butterworth (2006) model, incorporating model improvements and updates of abundance and trend information in krill and predator species (SC/67a/EM14). Key additions to the model were the inclusion of a dispensatory effect for Antarctic fur seals in the krill and predator dynamics, and the imposition of bounds on K_a (the carrying capacity for krill in Region *a*, in the absence of its predators); these led to a better fit to the data overall. A particular difference in results compared to those from the Mori-Butterworth model was more oscillatory behaviour in the trajectories for krill and some of its main predators. This likely resulted from the different approach to modelling natural mortality for krill (which decreases the residual mortality remaining after taking account of consumption by the main predators) and warrants further investigation. That may in turn resolve a key mismatch in the model, which predicts minke whale oscillations in the Indo-Pacific region to be out of phase with results from a SCAA assessment of these whales.

Tulloch presented SC/67a/EM12, which described a focused spatial 'Model of Intermediate Complexity for Ecosystem Assessments' (MICE) for phytoplankton, krill, copepods and five baleen whale species for the Southern Hemisphere. The model included predator-prey interactions, and estimated whale population trajectories from 1890 to present. Forward projections to 2100 coupled the predator-prey model to a global climate model. The model predicted Antarctic blue, fin, and southern right whale populations at <50% pre-exploitation numbers (*K*) in 2100, even given 100 years without catches, because of slow growth rates. Southern right whales were estimated to currently be <11% of their carrying capacity, while humpback whales were predicted to recover to *K* by 2050. Spatial differences in the recovery of whale species between oceanic regions were highlighted, with slower recovery of blue and fin whales in the Atlantic/Indian region, and slower recovery of southern right whales in the Pacific. Minke population trajectories tracked future expected increases in primary productivity. By using the most up-to-date corrected whaling records, accounting for some key uncertainties (e.g. through model calibration, sensitivity analyses) and fitting to all available survey data, the model presented an updated assessment for blue, fin, humpback, right and minke whales in the Southern Hemisphere as a basis for exploring ecosystem dynamics in the Southern Hemisphere. Results demonstrated key differences in population trajectories and estimates between models that account for, or ignore, predator-prey linkages. This is a strategic model that provides a platform for exploring additional hypotheses and management strategies, and is being modified in a step-wise fashion to explore predator-prey interactions and the effects of future environmental change on krill and whales.

In considering the ecosystem models presented in SC/67a/EM14 (MB model) and SC/67a/EM12 (MICE model), the Working Group noted the differences in objectives, trophic interactions captured and scales of the models, but also some of the synergies in key data requirements. Both are krill-based predator-prey multispecies models, and are naturally underpinned by similar data requirements (though at different scales) and a requirement for a sound understanding of ecosystem function. As ever, models and data are imperfect. A discussion of data deficiencies, or 'missing links' in the models, identified cephalopods and salps as two potentially important species about which relatively little is known. More broadly, it was acknowledged that little was known about dynamics, abundances or trends in mesopelagic species.

The need for better data for describing population dynamics of individual species, and for more quantitative information about energy transfer between related trophic levels was emphasised. While MB is macro scale, and MICE tends towards mesoscale, both have the potential to derive useful input from studies of small-scale processes. Telemetry-based studies of individual animal energetics might provide one such example, with the additional possibility that such studies can help to quantitatively determine the nature of functional responses. Other advances in technology also open new opportunities, such as cameras on drones, fishing gear, and land-based remote monitoring.

The implications for hypothesis generating or testing from ecosystem models was briefly discussed. The MB model is well suited for assessing large-scale, whole-of-ecosystem response to broad-scale change (e.g. the differential recovery of baleen whales after the cessation of long-term whaling). MICE, on the other hand, is able to utilise covariates at various scales to provide short- to medium-term predictions for defined ecosystem responses to hypothesised changes in covariate values. Ecosystem response to changing resource availability is an obvious example, which has seen application in monitoring CCAMLR Small Scale Management Units (SSMUs).

4.2 Cooperation with CCAMLR on multi-species modelling

The Working Group was pleased to be able to welcome several CCAMLR members to participate in discussions, in particular Mark Belchier, current Chair of the CCAMLR Scientific Committee. A previous IWC-CCAMLR workshop on data requirements for ecosystem models was held in 2008, so it was timely that another workshop is in the planning stages for 2019. The Working Group **agreed** that data sharing, data quality control, and identifying data gaps were key issues to be resolved at an institutional level between the IWC and CCAMLR. 'Data first, models second' was the flavour of the discussion. It was recognised that CCAMLR and IWC both share similar goals in terms of developing whole-of-ecosystem modelling approaches, and that this similarity could be leveraged to the advantage of both organisations. A defined area for collaborative modelling between CCAMLR and IWC members was suggested, with the Antarctic Peninsular as one possibility. This would perhaps be a worthwhile topic for an IWC-CCAMLR workshop on ecosystem processes and models.

4.3 Plan for joint SC-CCAMLR – IWC SC workshops

Plans for two joint SC-IWC/SC CCAMLR workshops to develop multi-species models of the Antarctic marine ecosystem were discussed. The chairman of CCAMLR's SC noted that there had been no agreement reached at CCAMLR XXXV to fund attendance of CCAMLR scientists at the proposed 1.5 day 'plenary' workshop scheduled for 2017. However, it was recalled that the CCAMLR Commission anticipated that a workshop would be held in 2018.

Noting that there was still a clear need to progress the development of multi-species models, several options to advance the work were considered. It was **agreed** that this work would best be facilitated through workshops, noting that the breadth of topics was likely to make the use of an Intersessional Contact Group difficult. The TORs agreed in 2015 were reviewed and were still considered valid. However, it was suggested that there should be a greater emphasis on the Western Antarctic Peninsula region (CCAMLR subarea 48.1) and especially in the regions in which the krill fishery has, in recent years, become much more spatially constrained. Outputs could help to inform the 'risk assessment' approach to spatial management in the region and assist in the development of the feedback management of the krill fishery.

Two workshops could be run in conjunction with the IWC-SC and WG-EMM (or CCAMLR intersessional meetings) in 2018 and 2019 respectively (see Appendix 5). The Working Group endorsed the revised plan for the workshops with CCAMLAR. It was noted that progress may be facilitated if the attendance at the first workshop was limited (to a maximum of about 4 attendees each as for primary goal would be planning future initiatives rather than reviewing research). The broad ecological scope the 2008 IWC/SC meeting had been ambitious but this may have reduced its overall impact.

The Working Group **recommended** that collaboration between IWC-SC/SC-CAMLR be ongoing, and that the revised plan for the workshops be implemented.

5. APPLICATION OF SPECIES DISTRIBUTION MODELS (SDMS) AND ENSEMBLE AVERAGING

5.1 Review progress of guideline for SDMs

An intersessional Correspondence Group (CG) has been established since SC/65b to develop guidelines and recommendations for best modelling practices of species distribution models (SDMs). The group conducted a preliminary review of SDMs applied to baleen whales during the first intersessional period between SC/65b and SC/66a (Murase *et al.*, 2015). Subsequently, the group conducted preliminary reviews of machine learning methods, which are commonly used as SDMs, and during the subsequent intersessional period between SC/66a and SC/66b developed general guidelines for their application (Murase *et al.*, 2016). SC/67a/EM15 reported on progress made by the CG between SC/66b and SC/67a. During the period, the group updated Murase *et al.* (2015) by adding information from Murase *et al.* (2016) as well as integrating a further 12 reviews of SDM papers published between March 2015 and December 2016. The CG plans to complete the tasks assigned to the group during the intersessional period from SC/67a to SC/67b. The work plan includes the following tasks: (1) revising descriptions of each machine learning method; (2) adding short methods descriptions for boosted regression trees (BRT) and generalised additive models (GAM); (3) adding a short guideline for GAM, with appropriate citations; and (4) final preparation for journal publication.

The Working Group thanked the CG for work during the intersessional period, and invited interested members of the group to provide feedback. It was noted that while the focus of the review had been on machine learning methods for species distribution models, GAMs were becoming an increasingly useful framework for these kinds of analyses and that section could potentially be expanded. It was noted that many machine learning methods are relatively opaque when it comes to model checking diagnostics, but that modern GAM's are firmly grounded in statistical theory and have available a rich suite of GLM-related diagnostic tools. The Chair noted that the guidelines for SDMs is intended to be a living document, and so areas could be expanded as interest and time allowed. Finally, it was noted that an explanatory application of the guidelines to some real or simulated data would be useful.

5.2 Review progress of works on SDMs and ensemble modelling

A joint IWC-National Marine Fisheries (NMFS) Workshop titled 'Towards Ensemble Averaging of Cetacean Distribution Models' was held in San Diego, USA, prior to SC/66a. The objective of the Workshop was to convene a group of experts in modelling, statistics, and marine ecology to identify methods to compare and combine model predictions using existing species distribution models (SDMs) for Eastern North Pacific blue whales as a case study.

In 2016, the US E-mail Correspondence Group (US-CG) (Elizabeth Becker, Monica DeAngelis, Daniel Palacios, and Jessica Redfern) determined that a scaled-down version of the original work plan was necessary. The US-CG decided to focus on the risk of ships striking blue whales on the USA west coast and to use only those models that covered the entire USA west coast. Preliminary work to create an ensemble of the predictions was conducted and raised a number of questions.

In 2017, the US-CG, together with Karin Forney and Elliott Hazen, made significant progress in addressing these questions. In particular, the predictions from each model were developed using unique grids and spatial resolutions. The group created a unified grid for all predictions and identified areas where model predictions were similar and where they were different. They also developed methods to scale the different predictions (e.g. density versus probability of occurrence). Finally, the authors used the area under the receiver operating characteristic curve (AUC) and related metrics to explore different methods for weighting the predictions in the ensemble. This work is expected to be completed in the coming year and the plan is to submit a manuscript to a peer-reviewed journal.

In considering Redfern *et al.* (2017), the Working Group noted that a summary of this work had also been presented during SH (see Annex H), but that the focus of discussion here would be on the methodological aspects of the study. The goal of the study was to predict cetacean distributions in data poor ecosystems. Blue whales (*Balaenoptera musculus*) were used as a case study because they are an example of a species that have well-defined habitat and are subject to anthropogenic threats. The highest blue whale densities in the eastern Pacific Ocean are associated with upwelling-modified waters that are highly productive and support dense aggregations of krill. Consequently, habitat variables that identify variations in upwelling, circulation, and water column stratification that may affect forage availability were used in the models. The study used 377 sightings of one or more blue whales and approximately 225,400km of effort from surveys conducted by NOAA Fisheries' Southwest Fisheries Science Center from August through November (California Current: 1991, 1993, 1996, 2001, 2005, 2008, and 2009; eastern tropical Pacific: 1998, 1999, 2000, 2003, and 2006). Generalised additive models (GAM) (Wood, 2006) were used to relate the number of blue whales in each transect segment to the habitat variables, largely following the methods of Becker *et al.* (2016). Four measures of model performance (AUC, TSS, and the percentage of sightings in the highest 2 and 10% of predicted densities) identified a single model that provides the best match to the blue whale sightings in each ecosystem. This model was used to predict blue whale distributions, rather than using an ensemble of predictions from GAMs with different habitat variables.

The Working Group queried why ensemble averaging hadn't been performed for competing models. The authors explained that model assessment metrics and independent experts identified a single best model that performed better than ensemble. The chosen models performed consistently well on both quantitative metrics and qualitative expectations. There was some discussion which pointed out that the methods performed well for these particular data, but that the good performance may be specific to the case in question. Therefore, there was interest in whether picking a best model may result in uncertainty being under-represented should the method be applied more generally. It was suggested that the broad geographic area of the study region would likely capture several distinct behavioural states (e.g. transiting and foraging), and that different models may be capturing different aspects of behaviour unequally. In discussion of the on-going ensemble modelling, it was noted that the methods for combining uncertainty when averaging an ensemble of models were not yet well developed. The Working Group **encourages** an update on the progress of this work at a future meeting of the Scientific Committee.

6. OTHER MATTERS

6.1 Review information on krill distribution and abundance by NEWREP-A

SC/67a/EM09 reported on krill and oceanographic surveys in Antarctic Areas V-W during the 2016/17 austral summer season as a part of second New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) dedicated sighting survey. Two research vessels, one of which is a trawler-type vessel since this year, were engaged with krill acoustic survey and net samplings by small ring nets and an Issak-Kid Midwater Trawl (IKMT) for species identification and size compositions of plankton at 32 stations and 13 stations, respectively. Oceanographic observations using CTDs and water sampling were also conducted coincidentally. Krill and oceanographic data are currently being examined, and results obtained in the 2016/17 season will be presented to a CCAMLR specialists' workshop. Feedback from the specialists will be reflected in the planning of the 2017/18 survey.

The Working Group thanked the authors for their work. It was also clarified that the departure from the expected krill survey design was due to the data being collected in conjunction with a survey for whales, and would still meet the needs of the study.

6.2 Other

Mate *et al.* (2016) described new archival Advanced Dive Behaviour (ADB) tag technology that has documented dive profiles (depth and duration) as well as foraging effort by blue, fin and sperm whales. ADB tags need to be recovered to obtain all of the detailed data for subsequent analysis, so there is a practical limit of how long they are allowed to stay attached for convenient surface recovery in the study area. For example, 7 ABD tags on blue whales provided data on >17,300 dives, during average attachments of 23 days, documenting high daily variability in diel dive depths and foraging effort. The time between intense foraging bouts (with ARS type movements) was frequently characterised by 'transiting' (more linear) travel that can last 8-16 days and cover long distances with continued diving without foraging proxies to search for dense prey patches. The

Table 1
Summary of the work plan for the EM working group.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
(1) Cooperation with CCAMLR on multispecies modelling	Prepare a pre-meeting Workshop under a Steering Group (see Table 2).	Hold a pre-meeting Workshop to review the status of multispecies models and available data series (see Appendix 5).
(2) Applications of species distribution models (SDMs)	Intersessional Working Group activity (see Annex W).	Review progress by SDM working group.
(3) Effects of long-term environmental variability on whale populations	Continue further analyses.	Review progress by working group.
(4) Further investigation of individual-based energetics models	Continue further analyses.	Review results of further analyses.
(5) Modelling of competition among whales	Continue further analyses	Review results of further analyses.
(6) Update of information on krill distribution and abundance by NEWREP-A	Conduct a survey by consultation of CCAMLR specialists.	Review results of the survey and analysis.

details of the foraging effort and variability had never been recorded for such long periods. On sperm whales, ADB tags documented how foraging bouts at different depths could change without diel influence to reveal details of habitat and prey preferences. Because researchers traditionally study foraging in 'good habitats', where whales are abundant, scientists have come to think whales do not have problems finding food. The foraging proxies reported by ADB tags now quantify the extent of changed foraging predicted by state-space analyses and give a much more detailed understanding of the patchy prey distribution whales encounter and which aspects of habitat types they find most productive. The authors deployed more advanced tags last year on blue and fin whales that no longer require recovery to acquire similar information for >100 days.

The Working Group thanked the authors for the work and encouraged the continuation of the research and expressed the desire that future results continue to be presented to the Working Group. The authors further clarified that they have used click reflection intervals to help estimate whale lengths.

7. WORK PLAN

See Table 1 for the work plan and see Annex W for a list of intersessional correspondence groups.

8. ADOPTION OF REPORT

The report was adopted on 17 May 2017 at 17:35. The Chair expressed his sincere appreciation to the rapporteurs, Butterworth, McKinlay, New and Skaug, for their excellent work. The Working Group thanked Kitakado for his leadership and gratefully accepted his offer to convene the Group next year.

REFERENCES

Aguilar, A., Borrell, A. and Gómez-Campos, E. 2007. The reliability of blubber thickness as a measure of body condition in large whales. 11pp. Paper SC/59/O17 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Becker, E.A., Forney, K.A., Fiedler, P.C., Barlow, J., Chivers, S.J., Edwards, C.A., Moore, A.M. and Redfern, J.V. 2016. Moving towards dynamic ocean management: how well do modelled ocean products predict species distribution? *Remote Sensing* 8: 149.

International Whaling Commission. 2011. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. *J. Cetacean Res. Manage. (Suppl.)* 12:399-411.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex K1. Report of the Working Group on Ecosystem Modelling. *J. Cetacean Res. Manage. (Suppl.)* 16:277-90.

Konishi, K. and Walløe, L. 2015. Substantial decline in energy storage and stomach fullness in Antarctic minke whales (*Balaenoptera bonaerensis*) during the 1990s. *J. Cetacean Res. Manage* 15: 77-92.

Lockyer, C. 1981. Growth and energy budgets of large baleen whales from the Southern Hemisphere. *FAO Fisheries Series No. 5 (Mammals in the Sea)* 3: 379-487.

Mate, B.R., Irvine, L.M. and Palacios, D.M. 2016. The development of an intermediate-duration tag to characterize the diving behaviour of large whales. *Ecol. Evol.*: 1-11. DOI: 10.1002/ece3.2649.

Mori, M. and Butterworth, D.S. 2006. A first step towards modelling the krill-predator dynamics of the Antarctic ecosystem. *CCAMLR Science* 13: 217-77.

Murase, H., Friedlaender, A., Kelly, N., Kitakado, T., McKinlay, J., Palacios, D.M. and Palka, D. 2016. Progress report of the intersessional corresponding group 'Applications of species distribution models (SDMs)' since 66a IWC/SC. Paper SC/66b/EM04rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 31pp. [Paper available from the Office of this Journal].

Murase, H., Friedlaender, A., Kelly, N., Palacios, D.M. and Palka, D. 2015. A preliminary review of species distribution models (SDMs) applied to baleen whales. Paper SC/66a/EM03 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

Redfern, J.V., Moore, T.J., Fiedler, P.C., De Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23: 394-408. [Available at: *http://wileyonlinelibrary.com*].

Solvang, H.K., Yanagihara, H., Oien, N. and Haug, T. 2017. Temporal and geographical variation in body condition of minke whales (*Balaenoptera acutorostrata acutorostrata*) in the Northeast Atlantic. *Polar Biol.* 40: 667-83.

Weinstein, B.G., Double, M., Gales, N., Johnston, D.W. and Friedlaender, A.S. 2017. Identifying overlap between humpback whale foraging grounds and the Antarctic krill fishery. *Biol. Cons.* 210: 184-91.

Wood, S.N. 2006. *Generalized Additive Models: an Introduction with R*. Chapman and Hall, Boca Raton, Florida. 391pp.

Yamamura, M., Yanagihara, H., Solvang, H.K., Oien, N. and Haug, T. 2016. Canonical correlation analysis for geographical and chronological responses. *Procedia Comput. Sci.* 96: 1,351-60.

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of Agenda
   1.5 Documents available
2. Body condition analyses
   2.1 Antarctic minke whales
      2.1.1 Review results of analyses
      2.1.2 Discussion
      2.1.3 Conclusion
   2.2 Review approaches used in body condition analyses for other stocks
3. Review issues relevant to ecosystem modelling within the Committee
   3.1 Individual-based energetic models
   3.2 Effects of long-term environmental variability on whale populations
   3.3 Modelling of competition among baleen whales
   3.4 Stable isotope analyses
   3.5 Review 'regime shift' component of NEWREP-NP
   3.6 Others
4. Ecosystem modelling in the Antarctic Ocean
   4.1 Review progress of modelling
   4.2 Cooperation with CCAMLR on multi-species modelling
   4.3 Plan of joint SC-CAMLR-IWC SC workshops
   4.4 Work plan
5. Application of species distribution models (SDMs) and ensemble averaging
   5.1 Review progress of guideline for SDMs
   5.2 Review progress of works on SDMs and ensemble modelling
6. Other matters
   6.1 Review information on krill distribution and abundance by NEWREP-A
   6.2 Others
7. Work plan
8. Adoption of report

Appendix 2

RELATIVE CONTRIBUTION OF BLUBBER AND OTHER BODY COMPARTMENTS TO THE LIPID BODY POOL OF LARGE WHALES AND THEIR ROLE AS PROXIES OF BODY CONDITION - COMMENTS ON SC/67a/EM01

Alex Aguilar

SC/67a/EM01 presented to this meeting proposes that fat stores in bone and muscle are as important as blubber stores and, consequently, that blubber thickness, or by extension any index based on blubber characteristics, would not be a good proxy of body condition. However, this assumption appears inconsistent with previous results on energetics and lipid metabolism, which do show that blubber indeed constitutes the main lipid depot in baleen whales (Aguilar and Borrell, 1994; Aguilar *et al.*, 2007; Lockyer, 1981; 1987b).

The reason for this apparent inconsistency appears to be that document SC/67a/EM01 was based on extreme values or non-representative data on muscle and bone lipid content extracted from two papers by Lockyer (1981) and Lockyer (1987b) North Atlantic (Iceland) fin whales. These papers are re-examined here to extract from them truly representative values, and incorporate other values obtained from a comparable study also on North Atlantic (Spain) fin whales (Aguilar and Borrell, 1994). As it can be seen in Table A2.1, which depicts the ranges of lipid content values determined in these studies, results were quite consistent in both cases.

Unfortunately, the sample size was not detailed in Lockyer (1987a), so an overall value for each tissue could not be calculated. However, when combining the ranges of the percent lipid values from Table A2.1 with the mean tissue weights by sex calculated for minke whales in document SC/67a/EM01, the resulting figures (Table A2.2) show that the contribution of the blubber to the total lipid body pool is about 5 to 10 times larger than that of bone and about 4 to 8 times larger than that of muscle.

Also, it should be pointed out that the lipid contained in the bone is not necessarily all available for energy because its main function is to lighten the bone density and thus provide buoyancy to the whale (Lockyer, 1987a). For this reason, the sensitivity of bone lipid content to changes in body condition should be expected to be very limited.

All this confirms previous findings that blubber is the main depot for lipid reserves in the body of baleen whales and, as a consequence, that thickness and lipid content of blubber are the most sensitive proxies of body condition in baleen whales.

Table A2.1

Lipid content of various tissue types in fin whales.

Tissue	Tissue/species	Lipid content %	Reference
Blubber	Fin whale	65.5-81.1	Lockyer (1987a)
	Fin whale	67.3-73.3	Aguilar and Borrell (1994)
Muscle	Fin whale	3.4-5-1	Lockyer (1987a)
	Fin whale	5.1-8.9	Aguilar and Borrell (1994)
Bone	Fin whale	18.37	Lockyer (1987a)
	Fin whale	8.2-10.4	Aguilar and Borrell (1994)

Table A2.2

Weight of the various tissue types in minke whales (extracted from SC/67a/EM01) and total lipid weight for these tissue types calculated from the ranges of values detailed in Table A2.1.

	Tissue weight (tonnes)		Total lipid weight (tonnes)	
Tissue type	Females	Males	Females	Males
Bone	1.39	1.17	0.11-0.25	0.09-0.21
Muscle	4.04	3.51	0.14-0.36	0.12-0.31
Blubber	1.76	1.38	1,15-1.43	0.90-1.12

REFERENCES

Aguilar, A. and Borrell, A. 1994. Reproductive transfer and variation of body load of organochlorine pollutants with age in fin whales (*Balaenoptera physalus*). *Archives of Environmental Contamination and Toxicology* 27(4): 546-54.

Aguilar, A., Borrell, A. and Gómez-Campos, E. 2007. The reliability of blubber thickness as a measure of body condition in large whales. 11pp. Paper SC/59/O17 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 11pp. [Paper available from the office of this Journal].

Lockyer, C. 1981. Growth and energy budgets of large baleen whales from the Southern Hemisphere. *FAO Fisheries Series No. 5 (Mammals in the Sea)* 3: 379-487.

Lockyer, C. 1987a. Cetacean bioenergetics. *In*: Huntly, A.C., Costa, D.P., Worthy, G.A.J. and Castellini, M.A. (eds). *Marine Mammal Energetics*. Society for Marine Mammalogy, Special Publication 1.

Lockyer, C.H. 1987b. The relationship of body fat, food resource and reproductive energy costs in North Atlantic fin whales (*Balaenoptera physalus*). *Symposia of the Zoological Society, London* 57: 343-61.

Appendix 3

SUPPLEMENTARY ANALYSIS

Celine Cunen

During discussions in the Working Group, the authors of SC/67a/EM04 (Cunen, Walløe, Hjort and Konishi, but specifically Cunen) were asked to provide some additional analyses. They were asked to investigate the effect of diatom-coverage by splitting up the dataset according to the dichotomous diatom variable proposed in SC/67a/EM02, thereby separately analysing animals of low and high diatom coverage. Later, it was also suggested to split the data by sex. Thus, here Cunen presents separate models for four groups of minke whales: males with low diatom coverage, females with low diatoms coverage, males with high diatom coverage and females with high diatom coverage. Two response variables are used, fat weight and BT11 (for definition see SC/67a/EM04).

Further suggestions concerned removing observations from the Ross sea, which was done here. In addition, the authors of SC/67a/EM04 were asked to produce plots showing the effect of each year, i.e. allowing each year to have a different intercept. The new model is referred to as the 'categorical model':

Y ~ YearCat + BLm +DateNumS + I(DateNumS^2) + LatNumS + (Fetus.length) + LatNumS*DateNumS +LatNumS*I(DateNumS^2) + Age + (0 +DateNumS + I(DateNumS^2)|YearCat)

Note that:

- 'region' was removed, as were all interaction terms with this categorical variable (not possible to use with year as categorical);
- 'age' was added (clearly significant and was mentioned in the meeting with interest);
- 'ice' was removed;
- the random effects of Year on the effect of date were retained, but the random effect on the intercept was removed, since this is in a way the same as the categorical year-term now included; and
- foetus length only applies to the female groups.

The categorical model was applied to the four groups of animals defined above, and for each group figures displaying the categorical effect of each year, along with error bars corresponding to one standard error are provided. In all cases, year 1 is set as the reference value. The figures must thus be interpreted as the *change* in intercept (compared to year 1) for each year. For fat weight the scale of measurements is tonnes, for BT11 it is centimetres.

The author also applied versions of our original wide model (see SC/67a/EM04) to each group. In this note, this model is referred to as the 'linear model'. The linear model had to be simplified in some cases due to the reduced sample sizes. For this model, all the estimated coefficients are provided.

In conclusion, the four groups of animals displayed somewhat differing patterns for some of the explanatory variables. The author claims that these differences can be taken care of by carefully chosen interaction terms and thus do not necessitate the data-splitting which has been undertaken here. Splitting up the dataset is generally considered unfortunate, leading to reduced power.

As a whole, the plots of the year effects from the categorical model indicated decrease in body condition for most of the animal groups. Generally, the negative trend was clearer with fat weight than with BT11 (which seems to display more year-to-year variation). An exception is the plot with fat weight for females with low diatom coverage. There the last years seem to indicate an increase in body condition. Note, however, that females with low diatom coverage is the smallest group among the four considered (for fat weight this group only includes 96 animals).

The results from the linear model are summarised in Table A3.1. The estimated linear effect of year was negative in all groups, and for several was clearly significant (at a 5% level). Groups with low diatom levels generally had less clear negative patterns than the groups with high diatom loads. This could have a biological reason.

Table A3.1

Summary results from the linear models.

	Fat weight		BT11	
Sex/diatom	*n*	Est. (*t* statistic)	*n*	Est. (*t* statistic)
Males, low	162	-0.013 (-4.2)	940	-0.008 (-0.8)
Female, low	96	-0.004 (-0.9)	573	-0.013 (-1.5)
Male, high	281	-0.010 (-3.6)	1,793	-0.016 (-2.0)
Female, high	103	-0.015 (-2.1)	657	-0.0028 (-2.1)

All in all, the results presented here do not change the authors' original conclusions from SC/67a/EM04. They are consistent with the hypothesis that there has been a decline in body condition during the 18 years of the JARPA study.

Fat weight results – Males with low diatom coverage (162 observations)

Table A3.2 provides the estimated coefficients for the linear model for the fat weight of males with low diatom coverage, and Fig. A3.1 displays the year effects from this categorical model.

Table A3.2

The estimated coefficients for the linear model for the fat weight of males with low diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	-1.370	0.334	-4.100
YearNum	**-0.013**	**0.003**	**-4.244**
BLm	0.322	0.041	7.915
Ice	0.052	0.028	1.842
DateNumS	0.069	0.018	3.762
I(DateNumS^2)	0.018	0.015	1.178
LatNumS	-0.02	0.021	-1.090
Age	0.003	0.001	2.218
DateNumS:LatNumS	-0.03	0.018	-2.155
I(DateNumS^2):LatNumS	0.003	0.019	0.173

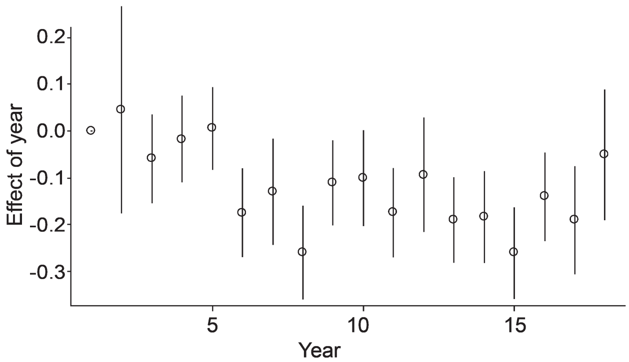

Fig. A3.1. The categorical effect of each year on fat weight (in tonnes) for males with low diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for the other years must be interpreted as the change in intercept compared to year 1.

Fat weight results – Females with low diatom coverage (96 observations)

Table A3.3 provides the estimated coefficients for the linear model for the fat weight of females with low diatom coverage, and Fig. A3.2 displays the year effects from this categorical model.

Table A3.3

The estimated coefficients for the linear model for the fat weight of females with low diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	-2.267	0.529	-4.285
YearNum	**-0.004**	**0.005**	**-0.881**
BLm	0.412	0.062	6.653
Ice	-0.057	0.053	-1.078
DateNumS	0.002	0.047	0.041
I(DateNumS^2)	0.072	0.032	2.269
LatNumS	-0.014	0.035	-0.404
Age	0.007	0.003	2.308
Fetus.length	0.002	0.001	1.794
DateNumS:LatNumS	-0.039	0.025	-1.544
I(DateNumS^2):LatNumS	-0.015	0.026	-0.582

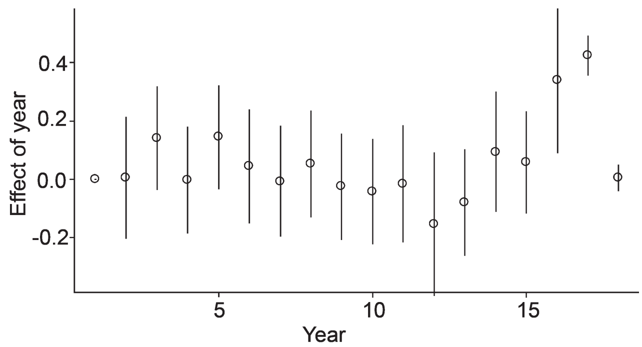

Fig. A3.2. The categorical effect of each year on fat weight (in tonnes) for females with low diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

Fat weight results – Males with high diatom coverage (281 observations)

Table A3.4 provides the estimated coefficients for the linear model for the fat weight of males with high diatom coverage, and Fig. A3.3 displays the year effects from this categorical model.

Table A3.4

The estimated coefficients for the linear model for the fat weight of males with high diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	-1.891	0.196	-9.659
YearNum	**-0.010**	**0.003**	**-3.622**
BLm	0.395	0.024	16.753
Ice	0.030	0.023	1.303
DateNumS	0.096	0.020	4.900
I(DateNumS^2)	0.006	0.012	0.469
LatNumS	-0.032	0.015	-2.083
Age	0.004	0.001	4.156
DateNumS:LatNumS	-0.024	0.011	-2.119
I(DateNumS^2):LatNumS	-0.003	0.010	-0.293

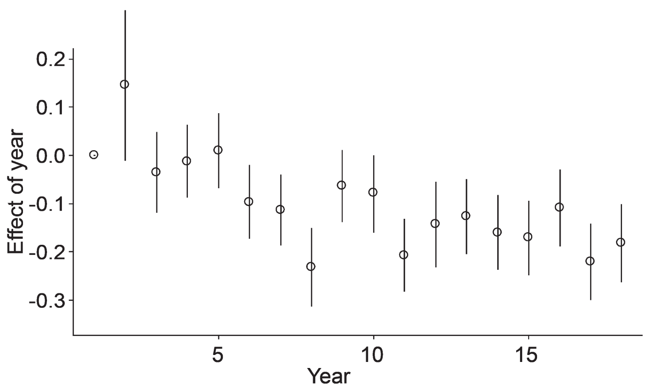

Fig. A3.3. The categorical effect of each year on fat weight (in tonnes) for males with high diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

Fat weight results – Females with high diatom coverage (103 observations)

Table A3.5 provides the estimated coefficients for the linear model for the fat weight of females with high diatom coverage, and Fig. A3.4 displays the year effects from this categorical model.

Table A3.5

The estimated coefficients for the linear model for the fat weight of females with low diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	-2.657	0.581	-4.571
YearNum	**-0.015**	**0.007**	**-2.133**
BLm	0.492	0.067	7.306
Ice	-0.128	0.092	-1.397
DateNumS	-0.003	0.047	-0.065
I(DateNumS^2)	0.027	0.035	0.764
LatNumS	0.002	0.050	0.048
Age	0.005	0.002	2.221
Fetus.length	0.001	0.001	2.065
DateNumS:LatNumS	0.004	0.040	0.092
I(DateNumS^2):LatNumS	-0.012	0.027	-0.460

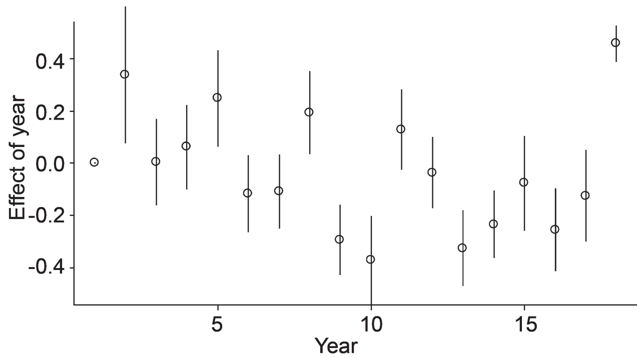

Fig. A3.4. The categorical effect of each year on fat weight (in tonnes) for females with high diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

BT11 results – Males with low diatom coverage (940 observations)

Table A3.6 provides the estimated coefficients for the linear model for BT11 for males with low diatom coverage, and Fig. A3.5 displays the year effects from this categorical model.

Table A3.6

The estimated coefficients for the linear model for BT11 for males with low diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	2.218	0.525	4.222
YearNum	**-0.008**	**0.009**	**-0.814**
BLm	0.107	0.063	1.700
Ice	-0.057	0.057	-0.987
DateNumS	0.327	0.037	8.949
I(DateNumS^2)	0.067	0.025	2.629
LatNumS	-0.005	0.036	-0.140
Age	0.000	0.002	0.084
Region1	-0.040	0.048	-0.831
Region2	-0.094	0.055	-1.722
DateNumS:LatNumS	-0.056	0.030	-1.885
I(DateNumS^2):LatNumS	-0.025	0.025	-1.009
LatNums: Region1	0.067	0.038	1.742
LatNums: Region2	-0.037	0.0447	-0.789

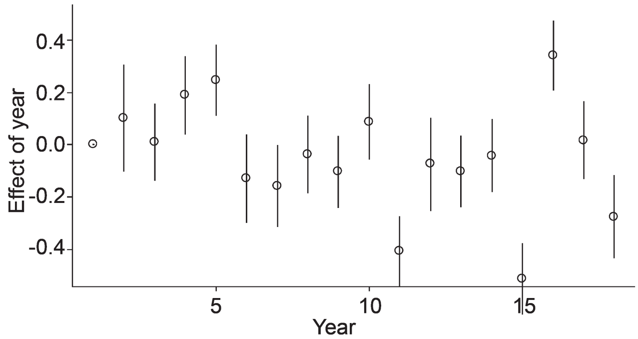

Fig. A3.5. The categorical effect of each year on BT11 (in cm) for males with low diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

BT11 results – Females with low diatom coverage (573 observations)

Table A3.7 provides the estimated coefficients for the linear model for BT11 for females with low diatom coverage, and Fig. A3.6 displays the year effects from this categorical model.

Table A3.7

The estimated coefficients for the linear model for BT11 for females with low diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	2.665	0.783	3.401
YearNum	**-0.013**	**0.009**	**-1.464**
BLm	0.051	0.091	0.562
Ice	0.131	0.089	1.472
DateNumS	0.065	0.051	1.289
I(DateNumS^2)	0.088	0.041	2.129
LatNumS	-0.129	0.061	-2.132
Age	A0.001	0.004	0.132
Fetus.length	0.009	0.002	5.779
Region1	0.011	0.052	0.203
Region2	-0.082	0.059	-1.386
DateNumS:LatNumS	-0.096	0.047	-2.037
I(DateNumS^2):LatNumS	-0.024	0.043	-0.556
LatNums: Region1	0.022	0.057	0.384
LatNums: Region2	-0.206	0.085	-2.414

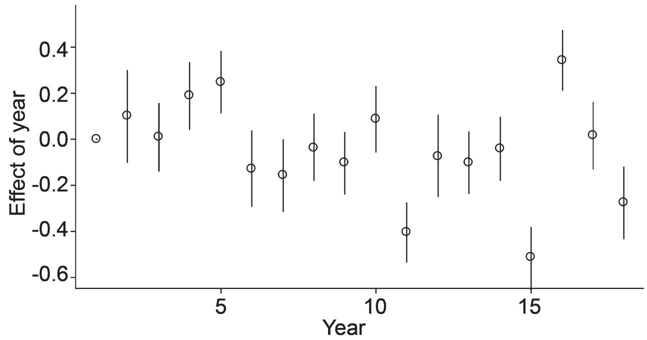

Fig. A3.6. The categorical effect of each year on BT11 (in cm) for females with low diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

BT11 results – Males with high diatom coverage (1793 observations)

Table A3.8 provides the estimated coefficients for the linear model for BT11 for males with high diatom coverage, and Fig. A3.7 displays the year effects from this categorical model.

Table A3.8

The estimated coefficients for the linear model for BT11 for males with high diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	3.076	0.420	7.316
YearNum	**-0.016**	**0.008**	**-1.978**
BLm	0.085	0.051	1.673
Ice	-0.063	0.052	-1.214
DateNumS	0.481	0.042	11.434
I(DateNumS^2)	0.050	0.034	1.464
LatNumS	-0.011	0.034	-0.318
Age	0.001	0.002	0.602
Region1	-0.144	0.042	-3.472
Region2	-0.057	0.050	-1.149
DateNumS:LatNumS	-0.021	0.025	-0.868
I(DateNumS^2):LatNumS	-0.025	0.022	-1.128
LatNums: Region1	0.044	0.033	1.354
LatNums: Region2	-0.044	0.043	-1.011

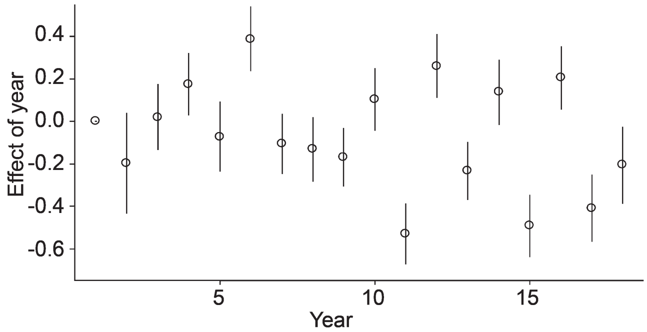

Fig. A3.7. The categorical effect of each year on BT11 (in cm) for males with high diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

BT11 results – Females with high diatom coverage (657 observations)

Table A3.9 provides the estimated coefficients for the linear model for BT11 for females with high diatom coverage, and Fig. A3.8 displays the year effects from this categorical model.

Table A3.9

The estimated coefficients for the linear model for BT11 for females with high diatom coverage.

	Estimate	Std. error	*t* value
(Intercept)	3.010	0.788	3.820
YearNum	**-0.028**	**0.014**	**-2.073**
BLm	0.049	0.089	0.548
Ice	0.013	0.119	0.108
DateNumS	0.134	0.083	1.608
I(DateNumS^2)	0.088	0.053	1.649
LatNumS	-0.165	0.075	-2.217
Age	0.005	0.003	1.733
Fetus.length	0.009	0.001	12.279
Region1	0.049	0.069	0.707
Region2	-0.013	0.075	-0.174
DateNumS:LatNumS	0.077	0.061	1.254
I(DateNumS^2):LatNumS	-0.046	0.045	-1.023
LatNums: Region1	0.141	0.073	1.942
LatNums: Region2	-0.186	0.114	-1.634

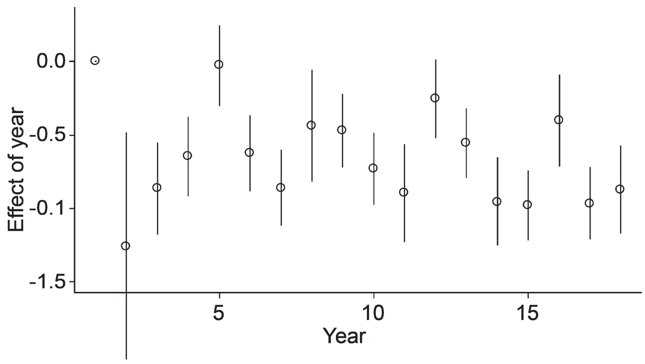

Fig. A3.8. The categorical effect of each year on BT11 (in cm) for females with high diatom coverage. The error bars correspond to one standard error. Year 1 is set as the reference value, and the values for other years must be interpreted as the change in the intercept compared to year 1.

SUPPLEMENTARY ANALYSIS 2: A QUESTION CONCERNING THE CORRECT VARIANCE ESTIMATES AFTER MODEL SELECTION WITH FIC

The authors of SC/67a/EM04 were asked an interesting question about how to correctly estimate the variance of the coefficient estimates after model selection with FIC. The authors computed the variances under the winning model (selected by the procedure), but Cooke pointed out that it may more natural to compute the variance estimates under the wide model (which is the assumed true model). In the figure below, the authors display the effect of these two choices (on fat weight, with the original model M0, and model M4 which was chosen by the FIC procedure – SC/67a/EM04). The black confidence curve uses the standard-error from M4 (computed by bootstrapping), while the blue curve uses the standard-error from M0 (the wide model, also by bootstrapping). As expected, the width of the confidence intervals increased slightly.

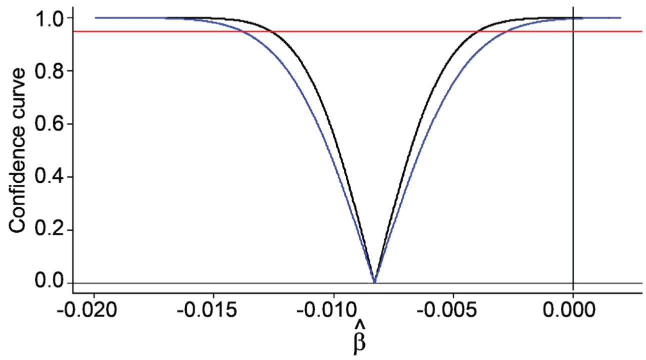

Fig. A3.9. Two confidence curves for the linear effect of year. Confidence curves point to the point estimate and display confidence intervals at all levels. The red line indicates the 95% level. The black curve is computed with the standard error from the selected model M4, while the blue curve uses the standard error from the wide model M0.

Appendix 4

EFFECTS OF LONG-TERM ENVIRONMENTAL VARIABILITY ON THE WHALE POPULATIONS

Justin G. Cooke

A Workshop held in 2010 (IWC, 2011), examined the issue of variability in baleen whale population dynamics. Data that could be used to estimate demographic variability was only available from a few populations, and are summarised in table 4 of the Workshop report. The mean observed coefficient of variation (CV) of the reproductive rate was about 0.4, but it was not possible to estimate long-term variability, which, if present, would have contributed only to a partial extent to the observed CV's in these relatively short series.

Predictions were made here using the environmental variability model of Cooke (2007) for recovering stocks of baleen whales in regions of low, medium and high habitat quality (see that paper and the discussion in IWC (2009) for explanation and definition).

For each habitat, there was assumed to be either only short-term variation in recruitment, with a CV of 0.4, or short and long-term variability each with a CV of 0.3, scaled to the rate at 0.25K. Long-term variability was modelled by assuming an inter-annual correlation of 0.9, which corresponds to variability on a decadal time scale.

A random sample of trajectories was plotted for each case, relative to *K* (mean carrying capacity) along with the deterministic trajectory for comparison (Figs. A4.1a-f).

It is notable that for medium and high habitat quality, the recovery was predicted to be very close to the deterministic trajectory until the population reaches about 0.5*K*. Observations of recovering populations over the last few decades, particularly in the Southern Hemisphere, have tended to be of populations below 0.5*K*, hence it is perhaps not surprising that population trajectories have not yet shown much variability. Now that populations of some species have reached or exceeded 0.5*K*, more variability can be expected.

It is not yet clear over what timescales the effects of long-term variability would become qualitatively different from shorter term variations.

REFERENCES

Cooke, J.G. 2007. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 presented to the MSYR Workshop, Seattle, USA, 16-19 November 2007 (unpublished). 19pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2009. Report of the MSYR Workshop, 16-19 November 2007, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, USA. *J. Cetacean Res. Manage. (Suppl.)* 11:467-80.

International Whaling Commission. 2011. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. *J. Cetacean Res. Manage. (Suppl.)* 12:399-411.

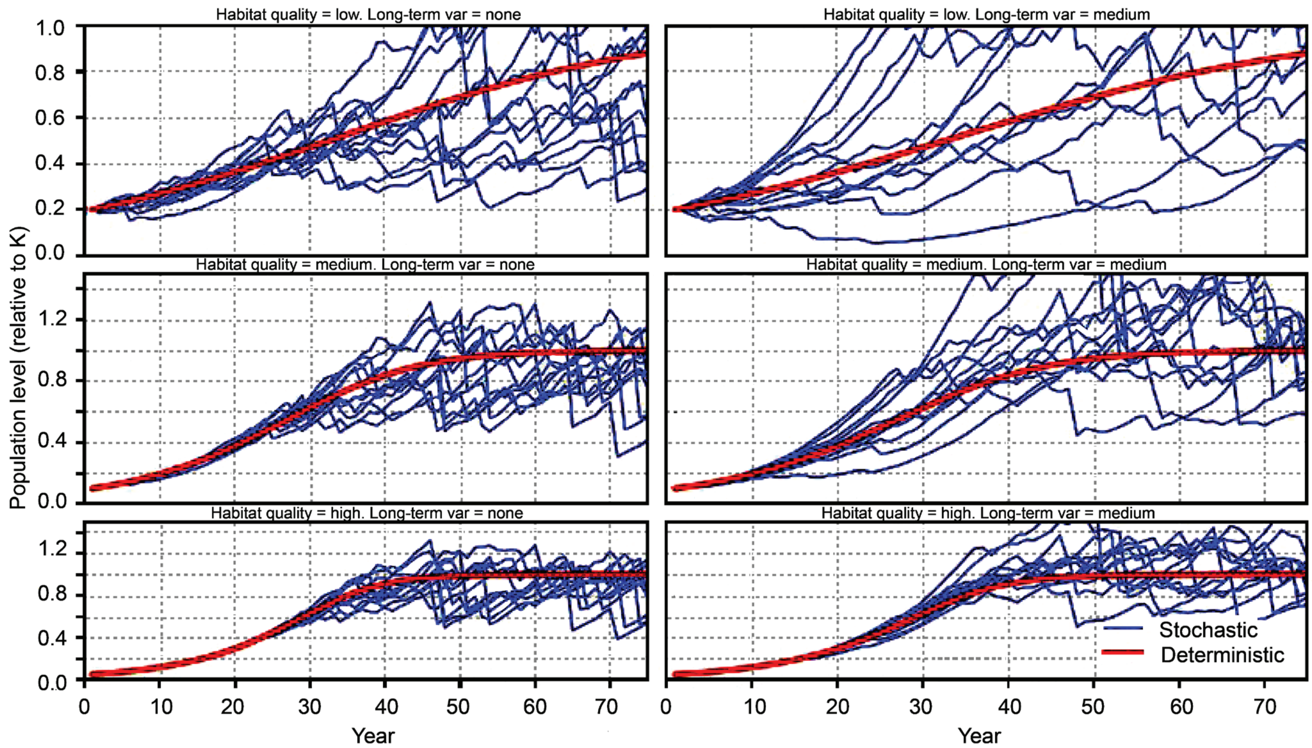

Fig. A4.1. Sample of stochastic population trajectories for recovering baleen whale populations using the environmental variability model of Cooke (2007), for three different habitat qualities, with and without decadal environmental variation.

Appendix 5

REVISED PLANS FOR THE JOINT SC-CAMLR AND IWC-SC WORKSHOP 2018-2019

A proposal for a Joint SC-CAMLR and IWC-SC two-day Workshop to develop multi-species models of the Antarctic marine ecosystem was discussed at the SC-CAMLR 2014, and a steering group to progress a Joint IWC-CCAMLR Workshop was formed (SC-CAMLR 2014 Paragraph 10.25). The joint workshop was perceived as an opportunity to increase knowledge on specific species and their interactions in different management areas, possibly initially focussing on the Antarctic Peninsula given it is a high-priority area for both CCAMLR and IWC (IWC, 2015). The steering group developed a paper identifying draft terms of reference (SC-CAMLR-XXXIV/BG/33). This was tabled to and endorsed by the SC-CAMLR 2015.

Terms of Reference (ToR) endorsed by SC-CCAMLR to guide the two CCAMLR-IWC Modelling Workshops in 2018 and 2019 are:

(1) foster collaboration between SC-IWC and SC-CAMLR;
(2) review outcomes from the joint workshop in 2008, assess progress since then including information on species interactions for species of interest to CCAMLR and IWC;
(3) initial discussion on multispecies models of the Antarctic marine ecosystem and develop work plans toward the second workshop; and
(4) consider multispecies models of the Antarctic marine ecosystem, at a scale that is able to inform strategic management advice, mainly focussing on the Antarctic Peninsula area as a test-case area, and set directions for future collaborative research activities that would be of mutual interest.

The 1st workshop (two days) in 2018 should briefly review outcomes from the joint workshop held in 2008 (assess progress since then and highlight information on species interactions that are of mutual interest to CCAMLR and IWC). It should initiate discussion on the purpose and the types of multispecies models that are needed by both organisations, and develop work plans towards the 2nd workshop in 2019. The ToR for the 2nd workshop will be updated following the 1st workshop.

After consideration, the steering group suggests the following draft agenda for the 1st workshop in 2018.

DRAFT AGENDA

1. Introduction
    - 1.1 Terms of reference
    - 1.2 Agenda and organisation of the meeting
    - 1.3 Background
2. Review the status of multispecies models and available data series
    - 2.1 Outcomes from the 2008 joint workshop and progress since then
    - 2.2 Key questions to be addressed by multispecies ecosystem models
    - 2.3 Purpose, status of, and suggestions regarding, relevant multispecies models
    - 2.4 Abundance and trends of species relevant for developing and fitting multispecies models
    - 2.5 Outstanding questions
3. Workplan for the 2nd workshop
    - 3.1 Review priority questions of mutual interest into the future
    - 3.2 The scale and the types of model to be developed
    - 3.3 Geographic areas and ecological issues of mutual interest
    - 3.4 Tasks and milestones
4. Report adoption
5. Close of the meeting.

WORKSHOP PREPARATION

The steering group will identify a list of potential participants and presenters by January 2018, and prepare a call for papers to be submitted to the workshop, with a deadline at least two weeks prior to the workshop. The call for papers will highlight the purpose of the workshop and identify the level of information sought including the purpose of existing models, the data required and data available for such models. The CCAMLR Observe is requested to liaise with CCAMLR Secretariat to discuss available from the CCAMLR Ecosystem Monitoring Program (CEMP) and krill fishery data and how that might be prepared and summarised ahead of the workshop.

REFERENCE

International Whaling Commission. 2015. Report of the Scientific Committee. Annex K1. Report of the Working Group on Ecosystem Modelling. *J. Cetacean Res. Manage. (Suppl.)* 16:277-90.

Annex M

Report of the Sub-Committee on Small Cetaceans

Members: Scheidat and Porter (Convenors), Aisha, Arguedas, Baker, Baldwin, Bell, C., Bjørge, Brockington, Brownell, Cañadas, Castro, Cipriano, Collins, Cosentino, Crespo, Currey, Diallo, Donovan, Double, Elwen, Filatova, Fortuna, Freitas, Frey, Fruet, Funahashi, Galletti Vernazzani, Genov, Greig, Gulland, Hall, Herr, Hielscher, Hoelzel, Holm, Hubbell, Ingram, Iñíguez, Jelić, Kelkar, Kim, Lang, Lauriano, Lee, Leslie, A., Lundquist, Mazzariol, Minton, Natoli, New, Northridge, Panigada, Parra, Parsons, Paudel, Phay, Pierce, Reeves, R., Rendell, Reyes, Ridoux, Ritter, Rojas-Bracho, Rose, Rosel, Rosenbaum, Rowles, Santos, Sequeira, Simeone, Simmonds, Slooten, Stachowitsch, Sutaria, Štrbenac, Thomas, Tiedemann, Van Waerebeek, Vermeulen, Wang, D., Weller, Willson, Ylitalo, Zerbini.

1. CONVENOR'S OPENING REMARKS

Scheidat and Porter welcomed the participants to the meeting.

2. ELECTION OF CHAIR

Scheidat and Porter were elected Chairs.

3. APPOINTMENT OF RAPPORTEURS

Reeves, Cipriano, Genov, Natoli, Rosel and Thomas undertook the duties of rapporteurs.

4. ADOPTION OF AGENDA

The adopted agenda is given as Appendix 1.

5. REVIEW OF AVAILABLE DOCUMENTS

The following available documents contained information relevant to the work of the sub-committee: SC/67a/SM01-02, SC/67a/SM04, SC/67a/SM06rev1, SC/67a/SM07, SC/67a/SM08rev1, SC/67a/SM09-13, SC/67a/SM14rev1, SC/67a/SM15-17rev1, SC/67a/SM19-21, SC/67a/SM22rev1, SC/67a/SM23-24, Walker (1981); Félix (1994); Sanino *et al.* (2005); Seguraa *et al.* (2006); Santillán *et al.* (2008); Kamaruzzan *et al.* (2011); Khan *et al.* (2011); Perrin *et al.* (2010); Sutaria and Marsh (2011); Allen *et al.* (2012); Minton *et al.* (2013); Ponnampalam *et al.* (2013); D'Lima *et al.* (2014); Somany *et al.* (2016); WWF and FiA (2017); WWF and FiA (2014); Defran and Caldwell (2015); Lowther-Thieleking *et al.* (2015); Paudel *et al.* (2015); Khanala *et al.* (2016); Peter *et al.* (2016); Weller *et al.* (2016); Kelkar *et al.* (2017); Porter and Hong Yu (2017) and Bayas-Rea *et al.* (Unpublished).

6. GLOBAL *TURSIOPS* TAXONOMY REVIEW

Papers related to this topic included: SC/67a/SM02, SC/67a/SM06-07, SC/67a/SM10; Walker (1981); Félix (1994); Sanino *et al.* (2005); Seguraa *et al.* (2006); Santillán *et al.* (2008); Perrin *et al.* (2010); Defran and Caldwell (2015); Lowther-Thieleking *et al.* (2015); Weller *et al.* (2016) and Bayas-Rea *et al.* (Unpublished).

6.1 Overall context for the *Tursiops* taxonomy review

At SC/65b the Small Cetaceans sub-committee decided that its priority topic would be a review of taxonomy and population structure in the genus *Tursiops*, to be carried out in stages over three SC meetings. Bottlenose dolphins (*Tursiops* spp.) are among the most widely distributed cetaceans. Factors contributing to taxonomic uncertainty in this genus include a wide distribution across highly variable environments, locally adapted populations, sympatry and parapatry of multiple forms (ecotypes, morphotypes, morphological variants) in some regions, a lack or shortage of specimens from many regions, and differences in research methods and designs. Worldwide, more than 20 different *Tursiops* species have been described historically but only two (*T. truncatus* Montagu 1821 and *T. aduncus* Ehrenberg 1832) are recognised at present. An additional aim of this exercise is to develop a taxonomy assessment framework for small cetaceans.

T. truncatus, the common bottlenose dolphin, has a world-wide distribution from temperate to tropical waters in both hemispheres, whereas *T. aduncus*, the Indo-Pacific bottlenose dolphin, is confined to the Indo-Pacific region and is found principally in near-shore waters; *T. truncatus* seems not to occupy inshore or near-shore areas in the range of *T. aduncus* although there are areas where the two species can be considered generally sympatric. Among the *T. truncatus* forms in the Atlantic and Pacific, multiple morphologically and genetically differentiated types have been described, i.e. coastal and pelagic (some authors use the terms nearshore and offshore or oceanic, respectively, for the same distinction). However, the correlation of morphotype with geography is not consistent across regions - for example, in the eastern North Pacific the coastal form is larger than the pelagic (or offshore) form (Perrin *et al.*, 2013), whereas in the western North Atlantic coastal (or inshore) animals are smaller than pelagic (offshore or oceanic) animals (Mead and Potter, 1995). The strong morphological differentiation between sympatric, partially sympatric, or parapatric coastal and pelagic forms has raised questions about whether these forms represent different subspecies or species, but these questions have not yet been formally resolved. Congruence between molecular data and osteological and external morphological characters (Wang *et al.*, 2000a; Wang *et al.*, 2000b) was strong evidence that the different forms of bottlenose dolphins in Chinese waters are reproductively isolated and comprise two distinct species (*T. truncatus* and *T. aduncus*) that are at least partially sympatric in that region. Natoli *et al.* (2004), using mtDNA and microsatellite markers, found that coastal *T. aduncus* in South Africa differed significantly from both *T. aduncus* from Taiwan and *T. truncatus* from various locations worldwide (Atlantic Ocean, Gulf of Mexico, Mediterranean Sea, and eastern North Pacific); they concluded that the *T. aduncus* in Taiwan may represent a third species (but Natoli and colleagues did not examine any sequences from Australian *T. aduncus*). Perrin *et al.* (2007) re-analysed the *T. aduncus* holotype (specimen from the Red Sea) using genetic and morphological data, and found that it clustered with the African *T. aduncus* specimens. Sarnblad *et al.* (2011) compared published *T. aduncus* sequences from China, eastern Australia, and South Africa with their sequences from Zanzibar and found that the African sequences clustered together, confirming the differentiation of African from Chinese and Australian specimens. Charlton-Robb *et al.* (2011) proposed a new species of *Tursiops* (*T. australis*) in southern Australian coastal waters based on morphological and genetic evidence.

6.1.2 Context and conclusions from the 2015 review of Tursiops in the Indian Ocean and southwest Pacific

At SC/66a the sub-committee reviewed taxonomy and population structure of bottlenose dolphins in the Indo-West Pacific including China, southern Japan, Taiwan, Australia, New Zealand and Oceania, the eastern Bay of Bengal, Bangladesh, and the east coast of Africa from the Red Sea to South Africa. The purpose of the review was to clarify understanding of *Tursiops* taxonomy across the region in general, and in particular the relationship of *T. australis* to other taxa. In the Indo-West Pacific, *T. aduncus* and *T. truncatus* are clearly distinguishable, and the distinction is consistent across many different areas, studies, and marker types analysed. However, *aduncus*-type dolphins exhibit considerable regional variability. New *T. aduncus* lineages off Pakistan and India and off Bangladesh have been suggested by recent analyses. The sub-committee at SC/66a found it difficult to reach conclusions on the taxonomic status of *T. australis* at least in part because of discordance in results using different genetic markers. Morphometric analyses did not show a difference between putative *T. australis* specimens and *T. truncatus* (Hale *et al.*, 2000; Jedensjö *et al.*, 2013; Kemper, 2004). However, the lack of morphological distinctiveness relative to *T. truncatus* could be related to the distinctions between species being blurred by convergence. Thus, some uncertainties remained after SC/66a concerning the taxonomy of *Tursiops* in the Indo-Pacific. The sub-committee therefore advised more consistency in approaches used and in morphological, genetic and behavioural characters employed to allow direct comparisons between areas and study groups. In such efforts, it will be critical to use additional, independent nuclear markers (such as multi-locus genotyping using SNP analysis) as well as both morphological and morphometric characters in analyses, and researchers will need to keep their minds open in the search to better understand the patterns observed.

6.1.3 Context and conclusions from the 2016 review of Tursiops in the Atlantic Ocean, Mediterranean Sea and Black Sea

At SC/66b the sub-committee reviewed the taxonomy and population structure of common bottlenose dolphins in the Atlantic Ocean, Atlantic oceanic islands (Azores, Cape Verdes, Canaries, Saint Peter and Saint Paul Rock), and the Mediterranean and Black Seas.

Unlike the situation in the Indo-Pacific, where there are two recognised species of *Tursiops*, only one recognised species, *T. truncatus*, is present throughout the Atlantic Ocean and the Mediterranean and Black Seas, and the Black Sea population is recognised as a subspecies, *T. truncatus* ponticus. Different local forms (ecotypes and morphotypes) have been described, however, based on distribution (offshore *vs* nearshore differentiation), morphology and genetic profile, and a new species/subspecies has been proposed, from time to time, in the western South Atlantic. Therefore, the main challenge when considering the Atlantic Ocean is to understand whether there is consistency of the various local forms across the range and to which taxonomic level(s) these forms should be assigned.

To provide context to what is known about geographic variation in *Tursiops* morphology, genetics and other characteristics within the five geographic regions of the Atlantic, the sub-committee discussed analyses in Moura *et al.* (2013), which also included samples from outside the Atlantic. A key objective of that study was to test hypotheses about the role that environmental change, particularly habitat release during interglacial periods, may have played in the radiation of *Tursiops* lineages. Mitogenome analysis was chosen as it has the advantage of high resolution and relatively simple interpretation for mutation rate, but nevertheless represents a single gene tree, subject to problems associated with incomplete lineage sorting and introgression. Biogeographic analyses; see Fig. 3 in Moura *et al.* (2013) suggested origins in coastal habitat followed by an early transition to pelagic habitat (at the base of the *T. truncatus* lineage) and later reversals back to the coastal ecotype. The tree topology; Fig. 2 in Moura *et al.* (2013) supports earlier proposals of a division between *T. aduncus* in Australasia from the lineage off South Africa, and between the offshore and coastal populations in the Western North Atlantic (WNA). However, the deepest and best-supported division was between *T. truncatus* and *T. aduncus* lineages, and a polyphyletic *T. aduncus* was suggested.

Minimal data are available on the ecology and taxonomic status of *Tursiops* sp. in the eastern South Atlantic, although it is assumed that they are all *T. truncatus* and more work is clearly needed in this area. For the eastern North Atlantic, there is convincing evidence of population structure and of offshore and coastal ecotypes, but mtDNA haplotypes are shared and no differences in external morphology have been detected (Louis *et al.*, 2014a; 2014b); morphometric analyses paired with genetics would be useful to improve understanding of *Tursiops* taxonomy in the region. Strong morphological differences have been identified between dolphins in the Black Sea and Mediterranean; these differences formed the underlying basis for the original subspecies designation, *T. t. ponticus*. Analyses of mtDNA control region haploytpes revealed shared haplotypes among the Black Sea, Mediterranean and eastern North Atlantic, but strong differentiation at both nuclear and mtDNA level (Natoli *et al.*, 2005; Viaud-Martinez *et al.*, 2008). Within the Mediterranean population structure has been identified at both mtDNA and nuclear level (Natoli *et al.*, 2005; Gaspari *et al.*, 2015).

Two distinct morphotypes of *Tursiops* are present in the western North Atlantic. Morphological and ecological (diet preferences, parasite loads) differences have been documented between a smaller coastal form and a larger offshore form (Mead and Potter, 1995). Genetic analyses revealed significant genetic differentiation for mtDNA, microsatellites, major histocompatibility complex genes, and amplified fragment length polymorphism (AFLP) markers (Hoelzel *et al.*, 1998; Kingston *et al.*, 2009; Moura *et al.*, 2013; Rosel *et al.*, 2009). The mtDNA control region and mitogenome sequences, AFLP data, and preliminary genomic data yield reciprocally monophyletic clades, suggesting a relatively deep divergence time for the coastal morphotype in the WNA (Hoelzel *et al.*, 1998; Kingston *et al.*, 2009; Moura *et al.*, 2013; Rosel *et al.*, 2009).

Significant morphological differentiation in the western South Atlantic between a large coastal form and a smaller offshore form may be indicative of subspecies-level differences (Costa *et al.*, 2016). The two morphotypes are parapatric along the coast from southern Brazil and sympatric in northern Argentina. A network analysis did not reveal complete separation of haplotypes corresponding to a priori morphological identification of offshore and coastal samples. Further analysis of nuclear data is necessary to examine the possibility of introgression between the two forms, as is suggested by microsatellite data (Fruet *et al.*, 2014).

The sub-committee considered the results presented in a number of papers in an attempt to determine whether there was sufficient evidence to: (a) elevate the coastal form in the Western South Atlantic (WSA) to species status (as *T. gephyreus*); (b) elevate it to subspecies (*T. t. gephyreus*); or (c) conclude that no subspecies distinction is justified. It was noted that in several of the papers only a single line of (morphological) evidence had been used and therefore the criterion that at least two lines of evidence are needed for delimiting cetacean species (Reeves *et al.*, 2004) was not met. The sub-committee concluded that there was not enough evidence to draw firm conclusions about species status for T. gephyreus. In addition, it stressed the necessity of evaluating the genetic context before proposing new species. However, the significant morphological differentiation between the large coastal form and a smaller offshore form (a single, but strong line of evidence) is indicative of subspecies-level differences. Because environmental factors can influence morphology (ecophenotypic variation) even if there is interbreeding, caution should be exercised when interpreting morphological differences alone when attempting to delimit species. In addition, consideration should be given to whether characters are phenotypically plastic and behavioural differences should be taken into account.

In addition to the *Tursiops* taxonomy review, during SC/66b the sub-committee discussed a proposed framework for making cetacean subspecies delimitations (Taylor *et al.*, 2017a; 2017b). The paper suggests standards and guidelines for which types of data and supplementary information should be included when formulating a taxonomic argument. This framework is aimed at promoting consistency when using genetic data to examine taxonomic questions for cetaceans, and focuses on the use of: (i) the mitochondrial DNA control region for making taxonomic delimitations at subspecies and species levels; and (ii) qualitative and quantitative benchmarks for identifying levels of genetic divergence, along the continuum from population to species, that correspond to subspecies- and species-level delineations. The Taylor *et al.* (2017a; 2017b) guidelines and standards elicited discussion of various issues relevant to the current review of *Tursiops* taxonomy, including: (i) general considerations for the use of genetic markers for classification; (ii) specific considerations of which markers (i.e. mitochondrial versus nuclear), analytical techniques and methods of inference are useful for population genetics and taxonomy [see also the Genetic Analysis Guidelines recently updated by the Working Group on Stock Definition and DNA Testing]; and (iii) the appropriate sequence of steps to be followed for developing and then testing taxonomic hypotheses.

At SC/66b the sub-committee agreed that the use of complementary datasets including genetic markers, morphometrics, demographic analyses, ecological and behavioral data (including acoustics), and discontinuities in distribution provides the strongest arguments when making taxonomic decisions. However, caution should be used when attempting to combine results from some types of markers across laboratories. The sub-committee agreed that dependence on a single molecular marker suffers from the possibility that the gene tree may not accurately reflect the true species tree (Doyle, 1992) and use of a single marker (genetic, morphological or other) for species delimitation does not meet the level of evidence standards recommended in Reeves *et al.* (2004). Furthermore, offshore and nearshore designations are often too simplistic and require careful characterisation, using all lines of evidence possible. The sub-committee also agreed that the framework provided by Taylor *et al.* (2017a) is best used to make taxonomic distinctions following a stepwise approach, bringing in additional markers in order to resolve ambiguities when necessary. The sub-committee also agreed that another valuable approach is to use mtDNA control region sequence data to formulate a taxonomic hypothesis, then identify an appropriate sample design, marker(s) and analytical tool(s) needed to test that hypothesis.

*6.1.4 Review of taxonomy and population structure of bottlenose dolphins (*Tursiops *spp.) in the East Pacific and Western North Pacific Oceans*

At SC/67a the sub-committee reviewed the taxonomy of bottlenose dolphins in the remaining areas – eastern North Pacific, eastern South Pacific, western North Pacific and oceanic islands - to complete the three-year review.

Natoli and Rosel presented a brief synopsis of the results of the 2015 and 2016 meetings and highlighted some of the outstanding taxonomic and population distinction issues concerning bottlenose dolphins in different parts of the Pacific Ocean. As in other regions where bottlenose dolphins are found, different forms (ecotypes/morphotypes) have been described based on distribution (e.g. offshore *vs* coastal differentiation), morphology and genetic profiles, and new species and subspecies have in some cases been proposed. Therefore, the main challenge when considering the Pacific Ocean is again to understand whether there is consistency in the derivation of various local forms across the range, and to which taxonomic or population unit(s) they belong. The almost total lack of information from some regions (e.g. Central America) has made progress in understanding the pattern of bottlenose dolphin diversification worldwide even more difficult. Other lessons learned during the first two years of the review include the need to standardise and widen the types of markers (morphological, genetic, ecological and behavioral/acoustic) used, and that cooperation/communication between research groups to avoid duplicating work on the same samples/specimens/ areas is also needed.

Rosel and Natoli presented an overview of published information about bottlenose dolphin distribution and potential 'taxonomic' (species, subspecies) distinctions in the eastern Pacific and western North Pacific and specific references are reported at the beginning of each section. This document was not intended to be an exhaustive review but only a means to document the occurrence of *Tursiops* throughout the regions subject to our review.

6.1.4.1 EASTERN NORTH PACIFIC (ENP)

In the Rosel and Natoli overview of published information, the distribution of bottlenose dolphins in the Eastern North Pacific region appears to cover coastal and offshore waters from Columbia to approximately 42°N at the California-Oregon border in the US. Palacios *et al.* (2012) compiled and analysed both shipboard survey data and information from platforms of opportunity to examine presence, density, and abundance of cetacean species within the Columbian Exclusive Economic Zone (EEZ). Common bottlenose dolphins were the third most commonly sighted species and were seen in both nearshore and offshore waters throughout the EEZ. The authors suggest the presence of *Tursiops* in both nearshore and offshore water may indicate the presence of coastal and offshore ecotypes.

Common bottlenose dolphins are commonly seen in both offshore and nearshore waters of the Gulf of Panama and at the Panama Canal entrance (Campbell, 2014). However, García and Dawson (2003) did not record the species in Bahia Hondo; instead pantropical spotted dolphins, Stenella attenuata, were common in this area.

In Costa Rica and Guatemala, *Tursiops* appears to occupy waters throughout the EEZ. May-Collado *et al.* (2005) compiled large- and small-vessel survey data collected between 1979 and 2001 in Costa Rican waters and reported sightings of *Tursiops* throughout the area. The species also appears to occupy the relatively large bay of Golfo Dulce year-round (Acevedo-Gutierrez and Burkhart, 1998). Arreola *et al.* (2014) similarly compiled published records of *Tursiops* within the EEZ of Guatemala. *Tursiops* was the most frequently recorded species and was widely distributed in both offshore and nearshore waters. There appear to be fewer sightings in nearshore waters of the northern portion of the country, but it is not clear if that is related to effort or a true lack of sightings.

The distribution of *Tursiops* along the Mexican coastline seems complete, although there are limited data in some areas. Meraz and Sánchez-Díaz (2008) documented its presence along the central coast of Oaxaca (from January to August), it was the second most sighted species (7.7% of sightings) and was always associated with S. attenuata. Viloria-Gómora and González (2015) reported year-round presence of the species in Bahía de Banderas and surrounding waters near Puerto Vallarta and suggested three morphotypes based on color pattern. *Tursiops* is well documented in the Gulf of California (Guevara-Aguirre and Gallo-Reynoso, 2015; Jackson *et al.*, 2008; Seguraa *et al.*, 2006) and the Pacific coast of the Baja peninsula (Defran and Caldwell, 2015; Hwang *et al.*, 2014; Weller *et al.*, 2016). The presence of both a coastal and an offshore morphotype/ecotype has been documented in the Gulf of California (Seguraa *et al.*, 2006).

In US waters, the species is present in coastal waters to approximately San Francisco and in offshore waters as far north as 42°N (Carretta *et al.*, 2008; Carretta *et al.*, 2015; Hwang *et al.*, 2014; Walker, 1981). Two morphotypes are documented (Lowther-Thieleking *et al.*, 2015; Perrin *et al.*, 2010), a coastal morphotype restricted to within ~1-2km of the coast as far north as San Francisco, and an offshore morphotype in deeper waters distributed as far north as 42°N.

Lang presented results from Lowther-Thieleking *et al.* (2015), which describes the population structure of common bottlenose dolphins in the Southern California Bight, in the eastern North Pacific. Within this region both coastal and offshore ecotypes are found. The California coastal ecotype, which numbers approximately 450-500 animals, is typically found within 1 km of shore and ranges widely within this narrow coastal corridor from at least as far south as Ensenada, Baja Mexico to as far north as San Francisco, CA. The offshore ecotype is typically found >4km from shore and is estimated to include ~1,000 animals, ranging primarily in Californian waters with occasional sightings in the waters of Oregon and Washington. Samples were collected from coastal (n=64) and the offshore dolphins (n=69) defined based on sampling location, and used to generate mitochondrial DNA control region sequences and genotypes from 15 microsatellite loci. Significant genetic differentiation was observed between the two strata for both mtDNA and nuclear markers. Thirty-six haplotypes were found among the offshore dolphins, while only five mtDNA haplotypes were identified within the coastal dolphins. One haplotype, which was found in relatively high frequency within the coastal stratum, was also found in a single offshore dolphin. The level of genetic differentiation between the coastal and offshore dolphins is consistent with long-term separation, and the comparatively low diversity and small population size of the coastal stock highlights the importance of continued monitoring of this stock, which is vulnerable to a variety of anthropogenic threats.

Lang also presented a summary of pertinent information from Perrin *et al.* (2010), which documents cranial osteological differentiation of the coastal and offshore ecotypes of bottlenose dolphins within southern Californian waters. The samples analysed included 139 skulls from live captures, direct takes, fishery bycatch, and strandings. Most of the skulls were assigned as coastal or offshore by collection locality and mtDNA haplotype; skulls that could not be classified by these means (e.g. those that were assigned to the one haplotype known to be shared by the two ecotypes within this region) were classified to ecotype using a Random Forest classification algorithm based on the mtDNA data. Comparison of the coastal and offshore skulls revealed differences in 23 of the 28 cranial measurements as well as both tooth count measures. The coastal form differs from the offshore form mainly in features associated with feeding: larger and fewer teeth, more robust rostrum, larger mandibular condyle, and larger temporal fossa. The morphological differences between the two ecotypes indicate evolutionary adaptation to different environments and emphasise the importance of conserving the relatively small coastal population and its habitat.

In discussion of both these publications (Lowther-Thieleking *et al.*, 2015; Perrin *et al.*, 2010), it was clarified that in this region (off the Pacific coast of California and around Baja California) the coastal ecotype shows a larger overall body size, and has larger teeth. This pattern is also observed in the western South Atlantic; however, in the western North Atlantic the opposite pattern (a larger offshore form) is seen. The lack of a discussion of taxonomic status of the two morphotypes in Perrin *et al.* (2010) was likely due to recognition that the taxonomy of common bottlenose dolphins in that region and elsewhere was confused and deserved wider consideration.

Hoelzel presented Seguraa *et al.* (2006), which reviewed the genetic and ecological distinction of *Tursiops truncatus* ecotypes in the Gulf of California, Mexico. The study used 480bp of mtDNA control region sequences from 83 bottlenose dolphins biopsied in the northern, central, and southern Gulf; offshore and coastal ecotypes were first classified by external morphology, with corroboration for 38 of the samples using d13C stable isotope values (Diaz-Gamboa, 2003). This analysis revealed 26 haplotypes; there were private haplotypes in both coastal and offshore groups and evidence for population structure within the Gulf based on F_{ST} but not Φ_{ST}. There was evidence for significantly higher haplotype diversity for offshore-type individuals (offshore=0.94, nearshore=0.86, t=1.91, p<0.05), but no significant difference in nucleotide diversity. A neighbor-joining tree and minimum spanning network indicated polyphyly without clear lineage structure associated with ecotypes (Seguraa *et al.*, 2006). The authors suggested that the division between ecotype distributions occurred around the 20-60m depth contour. This study focused on the distinction between ecotypes within the Gulf of California and proposed two distinct stocks using information from behavioural, ecological, and genetic divergence data, but the authors also pointed out a potential geographic component, with most nearshore samples coming from the north of the Gulf, and most offshore from the centre and south, see Fig. 1, Seguraa *et al.* (2006).

Hoelzel presented an updated analysis of genetic divergence in Gulf of California common bottlenose dolphins by Segura and colleagues (unpublished data), based on eight dinucleotide microsatellite loci (most loci in most populations were in Hardy-Weinberg Equilibrium with no consistent pattern of deviation), 480bp of mtDNA control region sequence data and including samples from both sides of the Baja Peninsula. Assignment analysis using STRUCTURE and ordination analysis using FCA both showed differentiation between ecotypes (coastal compared to offshore populations), with some overlap between them. Not all individuals could be classified a priori (based on phenotypic differences as well as location). In addition to differentiation between ecotypes, significant differentiation among some regional populations within an ecotype, especially on either side of the Baja Peninsula, was detected. This divergence was also supported by pairwise F_{ST} comparisons for the microsatellite DNA data, and by the AMOVA analysis from the same data. A hierarchical AMOVA showed the greatest variation among all pairwise population comparisons, next between ecotypes, and last among populations within an ecotype (p<0.00001 for each). Segura and co-authors also investigated δ13C and δ15N stable isotope values among a subset of the populations and here too there was differentiation both between and within ecotypes.

In response to a question about whether it was possible to distinguish between offshore and coastal ecotypes from field observations, Hoelzel clarified that he was not involved in the sample collections in the Gulf of California (which were all biopsies), but had been told that trained observers could generally distinguish between the two types, although some samples could not be classified from visual observation. Hoelzel pointed out that it was likely that some samples were not classified accurately from observation alone, as revealed by the genetic analysis of some individuals. Use of stable isotopes for discriminating between these types showed differentiation both by ecotype and by region (Seguraa *et al.*, 2006), and a published paper (in Spanish) using cranial morphometric, (Vidal-Hernandez, 1993) and not reviewed here, is available. Brownell noted that no skulls from the northern Gulf were consistent with the smaller offshore form, but skulls from the southern Gulf included both types. Lang noted that tissue samples from bottlenose dolphins in the ETP had been collected, but the genetic comparisons with coastal and Gulf of California bottlenose dolphins were not yet available. Brownell pointed out that the morphometric of a small number of specimens from the ETP had been analysed by Walker (1981) and were consistent with the offshore type. The significance of the levels of population differentiation implied by these results was discussed, as both morphological and genetic differences are observed in many coastal *vs* offshore and some northern *vs* southern comparisons in regions around the world. The magnitude of these differences varies, but in most cases the coastal *vs* offshore differences are more consistent with taxonomic (species or subspecies) distinctions, while northern *vs* southern differences within coastal bottlenose dolphins are typically more at the population differentiation level. In this case the magnitude of differences between geographic and ecotype comparisons was similar. In many (perhaps most) cases, we do not have sufficient information to decide whether the differences warrant species or subspecies-level distinction. The group concluded that, even though strong population-level differences are observed among these samples from the Gulf of California and the Pacific coast of Baja California, the evolutionary trajectories that would support distinctions at the species or subspecies-level are not clear.

Conservation implications related to the potential for taxonomic or population-level divergence for common bottlenose dolphins in the northern Gulf of California, which may form an isolated and distinct group, were briefly discussed. Like the vaquita, common bottlenose dolphins in the northern Gulf are impacted by fishing activities and habitat degradation and, although more abundant than vaquita, likely represented by a very small population. Hoelzel added that in the new Segura *et al.* analysis, both F_{ST} and Φ_{ST} based on mtDNA for dolphins in the Gulf of California compared to the coastal population near Ensenada (west coast of Baja) were high and significant indicating strong differentiation. Microsatellite-based comparisons for the northern Gulf showed significant differentiation from the central Gulf (offshore), southern Gulf, southern west side of Baja and Ensenada but not from a small sample of coastal dolphins in the central Gulf, and a mainland population near Mazatlan. Rosel suggested that additional work is needed to clarify the Southern California *vs* Gulf distinctions, and that a combination of genetics and morphological analyses would provide a stronger argument for any conclusions to be drawn there. Hoelzel noted that the haplotypes in Ensenada match those reported for southern California (Lowther-Thieleking *et al.*, 2015). If the coastal form in the northern Gulf of California is isolated (as supported by some genetic analyses to date), there would be conservation concern for that population, and this should be carefully considered during the 'global synthesis' workshop on *Tursiops* taxonomy planned for early 2018 (see below).

6.1.4.2 EASTERN SOUTH PACIFIC (ESP)

Based on the Rosel and Natoli review of published information, data on the occurrence of *Tursiops* and other cetaceans in the ESP are overall scarcer than in the ENP and in many cases the occurrence of the species is based on records of direct or indirect catches (Majluf *et al.*, 2002; Mangel *et al.*, 2010; Van Waerebeek *et al.*, 2002; Van Waerebeek *et al.*, 1990; Van Waerebeek *et al.*, 1997). In this area, *Tursiops* is recorded from Ecuador to Chile down to the Magellan Strait (54°S). *Tursiops* is also reported from the Galapagos Islands (Palacios *et al.*, 2005; Walker, 1981) and based on historical records, *Tursiops* has also been recorded around Easter Island and Salas y Gómez Island (Hucke-Gaete *et al.*, 2014).

Van Waerebeek and coauthors provided a comprehensive review of information available for *Tursiops* in the eastern South Pacific (Colombia, Ecuador, Peru and Chile) in SC/67a/SM10. They noted that research effort in the region is limited to a few areas and often the information available is old or scattered in local publications. Bottlenose dolphins are one of the three most commonly captured small cetaceans in Ecuador and Peru (despite legislation prohibiting directed takes) and are occasionally taken in Colombia and Chile.

In the eastern South Pacific one species of *Tursiops* is currently recognised, and phylogenetic/taxonomic issues are mainly related to delimiting discrete populations for conservation management. However, the level of the distinction between offshore and coastal morphotypes in the eastern South Pacific and their relationship to offshore and coastal morphotypes elsewhere in the Pacific is unknown.

The authors reported that animals are found in coastal waters along the entire coastline of Pacific South America, although there are several areas where there may be gaps in the distribution, especially in Chile. In Colombia (Pacific side), sightings have confirmed the distribution of coastal common bottlenose dolphins (e.g. Bahia Malaga, Isla Gorgona, Choco area) (García *et al.*, 2008; SC/67a/SM10), but little or no specimen information, and no phylogenetic studies are available. In Ecuador, coastal *Tursiops* is widely distributed throughout the Gulf of Guayaquil (Félix, 1994) and at least present on the south west coast where a few stranded animals have been recovered (Salinas) (Santillán *et al.*, 2008).

In Peru, several semi-resident communities have been identified in coastal waters from northern Peru (Tumbes), to the south/central coast (south of Bahía Independencia [14°S]). Recently, a few stranded specimens have been collected from the southern area, but their morphotype has not been determined and the authors stressed the urgent need for increased research effort in this area.

In Chile, *Tursiops* are regularly sighted close to shore in four documented areas, but there are indications that several of these animals may belong to the offshore morphotype. However specimens from this area are scarce and research effort limited. It was noted that in northern and north central Chile, the Atacama Trench creates an extremely narrow, steep shelf with very deep water close to shore, with strong local coastal upwelling and increased productivity. This habitat seems to attract oceanic cetaceans, including sperm whales and Risso's dolphins and the presence of the *Tursiops* offshore morphotype close to the coast is therefore plausible. *Tursiops* is sighted in the stretch of about 190km of coastline centered on Antofagasta and the Mejillones Peninsula (23°10'S) in Chile, and these animals are also likely of the offshore morphotype. In north central Chile (near Choros island), a resident community of about 25 animals (named 'Pod-R' R for Resident) has been called coastal due to its location, however the dorsal fin shape and mitochondrial DNA control region sequences of these individuals resemble that of the offshore morphotype (Sanino *et al.*, 2005); SC/67a/SM02). In central Chile, *Tursiops* has been regularly sighted along the approximately 60km stretch of coastline centered at Valparaiso/Laguna Verde (33°10'S) (Díaz-Aguirre *et al.*, 2009) and it is likely to be the offshore morphotype, but no specimens have been available to test this hypothesis. In southern Chile (Los Lagos and Aysén regions, Patagonia, 45°30'S) large groups of common bottlenose dolphins often forage nearshore and occasionally in the fjords. Water depths in this area can reach 100m and offer a quasi-oceanic habitat, and the behaviour and external features of these animals suggest the offshore morphotype; two skulls from the Aysén region are consistent with this observation. The authors reported an apparent gap of presence between ~45°S and 53°S, with only a single group of 5 animals reported in the Magellan Strait (Olavarría *et al.*, 2010) and they suggested that these individuals may have come from the Atlantic Ocean.

In SC/67a/SM10, the occurrence of offshore animals along the entire Pacific coastline south to at least 45°30'S and around the associated oceanic islands is reported. Available records also suggested the presence of one stock (ETP offshore stock) in offshore Colombia and Ecuador waters, including the Galapagos Islands (Scott and Chivers, 1990; Walker, 1981), and the existence of a large Peru-Chile offshore population, with group sizes up to 500-1,000 (Sanino *et al.*, 2005). Comparisons between the Colombia/Ecuador/ETP and the Peru-Chile offshore populations have not been conducted and the population identity of insular animals around Easter and Sala and Gomez Islands is unknown. There are no confirmed records of *Tursiops* at San Felix and San Ambrosio, or Juan Fernandez islands.

Van Waerebeek and co-authors reviewed and summarised the main biological differences observed between coastal and offshore morphotypes in Peru (table 2 in SC/67a/SM10) as follows:

- cranial morphology (four non-metric and three metric characters) strongly differentiates the two morphotypes;
- external morphology, including: dorsal fin shape (falcate in offshore *vs* triangular in coastal) (SC/67a/SM02); body shape and mass (stocky in offshore, slender in coastal); coloration (dark grey dorsal overlay in offshore and light grey with clear dorsal cape in coastal);
- diet, parasite load, and behavioural differences reflecting difference in habitat and feeding behavior; and
- differences in prevalence of some infectious diseases (such as tattoo skin disease [poxvirus], lobomycosis-like disease, papillomavirus and morbillivirus).

In summary, Van Waerebeek and co-authors. (SC/67a/SM10) concluded that two different morphotypes (offshore and coastal) occur in the Eastern South Pacific, and possibly six different populations: Colombia-Ecuador Offshore stock, (Eastern Tropical Pacific (ETP) offshore); Peru-Chile Offshore; Colombia Coastal (unstudied); Ecuador Coastal (Gulf of Guayaquil); Peru Coastal (north and central coast); Chile 'Pod-R' with some hybrid features, currently recognised as an ESU. Van Waerebeek also noted that currently ~25-50% additional new specimens and data are available and a synthesis of old and new data is needed. The main uncertainties are related to degree of differentiation and precise geographic borders.

Van Waerebeek presented information from Sanino *et al.* (2005), which provides the first genetic evidence for population structure among *Tursiops* in the Eastern South Pacific. Sanino *et al.* (2005) analysed 331 bp of mtDNA control region sequence data to evaluate genetic relationships among four populations: coastal Pod-R in Chile (n=8), Chilean offshore population (n=8), Peruvian offshore (n=12), and Peruvian coastal (n=3). Sample sizes were quite small but the geographic origin and morphotype were ensured. Twenty-one haplotypes were observed and most haplotypes were found in single individuals. One haplotype was shared between the two offshore populations. The Peruvian coastal population was represented by two haplotypes that grouped together and separate from all other haplotypes in a phylogenetic tree based on a neighbor-joining analysis. The coastal Chilean (Pod-R), was divergent from the Peruvian coastal samples and clustered with all offshore samples. This was in agreement with the morphological hybrid characteristics observed among the Pod-R individuals (e.g. pronounced falcate offshore-type dorsal fin, in contrast with inshore-type slender body shape and light grey coloration). The mtDNA evidence, although limited in scope, was in full agreement with the earlier morphological findings, as well as ecological lines of evidence. The authors concluded that the results argue for the need for these stocks to be managed as distinct units.

Discussion centered on whether there was the possibility that the samples collected from R-pod resulted in kin-biased sampling given the small population size. Such a sampling bias would result in the high F_{ST} values seen in the analysis by Sanino *et al.* (2005). Van Waerebeek noted that if reproductive isolation is confirmed, the long-term survival of the Pod-R (25 individuals left) looks uncertain, especially considering the high pressure from dolphin-watching operations. Vermeulen reported that a similar situation has been observed in Argentina where a population of *Tursiops* residing in coastal waters includes individuals exhibiting oceanic and coastal dorsal fin attributes within in the same group. Van Waerebeek suggested the situation in Rio Negro was unique in finding individuals possibly of two forms within one group, but that the differentiation between dorsal fin types (falcate versus triangular) was similar to what is seen in the eastern South Pacific. Hoelzel commented that if Pod-R originated as a founder event from the offshore population, it could still have the signature of the offshore genotype if the founding event was relatively recent. Van Waerebeek agreed and added that some morphological characteristics may have been maintained in Pod-R animals due to the oceanic features of the waters in the area.

Van Waerebeek also summarised information from Santillán *et al.* (2008) which provides preliminary results from a comparative morphological study of skulls of common bottlenose dolphins from Peru (39 skulls) and Ecuador (12 skulls), using 30 cranial measurements. Samples from Ecuador were principally from the Gulf of Guayaquil (coastal), while some were collected from Salinas where both coastal and offshore specimens may have occurred. Ecuadorian samples were not a priori identified to morphotype, so some offshore specimens may have been included in the sample set. Samples from Peru came from the central and northern coasts, and location and morphotype were well documented. Skulls were used only if cranially mature and of known sex. Considering the small sample size, both sexes were considered together, but the variables found to be sexually dimorphic in the offshore sample from Peru were removed from the multivariate analyses under the assumption the same would be true for the coastal morphotype. The PCA analysis identified three main clusters corresponding to the Ecuadorian (coastal), Peruvian coastal, and Peruvian offshore specimens. Limited overlap was observed between the coastal specimens of both areas but a few offshore samples clustered with the coastal groups and some Ecuadorian specimens shared characteristics with the offshore form. A cluster analysis provided unclear segregation with a number of coastal and offshore specimens clustering together. Bone lesions caused by the Crassicauda sp. nematode were observed only in Peruvian specimens and primarily in the offshore specimens.

Van Waerebeek commented that the lack of separation of the three groups in the cluster analysis may have resulted from observer bias in measurements, although that should have also affected the PCA analysis as well. He also noted that adding non-metric characters would be useful because those characters separate coastal and offshore specimens in Peru very well.

Rosel presented information from Bayas-Rea *et al.* (Unpublished), a study which examined genetic divergence and fine scale population structure of common bottlenose dolphins in the Gulf of Guayaquil, Ecuador. The study used 10 microsatellite loci, mtDNA control region sequences and multiple mtDNA gene sequences to examine population structure and phylogenetics of the resident population of coastal common bottlenose dolphins in the Gulf of Guayaquil. Most pertinent to the issue of taxonomy is the phylogenetic analysis. Using 5,237bp of mtDNA sequence data, the Guayaquil estuary samples grouped together with a few samples from the outer estuary. Other samples collected in the outer estuary grouped with *Tursiops truncatus* haplotypes obtained from GenBank covering a broader geographic context, including the Gulf of California, Black Sea, western North Atlantic, eastern Mediterranean, etc; mostly likely representing the more globally distributed offshore form. A network analysis using 406bp of the mtDNA control region and a broad geographic range of haplotypes from GenBank again grouped many of the Gulf of Guayaquil haplotypes together. Population differentiation estimated among three sampling areas within the Gulf of Guayaquil (Posorja Harbor, Morro Channel, and Puná Island) based 694bp of the mtDNA control region was significant, although some sample sizes were small. The microsatellite data were used to conduct an analysis of population differentiation among three sampling areas within the Gulf of Guayaquil, and, although the best number of populations (K) was equal to three, the bar plot revealed that each individual had a nearly equal probability of belong to each of the three groups, suggesting the analysis could not identify significant genetic partitioning within the sample.

Hoelzel noted that the software used to analyse the microsatellite data can sometimes be misleading, indicating a higher number of clusters than is actually present in the data. It was also noted that the mtDNA network analysis did not include haplotype frequencies for the DNA sequences obtained from GenBank, making interpretation of the network difficult.

Castro summarised SC/67a/SM02 that describes an analysis of morphological variation in dorsal fins among common bottlenose dolphin populations in the eastern South Pacific Ocean (SC/67a/SM02). From field observations, in Ecuador and in Peru, the authors noted difference in the fin shape between coastal and offshore individuals, with offshore being more falcate and coastal being more triangular shape. To test this observation, three morphological indices were considered (fin height/length base, fin width at mid-height/length base, overhang of fin tip/length base) to analyse dorsal fin pictures and direct measurements from carcasses of 165 adult individuals from Ecuador (129 coastal and 34 offshore), 60 individuals from Peru (9 coastal and 51 offshore) and 25 individuals from the 'Pod-R' population (coastal but with offshore features, north-central Chile). A small but statistical significant difference was found for the indexes 'height/length base' and 'fin width at mid-height/length base' between specimens from coastal Ecuador and coastal Peru and specimens from offshore Ecuador and offshore Peru, and Pod-R. No significant variation was observed for the index 'overhang of fin tip/length base'. However, when all coastal were compared with all offshore samples this latter index was found to be significant, with Pod-R individuals clustering with the offshore morphotype and exhibiting extreme falcateness. The authors suggest that 'Pod-R' may represent a recent radiation into the coastal environment from an offshore population and that the strong fin falcateness may be a trait retained due to some oceanic features of the local nearshore environment (e.g. deep water, strong currents) and that future research should evaluate sexual dimorphism within the populations.

In discussion, Fruet recognised the paper as a good example of collaborative research in South America. He pointed to one concern that some coastal-type dorsal fins in figure 4 of SC/67a/SM02 are very similar in shape to dorsal fins classified as offshore in the same figure. He noted that in Brazil the same pattern in dorsal fins occurs but that there are occasions in the field when it is very difficult to distinguish an animal with great confidence. Genov noted that in the Adriatic and Ionian Seas, such variation in dorsal fin types is very common, both within the same population as well as within a single group. Van Waerebeek noted that he has never detected the two fin types within the same sighting in Peru or Chile, but agreed ample experience with both types was needed to confidently distinguish between them. It was also noted that the coastal dorsal fin type has been documented in Colombian nearshore waters. Fruet also suggested that it would be useful to compare fins between Brazil and the eastern South Pacific and requested information on how to define the landmarks of the fins with which to make the measurements.

Vermeulen also noted that there are similar observations of differences in dorsal fin shape between offshore and coastal animals in the eastern South Atlantic. Lang mentioned that there has been similar study in the Pacific waters of Mexico as well, with the work currently in review. It was noted that there are several publications looking at dorsal fin characteristics in New Zealand. Rosel asked whether it was likely the features of the coastal dorsal fin could be considered a valid character in species delineation or whether these features represent convergent evolution resulting from multiple independent forays into coastal habitats. Van Waerebeek suggested it was a functional adaptation to habitat. Overall, the sub-committee felt convergent evolution was likely.

6.1.4.3 WESTERN NORTH PACIFIC (WNP)

The Rosel and Natoli overview of published information highlighted that both *T. truncatus* and *T. aduncus* are present in the western North Pacific. Kaiya and Weijuan (1985) provided evidence for both species in the South and the East China seas and the Yellow Sea through compilation of stranding records. Shirakihara *et al.* (2003) provided osteological and mitochondrial cytochrome b results from 2 specimens stranded in western Kyushu, Japan and identified them as *T. aduncus* and Shirakihara *et al.* (2002) report year-round residency for *T. aduncus* in this area. Kim *et al.* (2010) identified *T. aduncus* in southern South Korean waters through external morphological data and examination of the skull of a stranded animal and Song (2014) provide further information on this species in Korean waters.

Hoelzel presented SC/67a/SM07, a study of population divergence among bottlenose dolphins in Taiwan, and western and eastern Japan. This study used microsatellites (20 loci compliant with HWE) and mtDNA control region sequence data and augmented the latter data set with sequences using published data from GenBank. Only two populations were sufficiently well sampled for summary statistic assessment, Taiwan (*n*=28) and east Japan (*n*=32) and F_{ST} was low but significantly different from zero between them. Assignment analysis using the program STRUCTURE showed only a weak pattern, and only when using a location prior. However, this is consistent with the low power of the method for that magnitude of F_{ST} observed. Ordination analysis using FCA showed a clearer pattern and could also incorporate the very small sample sizes from the Philippines (*n*=2) and west Japan (*n*=4). From the FCA analysis, the Philippines samples appeared sufficiently differentiated to encourage further analysis in the future, and a set of captive animals used in the dataset appeared to have been sourced from east Japan.

Using the two most informative factors in the FCA, west Japan samples were closest to the Taiwan samples, but when the first and third most informative factors are used west Japan was more differentiated from Taiwan. Geneland analysis grouped Taiwan with west Japan, and in general supported three putative populations. A small sample set of *T. aduncus* (*n*=7) confirmed the strong differentiation between the two recognised species of *Tursiops* in this region. MtDNA data for a consensus 388bp portion of the control region was compared with samples obtained from GenBank to provide a broader geographic context for a total of 353 samples for *T. truncatus*. In this analysis, the Taiwan samples grouped with samples from southeast China and were differentiated from all others except for northeast China. Some indication of lineage sorting between the east Japan samples and southeast China samples was observed. All populations show high levels of diversity compared to coastal populations elsewhere in the world (e.g. the population off southern California and northern Baja Mexico). Other species have been found to show an east vs. west pattern in this region, and this may be consistent with these data, but the sample size is insufficient to test this fully. In summary, the mtDNA data suggested differentiation among sites in the central Pacific (Hawaii and Palmyra) and western Pacific, and between samples from Taiwan and Japan, with some indication, from the microsatellite data, of differentiation between the east coast of Japan and both Taiwan and west Japan.

In response to questions about how coastal *vs* offshore specimens were diagnosed, and the source of the samples analysed, Hoelzel clarified that while the data were not inconsistent with a coastal *vs* offshore distinction suggested previously, the current study could provide no firm confirmation of that. Supplementary table S3 in SC/67a/SM07 gives details on the source of all specimens, which included a mix of biopsy samples, bycaught and stranded individuals, and one specimen each from a directed fishery and an oceanarium. Natoli asked for clarification on the location of the *T. aduncus* samples used in the study. Brownell pointed out that this species is found mainly on the west side of Honshu including the Noto peninsula, the south and west sides of Kyushu and at some offshore islands south of Tokyo (including the Izu Seven Islands and Mikura Island. Hoelzel indicated the *T. aduncus* samples came from Kyushu.

Funahashi presented SC/67a/SM06, which reviewed available information on Indo-Pacific bottlenose dolphins (*T. aduncus*) and common bottlenose dolphins (*T. truncatus*) around Japan. The author reported that Indo-Pacific dolphins prefer warmer waters, are distributed to the south of Kanto and Toyama Bay, and tend to reside in coastal areas and inland bays. *T. aduncus* is found off Amami Oshima Island, of Tsujishima Island, in Kagoshima Bay, around Mikurajima Island, Ogasawara Islands, Torishima Island and other islands. It is almost certain that it occurs in Okinawa. Some populations have been studied over many years in these locations. Sightings of distinctively marked individuals showed movement of some dolphins into other areas. A small cetacean fishery has been operating for a long time in several places around the coast of Japan. Since Indo-Pacific bottlenose dolphins inhabit coastal waters, they could have been exterminated in some regions by these fisheries before scientists recognised their presence. Recent expansion of habitat of the species can be a process of population rebuilding. Monitoring of this process will provide information on population structure.

Little is known about population structure of *T. truncatus* around Japan. Analysis of common bottlenose dolphin life history parameters revealed several differences between samples from the Pacific Coast and the Iki Island area, suggesting the presence of discrete populations in each area and further population subdivision could not be excluded. It is suggested that bottlenose dolphin of the East China Sea will enter Sea of Japan from spring to autumn and return to the south of Tsushima Strait in winter, but from different surveys there is evidence that coastal common bottlenose dolphins move further north in summer than the offshore bottlenose dolphins. The lowest surface water temperature recorded during sightings of common bottlenose dolphins was 11°C. Temperature drops remarkably in the winter off the Sanriku area; it is suggested that in this season common bottlenose dolphins that summer in the Sanriku area move south. Density distributions of common bottlenose dolphins in the western North Pacific reveal a gap between coastal and offshore waters. This information suggests the presence of two common bottlenose dolphin populations off the Pacific coast of Japan, separated by the warm Kuroshio Current. This observation is supported by movements of 4 dolphins caught in Taiji and radio tagged and released in 1985, 1986 and 1994. These animals stayed between the Japanese archipelago and the Kuroshio Current and did not go into warm waters of the Kuroshio Current.

Brownell presented information from Kurihara and Oda (2006), a published study of bottlenose dolphin distribution in the islands around Japan, which analysed the skulls of 27 bottlenose dolphins to clarify differences in distribution between *T. truncatus* and *T. aduncus*. These authors divided the Japanese bottlenose dolphins into two morphological groups: Group A (six specimens from the coastal waters of the Amami Islands, Amakusa-Shimoshima Island, and Mikura Island) and Group B (21 specimens from other areas around Japan). Comparisons with type specimens showed that Groups A and B were identical to the types of *T. aduncus* and *T. truncatus*, respectively. Thus, *Tursiops aduncus* is known to occur in at least three locations near the main Japanese islands: (1) Amami Islands; (2) Amakusa-Shimoshima Island; and (3) Mikura Island.

Kim presented a summary of published reports of bottlenose dolphin distribution around the Korean peninsula. Both *Tursiops* spp. commonly inhabit Korean waters. The species identification was determined by external features from free-swimming individuals, and cranial and meristic measurements from bycaught animals. The genetic data agreed with morphological classifications. The results of sighting surveys and bycatch data confirm that *T. truncatus* is found in the Korean waters including the East Sea, Yellow Sea and East China Sea, while *T. aduncus* is only distributed in coastal waters of Jeju Island.

In response to a question about the evidence for distribution of the two bottlenose dolphin species in this region, Kim clarified that photographs of free-swimming animals were used to identify external morphological characters. Specimens for which cranial measures were available, including bycaught animals from around Jeju, were also examined and all were *T. truncatus*. In addition, 9 days of shore-based surveys were conducted around Jeju Island (2011-15) and 27 dolphin groups were encountered, all within 500m of coast, and all were *T. aduncus*. Funahashi commented that observations off Ogasawara confirmed the presence of both species there. Brownell pointed out that additional information, based on genetic analysis of 165 samples from Taiji (Kita *et al.*, 2013) was not presented here but is mentioned in SC/67a/SM07.

6.1.5 Updates from areas previously reviewed

The sub-committee reviewed new information relative to geographic areas previously reviewed during the IWC 2015 and 2016 meetings.

6.1.5.1 UPDATE ON SECOND INTERNATIONAL WORKSHOP ON RESEARCH AND CONSERVATION OF *TURSIOPS* IN THE WESTERN SOUTH ATLANTIC

Vermeulen presented a summary of the Second International Workshop on the Research and Conservation of *Tursiops* in the western South Atlantic, held in Brazil between the 6th and 8th of April 2017. This workshop was organised under the leadership of Pedro Fruet, and brought together 60 researchers from Brazil, Uruguay, and Argentina, with invited participants from South Africa and the United States. The workshop reviewed a total of 50 working papers. The focus of the workshop was to:

- review progress with research priorities recommended at the previous workshop held in 2010;
- review the taxonomy, population structure and the conservation status of the recognised Management Units of bottlenose dolphins in the Southwest Atlantic Ocean;
- discuss research priorities for the next five years; and
- develop multi-institutional research collaborations for the conservation of bottlenose dolphins in this region.

The main conclusion of this workshop regarding taxonomy was that no consensus could be reached as to whether the two morphotypes in the Southwest Atlantic Ocean (SWAO) should be considered subspecies or species. However, all the researchers agreed that both forms of *Tursiops* in the SWAO are distinct to some level and that this should be considered in future research projects and for conservation purposes. Workshop participants agreed that the taxonomy of *Tursiops* in the SWAO requires further in-depth assessment. Therefore, it was recommended to:

(1) ensure an improved and increased biopsy sampling effort of specimens in the extreme ranges of the distribution of the gephyreus-type;
(2) improve the assessment of fine-scale population structure of the '*truncatus*-type';
(3) re-assess the population structure of gephyreus-type considering that a significant number of new samples are available; and
(4) improve collaboration among all researchers.

In addition to taxonomy, many other topics were discussed, including population structure, demographic parameters, distribution and conservation status. One of the other main conclusions outside of the area of taxonomy was agreement to create a regional photo-identification database. The final report of the workshop will be finalised by the end of 2017.

Natoli asked whether any new data, that had not been presented SC/66b, had been presented at the workshop. Fruet indicated that new analyses summarised in the workshop report included carbon and nitrogen stable isotope analyses of skin biopsies and no overlap was seen in ellipses encompassing either the carbon or nitrogen signatures for the two morphotypes. In addition, differences in acoustics between the two morphotypes were also presented. Some new genetic data and analyses are also forthcoming, with a manuscript under review, but no working paper or analytical details were provided at the meeting.

6.1.5.2 UPDATE ON GLOBAL PHYLOGENY BASED ON GENOME SAMPLING USING DDRAD

Hoelzel presented a new phylogenetic analysis of 57 bottlenose dolphin samples across a wide geographic range and including examples of most of the taxonomic contrasts under consideration and 9 outgroup species samples. Phylogenetic trees were built from 4,029,091bp of sequence data derived from ddRADseq analyses, containing a total of 26,720 variable sites, using the MrBayes method with 100,000,000 total iterations. Partitioning schemes grouped nearby loci (referenced to the available *Tursiops* genome data) and considered GC content. The partitioning scheme was determined using PartitionFinder and the rcluster method with the RaxML option, and the resulting partitioning then used to determine a nucleotide substitution model in MrBayes. This represented an update to a phylogeny presented last year using the same dataset, and the refined analyses produced essentially the same topology as before. Samples from Taiwan were found in a lineage together with offshore samples from the North Atlantic and Indian Oceans. The deepest division within the genus was between *T. truncatus* and *T. aduncus* populations. Three lineages within the *aduncus* lineage represented South Africa, Australia and the 'Burrunan form' from Australia (putative *T. australis*). The *T. truncatus* samples presented five lineages, and more samples should be included to better resolve the broader *truncatus* lineage. The western North Atlantic coastal samples still produce a monophyletic grouping at the base of the *truncatus* lineage similar to the results presented in 2016.

In response to a question, Hoelzel clarified that in order to deal with the loss of potentially informative sites due to restriction site polymorphism, filtering was applied that reduced the total number to roughly 4M bp, down from a much larger number. To a question about heterozygous sites, Hoelzel responded that ambiguity codes were applied. It was noted that closely related taxa will have a recent shared history and so won't be fixed for alleles.

6.1.6 Work plan to complete Tursiops *review*

Natoli reported that plans for an intersessional Workshop proposed last year (IWC, 2017) to be held in 2018 are moving forward, and funding from the IWC has been made available.

The key objectives of the Workshop are as follows.

(1) Consider and discuss terms and a strategy for taxonomic classification for this genus that is consistent both with its distinct characteristics and accepted traditional procedures. So far there are two best defined lineages, the established species *T. truncatus* and *T. aduncus*. Within these, further structure has been recognised, but at different levels of differentiation and consistency. Discussions will focus on the relative importance of morphology, behaviour, mtDNA and nuclear genetic data for consideration of differences at the specific, subspecific and population levels.
(2) Following from (1), Workshop participants will evaluate the evidence available which informs taxonomic status of *Tursiops* in various localities, using the information compiled from the three years of review. A table will be complied that lists available types, amount, and strength of the evidence for consideration of each taxonomic 'contrast'.
(3) Hypotheses about taxonomic status for each taxonomic 'contrast' will then be formulated.
(4) Finally, the Workshop will identify important outstanding areas for further research and poorly known regional populations that are data deficient.
(5) The Workshop will prepare a report summarising conclusions from all review work, and provide recommendations for a consensus approach for use of standard genetic markers, morphotypic analyses, behavioural data, and their integration so that a consistent classification framework for the genus can be established.

Although starting from the premise that *Tursiops* merits classification as a single genus, the possibility of higher taxonomic classifications will be considered in the context of broader delphinid taxonomy by inclusion of information from a range of appropriate outgroups identified from the analyses conducted.

6.1.7 Conclusions from the 2017 review

The sub-committee's review of *Tursiops* in the eastern Pacific and western North Pacific, shows that well differentiated morphotypes of *T. truncatus* are present in the eastern Pacific while in the western Pacific (Japan, Taiwan, Korea) the presence of the two recognised species is well documented. Limited data are available for *Tursiops* in much of Central America, impeding efforts to understand relationships among morphotypes throughout the eastern Pacific.

In the eastern North Pacific, both morphological and genetic (mtDNA, microsatellites) data provide a convincing argument for the presence of two distinct morphotypes, with a level of genetic differentiation consistent with long-term separation. In California, the coastal morphotype is restricted to waters within 1km of the coast between approximately Ensenada, Mexico and San Francisco, California. Coastal and offshore morphotypes are also present in the Gulf of California and there appears to be significant genetic differentiation between the Gulf of California and California coastal populations, but a comprehensive morphological analysis comparing the two has not yet been performed. In the Gulf of California, the coastal morphotype is restricted in range to the upper portion of the Gulf and may be of conservation concern given documented bycatch in fisheries.

In the eastern South Pacific morphological data also support the presence of two morphotypes at least in Peru, Ecuador and Columbia. A few genetic analyses have been completed but sample sizes have been relatively low and the genetic analyses could be improved with increased sampling throughout the region. In addition, it was noted that there is a possibility that *Tursiops* may move around the tip of South America and comparisons of morphological and genetic data between both sides of the continent are encouraged. The area between 45° and 53°S needs further attention as the occurrence of *Tursiops* in this area is unknown. In addition, given the available evidence available to date, only the offshore morphotype and the hybrid-like Pod-R are documented in Chilean waters. Further work is needed to determine whether the coastal morphotype is present in Chile.

In order to confidently resolve the taxonomic status of the different morphotypes in the eastern Pacific, in addition to augmenting sample sizes for many regions, data (morphological, genetic and other) from the northern and southern regions need to be compared so that the ranges of any the potential taxonomic units can be fully explored.

In contrast to the eastern Pacific, data collected to date in the western North Pacific do not support the presence of multiple morphotypes of *T. truncatus* (although population genetic differentiation has been found). Instead both *T. aduncus* and *T. truncatus* appear to co-exist throughout much of the range examined in Japan and Korea. However, sample sizes in published morphological studies have been fairly small and so it is not possible to rule out the presence of multiple morphotypes in the waters of the western North Pacific.

7. REVIEW OF SMALL CETACEANS IN RIVERS, ESTUARIES AND RESTRICTED COASTAL HABITATS IN ASIA, *PLATANISTA* SPP., *ORCAELLA* SPP. AND *NEOPHOCAENA* SPP.

7.1 Coastal finless porpoise

SC/67a/SM09 provides a review of Indo-Pacific finless porpoise (*Neophocaena phocaenoides*) records from India with a special focus on the population in Sindhudurg, Maharashtra. Finless porpoise have been reported from shallow waters along both the east and west coasts of India. Vessel-based surveys in Gujarat, Maharashtra, Goa, Karnataka, Kerala and Pondicherry have confirmed the presence of the species in all of these areas. Sighting and stranding reports are more common on the west coast than the east coast, which could be due either to the presence of greater research effort on the west coast or to a habitat difference, with the east coast having only small pockets of preferred habitat and the west coast having more contiguous habitat availability. Karnataka and Maharashtra on the west coast of India seem to have higher densities, or at least higher reporting rates, compared to other west coast areas and the east coast. The compiled stranding records show that entanglement in fishing gear remains a major threat to this species. Gillnets, purse seine nets and shore seine nets are known to catch finless porpoise with a minimum of 10-12 individuals reported as bycaught every year in Maharashtra and Karnataka.

Vessel-based surveys covering 121km of the Sindhudurg coast in southern Maharashtra indicated a seasonal difference in finless porpoise distribution with higher densities in the months of October to February and lower densities in the drier months of March to May. Static acoustic monitoring using CPODs at Sarjekot has also revealed seasonal and diel patterns of occurrence in near-shore waters. There was a peak in echolocation clicks between 18:30 and 22:30hr and another at midnight in October and November, while in June to August there was a peak at 11:00hr. Acoustic monitoring also revealed that finless porpoise were present until early June and then disappeared, only returning to the area from October onwards.

Only relatively small portions of the vast India coastline have been surveyed for finless porpoise (e.g. the Sundarbans represents a major data gap), and at-sea observer effort to monitor bycatch and efforts to detect, investigate and report on strandings have been extremely limited. It was noted that teams of researchers along parts of the coast collect tissue samples from strandings but it was uncertain how these are being preserved, archived and analysed. Clearly, much more effort is required before any firm conclusions can be drawn concerning finless porpoise population structure and abundance or the scale and sustainability of bycatch in India. Acoustic monitoring offers a potential way of assessing distribution and perhaps relative abundance. It was noted that research effort in India is best organised at the state level.

Minton *et al.* (2011) provided information on Indo-Pacific finless porpoise in Sarawak, Malaysia. This species was the second most frequently observed cetacean in surveys of three locations, with the highest encounter rates in the Bintulu-Similajau region. A line-transect estimate of finless porpoise in Kuching Bay was 135 individuals (CV=31%, 95% confidence interval 74-246) (Minton *et al.*, 2013)[1]. Abundance varied seasonally, with higher densities observed between March and May, coinciding with the occurrence of larger groups with very small calves.

Also in Sarawak, one study compared the distribution, ranging patterns and space use of Irrawaddy dolphins (*Orcaella brevirostris*), Indo-Pacific humpback dolphins (*Sousa chinensis*) and finless porpoise. Finless porpoise preferred shallow waters farther from river mouths and from shore, and areas with higher pH values than those preferred by Irrawaddy dolphins (Zulkifli Poh, 2013). Finless porpoise behaviour was dominated by (probable) feeding, followed by milling and travelling. The shallow inshore waters of Kuching Bay serve not only as an important feeding ground for this species but also as habitat for calving with a high frequency of occurrence of groups with calves in March-May.

Further study in 2011-13 revealed that relative density of observed fishing activity depicted in 2km×2km grid-cells indicates a strong overlap between the primary fishing areas and the preferred habitats of Irrawaddy dolphins and finless porpoise, which are both concentrated in rivers, river mouths and close to the shore. This overlap indicates that the impact of artisanal fisheries on the cetacean populations through bycatch could be high, and interview data confirm that bycatch is prevalent, with 93% of fishermen reporting that they had heard of between one and five cases of bycatch in their village in the past year, and 35% of fishermen reporting that they had found at least one dolphin accidentally entangled (either live or dead) in their own net in the past year. Two beachcast finless porpoise in Sarawak had large shrimp in their stomachs (Sarawak Dolphin Project, unpublished data). During discussion, the smallness of the Sarawak study area relative to the known or predicted finless porpoise range in western Borneo was noted. Minton confirmed that finless porpoise also occurred to the north of the Kuching Bay. Porter reported that finless porpoise strandings were rare in the neighbouring state of Sabah and that she has not seen them during surveys in Sabah waters. It was noted that sightings have been reported from the Indonesian coastline contiguous to Sabah but not in any great number.

The sub-committee recommends that surveys for (relative) abundance, habitat use and distribution of Indo-Pacific finless porpoise be carried out with particular emphasis on areas where the least is known (e.g. India, Indo-Malay Archipelago, Arabian/Persian Gulf).

The sub-committee recommends that efforts be made to improve bycatch monitoring (ideally with onboard observer programs, and at a minimum with stranding notification, investigation, sampling and reporting) in all areas of known overlap between finless porpoise occurrence and fishing activity (especially gillnetting). Biological sampling of bycaught and stranded specimens is critical for assessment of population structure.

7.2 Yangtze finless porpoise

SC/67a/SM17 provides an update on the conservation of Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) since 2015. The Chinese Ministry of Agriculture has made substantial efforts to improve the conservation status of the Yangtze finless porpoise in recent years, in particular: (i) the Yangtze Finless Porpoise Recovery Action Plan (2016-25) was launched in 2016; (ii) a proposal to upgrade the conservation status of the Yangtze finless porpoise was adopted and submitted to the State Council; (iii) a year-round fishing ban is imminent in all *in situ* porpoise reserves within the Yangtze basin; and (iv) a comprehensive fishing ban throughout the entire Yangtze basin before 2020 has been proposed. In addition, ex situ conservation efforts have made several achievements: (i) a third ex situ reserve, Xijiang, was established in Anqing, Anhui Province; (ii) porpoise exchanges between reserves were initiated; and (iii) the number of animals in ex situ 'semi-natural' reserves has increased. Further, porpoise population numbers are increasing in some natural (*in situ*)

[1]This estimate has not yet been reviewed and endorsed as per the working procedures of the IWC.

reserve areas, namely Nanjing Reserve and Dongting Lake Reserve. Public awareness has significantly improved and more than 20 local NGOs are involved in the Yangtze finless porpoise conservation campaign.

In discussion, it was noted that genetic analyses have been conducted to assess paternity and to measure levels of inbreeding. Therefore, kin relations among these animals are known to some extent. Several translocations of animals between reserves has occurred. This involves considerable overland transport, which does not appear to unduly distress the porpoise. It is believed that some reserve populations are sufficiently large to allow future translocations between areas.

Wang Ding noted that the construction of dams and bridges block or reduce the usual movements of porpoise into and out of Poyang Lake. Activities such as dredging, sand-mining and fishing also have negative ecological impacts and degrade the quality of the habitat for finless porpoise. Given that the number of porpoise in Poyang Lake appears to be fairly constant, there is reason to believe that a reduction in human pressures might allow the numbers there to increase. The sub-committee welcomed the information that a fishery ban in the entire Yangtze basin by 2020 has been proposed, but concerns were expressed over such a plan's feasibility. The sub-committee agreed that, at a minimum, enforcement of a fishing ban at least throughout all finless porpoise reserves would be advisable.

The sub-committee further noted that the program for translocating finless porpoise appears to be effective, and commended the Chinese Government, Wang Ding and his colleagues for the progress they have made in this regard. Wang Ding suggested, and the sub-committee agreed, that a few areas of particularly high-quality habitat (e.g. oxbows along the main channel of the Yangtze) should be identified, and that the suitability of such areas as ex situ reserves be carefully assessed prior to any porpoise being introduced.

The sub-committee re-iterated previous recommendation that primary conservation actions should focus on restoring and maintaining suitable habitat for porpoise throughout the Yangtze River and associated lakes. This includes maintaining a network of *in situ* reserves, making efforts to ensure that genetic diversity is preserved and limiting harmful human activities.

7.3 Riverine Irrawaddy dolphin

Irrawaddy dolphins (*Orcaella brevirostris*) occur in relatively small populations of fewer than 200 individuals in coastal waters near river mouths, within three large rivers and in three large lagoons or sounds of the Indo-Pacific. The species is listed as Vulnerable on the IUCN Red List (Reeves *et al.*, 2008). In addition, five demographically isolated 'subpopulations' are red-listed as Critically Endangered due to small population sizes (<50 mature individuals). These include all three riverine populations – Ayeyarwady River in Myanmar, Mahakam River in Indonesia and Mekong River in Cambodia and Laos – as well as the populations in Songkhla Lagoon in Thailand and Malampaya Sound in the Philippines. Although the magnitude and nature of threats vary from area to area, entanglement in fishing gear, particularly gillnets, is a common problem throughout the species' range.

7.3.1 Irrawaddy dolphins in the Mekong River, Cambodia and Laos

Phay reported on monitoring of the critically endangered Mekong River population based on mark-resight studies. These dolphins are regarded as a 'living national treasure' of Cambodia. Khmer and Lao folklore tells of a human ancestry of the dolphin, which is a flagship species of Mekong biodiversity and viewed as an indicator of the health of this river system on which more than 60 million people depend for their livelihoods. The dolphin is one of the 58 recognised 'Fisheries Endangered Species' in Cambodia.

The population of dolphins has been declining for many years and is now believed to number fewer than 100 individuals. Phay reported that current results from the Mekong river surveys indicate the Mekong dolphin population is estimated at 80 individuals in 2015, with a 95% confidence interval of 64-100. The average annual population growth rate is estimated at 0.98 with an average annual decline of 1.6% per year between 2007 and 2015. Also, there has been evidence of poor recruitment with a documented high mortality of neonates and calves. Recent observations by WWF-Cambodia have been somewhat encouraging. Eleven calves were recorded in 2016 with only two reported to have died. During the first 5 months of 2017, 5 more calves were born (WWF and FiA, 2017).

Mekong dolphins face many threats, including bycatch in gillnets, illegal and destructive fishing with explosives, electricity and poison, as well as increased boat traffic in the river due to human population growth, development and tourism. Of particular concern is the construction of hydropower dams both upstream of their range and soon possibly within it.

The Government of Cambodia, in collaboration with WWF and development partners, have taken several steps to protect the dolphins, including: amendment of the law on fisheries; a Sub-Decree on the Determination of Types of Fisheries and Endangered Fisheries Products which accords full protection to 58 endangered fisheries species, including the Mekong dolphins; and a Proclamation (Prakas) on the Measure to Protect the Endangered Fisheries Species which established an office within the Department of Fisheries Conservation for management and conservation of marine mammals. The Mekong River Dolphin's Protection and Management Area was created in 2012 and 72 river guards are now permanently based at 16 outposts along the river to enforce the ban on gillnet use. Also, the Mekong River dolphin is the first endangered species under the Sub-Decree to receive funds from the Royal Government of Cambodia for management and protection. This budget supports fuel and salary for the river guards, capacity building and maintenance.

The Government of Cambodia, again in collaboration with WWF, has hosted a series of expert workshops on Mekong River dolphin conservation and research efforts (Somany *et al.*, 2016; WWF and FiA, 2014; 2017). The latest of these, hosted by the Deputy Director General of the Fisheries Administration (FiA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), was held in Kratie on 16-18 January 2017. These workshops foster valuable international collaboration on research methods and conservation approaches, e.g. threat identification, evaluation of sources of mortality and enforcement methods. Implementation of recommendations from the workshops has significantly contributed to a reduction in illegal fishing activities and a corresponding reduction in dolphin mortality from gillnet entanglement, greater survival of calves (a continuing concern) and an improved understanding of the dolphins' behaviour.

The 2017 workshop included participants from all three riverine populations as well as from Bangladesh, where Irrawaddy dolphins occur in the Sundarbans Reserved Forest and coastal waters. A detailed summary of information on current threats and recommendations pertaining to the Mekong population derived from the 2017 workshop report is reported below, and information on other populations is summarised in the relevant sections of this report.

Until a few decades ago, dolphins occurred along much of the length of the Mekong River, in its three main tributaries that include the Sekong, Sesan and Srepok rivers, and in the Tonle Sap Great Lake. Now they are restricted to a 180km segment of the Mekong mainstem between the Kampi dolphin viewing site in Kratie, Cambodia and the Khone water falls, Lao PDR. Their distribution is concentrated in nine deep pools where the dolphins reside in the dry season, but they range more widely in the wet season. Mekong dolphins show high site-fidelity around these deep pools, and appear to keep regular home-ranges with little dispersal between core areas. One of these core areas, the transboundary pool at the Lao PDR/Cambodia border, is separated from the nearest downstream pool by a complex 60km stretch of river containing a large number of rapids. It appears those dolphins inhabiting the transboundary pool are now an isolated sub-population and no movement of dolphins into or out of this area from other areas further south has been recorded.

The most immediate threat to Mekong dolphins is entanglement in fishing nets, especially gillnets, and destructive illegal fishing (e.g. explosives, electrofishing). Overfishing, environmental contamination and disturbance by boats and tourists are other threats. The river guard program has been successful in confiscating gillnets in the core dolphin zones in the Mekong River, although there is still a great deal of illegal fishing pressure. The presence of river guards has reduced the threat of gillnet entanglement and may be a significant factor in the recent increase in calf survival and apparent stabilisation of the Mekong dolphin population which had been subject to steep declines.

Hydropower developments both upstream of their range, and soon possibly within it, are expected to have significant impacts on Mekong river dolphins for five broad reasons:

- fragmenting of populations by creating impassable barriers to interchange;
- loss of habitat and microhabitats, both through siting of structures and changes to the very specific conditions riverine dolphins use to survive in constant river flow;
- loss of prey through fish declines;
- disturbance, both short-term during construction and long-term during operations; and
- direct mortality or debilitation from exposure to construction noise and explosions.

The 2014 international workshop (WWF and FiA, 2014) concluded that 'if built, Don Sahong dam will lead to the extirpation of dolphins from the Cambodia/Lao PDR pool and will increase extinction risk for the entire Mekong dolphin population'. Despite opposition from Thailand, Cambodia, and Vietnam, the Don Sahong dam has been under construction since 2014 in a channel of the Khone-Phapeng Falls complex in Laos, several hundred meters upstream of the transboundary 'dolphin pool' at the Laos-Cambodia border. The impacts of the construction on dolphin habitat are immediately apparent. The sediment load from the construction is reportedly making the trans-boundary pool gradually shallower. An interview study of villagers in the vicinity of the construction site indicated that in addition to direct impacts on dolphins, the ongoing construction has already had negative impacts on fish stocks in the deep pools, disturbed fish migration and disrupted the livelihoods of local communities. In addition, fishermen displaced from the site of dam construction are now fishing in the deep pool area, contributing to an increase in illegal fishing activities potentially dangerous to the dolphins (Somany *et al.*, 2016). Since the construction began, the transboundary population has declined from five to three individuals. The three remaining dolphins are moving more frequently away from the core habitat, presumably in response to the noise from blasting and excavation, daily fluctuations in water flow and water pollution from the dam site. The reduction in numbers and isolation of this group has raised the question of whether translocation of these animals to another area of population concentration should be explored as a conservation measure.

In addition to the Don Sahong dam, four major dam projects are of extreme concern to dolphins in the Mekong River (Brownell *et al.*, 2017). These proposed new dams are in Cambodia; specifically the Sambor dam, Kratie Province, with an anticipated electricity capacity of 2,600 MW, and the Stung Treng and Sekong dams in Stung Treng Province, with electric capacities of 900 MW and 190 MW, respectively, would have significant impacts. If these proposed dams were constructed, it is likely that the entire population of Mekong dolphins would be lost. The Sambor and Stung Treng dams are proposed within the immediate area of dolphin distribution. The Sambor site is of greatest concern. It would be within core habitat and upstream reservoirs and downstream changes in hydrology would certainly have major impacts on the dolphins. The proposed Stung Treng dam would inundate the entire Middle Stretches of Mekong River North of Stuoeng Treng Ramsar site, and cut off the transboundary dolphin subpopulation from any possibility of contact with downstream subpopulations.

The sub-committee **welcomed** the report of the 2017 international workshop (WWF and FiA, 2017) and **endorsed** its principal conclusions. The sub-committee **noted** that gillnets continue to represent a primary and ongoing threat and therefore, continued implementation of a suite of measures to address this threat is required, including enforcement of existing legislation through continuation of the river guard program, gillnet removal programs, efforts to discourage use of gillnets through awareness campaigns and education of local communities, as well as exploration and encouragement of alternative livelihood options for the vast number of people dependent on the Mekong River.

The sub-committee **noted** with concern that the construction of dams on the river poses a serious existential threat to Irrawaddy dolphins through population fragmentation, habitat destruction, limitation of prey availability, and changes in water levels. The sub-committee **agreed** that if the proposed construction of large hydropower projects on the Mekong mainstem in Cambodia proceeds, almost all of the dolphins' habitat in the Mekong will be modified or eliminated and the risk of extinction will be greatly increased. The sub-committee **recommends** that the IWC Secretariat write to the Cambodian Council of Ministers and relevant Cambodian Ministries expressing grave concerns regarding the impacts on Mekong dolphins of the proposed multiple dam construction.

Since construction of the Don Sahong dam began in 2014, the Laos/Cambodia transboundary group of dolphins has declined from five to three individuals and the animals have been driven away from their previous range in the vicinity of the construction site. This has brought the question of whether these animals should be translocated to another area of dolphin concentration further downstream. The sub-committee concluded that there is insufficient information to address the question properly. For example, without knowing more about the demographic and social structure of donor and recipient subpopulations, it would be difficult to conduct a scientific assessment of the possible benefits and risks of such an effort.

The sub-committee **recommends** that any effort to assess the conservation value and feasibility of translocating these individuals to another social group of dolphins downstream in Cambodia include consideration of the likely social and genetic consequences of such a move for the overall population. This would include determination of the age and sex of each dolphin in the transboundary pool through available information and tools, e.g. analysis of existing photo-identification data, genetic analyses of skin samples collected by biopsy, and photogrammetry.

7.3.2 Irrawaddy dolphins in the Mahakam River, Indonesia

This population inhabits a 420km stretch of the Mahakam River, Indonesia. Known as Pesut Mahakam, these dolphins are protected by Indonesian Law and are the official mascot of East Kalimantan Province. Abundance and distribution data have been collected during extensive monitoring surveys initiated in 1997. The most recent estimate of total numbers in this population, presented at the workshop, is 69-81 (CV 7%) individuals. Survey data indicates a declining population trend from 2005. At least 4-6 calves are born every year with a peak in calving in July-September (dry season). Between 2005 and 2016, on average four carcasses, 16% of them calves, were recovered every year: juveniles and adults represented 9% and 75% of carcasses recovered, respectively (WWF and FiA, 2017).

7.3.3 Irrawaddy dolphins in the Ayeyarwady River, Myanmar

Irrawaddy dolphins are found in the Ayeyarwady River in three apparently disjunct populations, estimated to total 60-70 individuals, from Mandalay to Bamaw. Coastal populations also occur in Rakhine State, the Ayeyarwady Delta and the Taninthari region. The Ayeyarwady is known for the unique culture of cooperative fishing between fishermen and dolphins. The main threats to Ayeyarwady dolphins are considered to be gold mining, gillnet fishing, and electric fishing. A Management Plan for the Ayeyarwady Dolphin Protected Area (ADPA) has been prepared by the Myanmar Department of Fisheries in collaboration with WCS. Direct count surveys covering a 445km segment of the river are conducted annually (WWF and FiA, 2017).

7.4 Indus River dolphin (bhulan)

SC/67a/SM22[2] summarises the status of Indus River dolphins (*Platanista gangetica minor*) and key challenges that these dolphins are facing within their current range in Pakistan. Indus dolphins are red-listed as Endangered and have been a global conservation priority for nearly half a century. The linear extent of their historical range along the Indus and its tributaries has been reduced to only about one-fifth of what it was in the 1870s (from *c*3,500 linear km of river to 1,000km), primarily owing to the shortage of water and the construction of dams and barrages across the Indus and its tributaries which have resulted in population fragmentation and degradation of the habitat. Dolphins frequently become stranded (in the sense of being blocked from returning to the main river channel) in irrigation canals, especially during the low-flow season. During canal closure the gates are closed, which ends up lowering water levels within the canal, resulting in the formation of small pools in which dolphins become trapped. Without rescue they generally die. Fish is an important component of the diet in many local communities along the Indus and intensification of fishing has caused a substantial increase in fishing-induced mortality of dolphins over the last five years. Use of poison, nets with illegal mesh size and over-night setting of gear are among the factors believed to contribute to this mortality.

WWF-Pakistan has been involved in the conservation of this subspecies since 1999. Surveys to estimate abundance suggest that the population has increased since 2001, with approximately 1,200 individuals estimated in that year rising to 1,550-1,750 in 2006 and 1,452 in 2011. A fourth range wide abundance survey conducted during March-April 2017 (with financial support from the IWC Small Cetacean Voluntary Fund) generated a provisional population estimate of 1,800-1,900 individuals. The total population of the subspecies in Pakistan is divided by six irrigation barrages into five largely discrete subpopulations, the largest of which (estimated at 857 dolphins in 2011) occurs between the Guddu and Sukkur barrages in Sind Province. This stretch of the Indus River is designated as a protected area, the Indus Dolphin Game Reserve, which is also an internationally recognised Ramsar Site.

Research and conservation priorities are to strengthen efforts to rescue dolphins from canals, continue population monitoring, assess and reduce fishery-caused mortality, and promote and support community-based conservation actions.

In conclusion as follows.

- Although Indus River dolphins are legally protected under wildlife conservation legislation in Pakistan, conservation is primarily a provincial responsibility and every province has different legislation and associated penalties, which makes it difficult to harmonise conservation actions. Indus dolphins currently inhabit three provinces of the country. In Aisha's view, the Government of Pakistan should develop a national plan of action covering key aspects of dolphin conservation and amend laws to ensure a common conservation framework throughout the country.
- Mitigation of threats to the survival of individual Indus dolphins, particularly reduction of fishing-induced mortality, stranding in canals and illegal hunting, should be addressed as priority issues.
- Significant gaps exist in knowledge of several aspects of Indus dolphin biology, ecology and threats; these need to be addressed. Also, the plan to conduct population assessments at five-year intervals should be maintained.

In discussion, it was suggested that capture and translocation methods be further developed as part of the canal rescue program. The potential value of tagging rescued dolphins and monitoring them after release back into the river was recognised. It may not only serve as a way of determining post-release survival but also facilitate the study of home range and movements (including through or around barrages during high water). Aisha pointed out that the only successful attempt to radio-tag an Asian river dolphin was in Pakistan and it provided the first direct evidence of movement through barrage gates both upstream and downstream.

Aisha also mentioned that WWF-Pakistan was considering ways (e.g. pingers) to deter dolphins from entering canals. Investigation of the efficacy of these deterrents was encouraged as this would enable mitigation of one of the major threats to the dolphin population.

[2]Presented by Aisha via Skype.

In response to a question, Aisha suggested that the historical disappearance of dolphins from all but one of the Indus tributaries is probably best explained by water development, i.e. the partitioning of main channels by barrages and withdrawal of water for irrigation such that very little water remains in the streambed during the dry season. The only tributary where Indus dolphins have persisted is the Sutlej River (as it is called in Pakistan) where, far upstream in India (some 600km from the Indus mainstem) a small population of 18-35 dolphins were documented as recently as last year in what is called the Beas River in India, above Harike Barrage[3]. In late March 2017 the flow of the Beas River was virtually stopped for barrage maintenance and most of the resident dolphins reportedly disappeared.

In light of the above concerns, the sub-committee recommends to the Pakistan Government and NGOs that are involved in Indus dolphin monitoring, research and conservation in Pakistan:

- strengthen and scale-up the dolphin monitoring and rescue network with the involvement of local communities and local authorities so that it covers the entire range of the subspecies. Among the aims of this work are to collect information on habitat loss, fishing-induced mortality, illegal hunting, and strandings and to support the program of rescuing dolphins that have become trapped in canals; and
- conduct focused research on dolphin movements through barrages, and collect tissue samples from canal-entrapped animals to assess population structure and genetic connectivity of Indus dolphin subpopulations.

7.5 Ganges River dolphin

7.5.1 India

As noted at the last meeting of this sub-committee, India has plans for industrial development of 111 river waterways (covering a major portion of the range of the endangered South Asian river dolphin) through a National Waterways Act passed in 2016. This sub-committee expressed serious concerns over the potential impacts of this emerging threat on the conservation status of dolphins in the Ganges-Brahmaputra basin (*Platanista gangetica gangetica*). SC/67a/SM16 describes preliminary research on responses of river dolphins to waterways development activities, mainly river bottom dredging and ship traffic. This research considers long-term (multiyear) trends (abundance estimated from double-observer boat surveys, coupled with acoustic monitoring) in relation to periods of minor and major dredging intensity. After major dredging began in 2014, a declining trend of dolphin presence was recorded in the 67km focal study area of Vikramshila Gangetic Dolphin Sanctuary along the Ganges River in Bihar State. The authors monitored river discharge (stream flow) through this period to determine if this variable might confound analyses of the impacts of dredging on dolphins. Dolphins were seen to avoid proximity to dredging sites, and displayed evasive behaviour throughout the dredging period. Over time, there was a reduction in the frequency of dolphins returning to the same dredging sites after dredging had stopped.

To examine changes in acoustic behaviour, acoustic monitoring was carried out using CPODs. Only preliminary data were available in advance of this meeting. The authors of SC/67a/SM16 hypothesised that the dolphins would increase their acoustic activity in response to dredging and ship traffic, perhaps to compensate for masking by the noise produced by these activities. However, the dolphins showed higher acoustic activity during vessel passage, but lower acoustic activity and strong signs of evasive behaviour in response to dredging. They did not show any discernible change in modal frequency, maximum sound pressure level (loudness of emitted sounds) or inter-click interval during ship passage. During dredging, the frequency range of sounds emitted by the dolphins increased. The authors concluded that the observed responses by the dolphins were likely different due to the fact that source frequencies of ship noise differ from those of dredging noise, and possibly because additional disturbances are associated with dredging such as altered sediment flux in the river.

The initial results of this study indicate that there are negative, and potentially stressful, impacts of waterways development activities on river dolphins. They highlight the need to expand the scope of systematic monitoring to other locations with higher levels of vessel traffic and dredging. There are plans to continue systematic monitoring across a range of sites and along a gradient of waterways activity in those parts of the Ganges where river dolphins persist. Ship and dredger sounds, which may be below 20kHz, the lower limit of CPOD detection range, will also be recorded.

Kelkar reported that the response from stakeholders, including government authorities, to the proposed development plans and information on dolphin responses has been mixed. Overall environmental concerns about the waterways development plans have received wider public attention and generated more awareness of the potential impact on the dolphins. Despite initial reluctance, waterways authorities have agreed to conduct a new or revised assessment of waterways impacts on river dolphins. The widened scope of policy awareness was also evident in a recent parliamentary question on what actions are planned to mitigate the impacts of waterways projects on endangered river dolphins. Nevertheless, dredging and ship traffic continue in the Ganges, indicating the urgency of the rapid re-evaluation of environmental impacts. Monitoring and engagement with various stakeholders must and will continue.

A five-day training workshop on the ecology and conservation of South Asian river dolphins was conducted at Kahalgaon, along the Vikramshila Gangetic Dolphin Sanctuary in Bihar in March 2017 (Kelkar *et al.*, 2017). Twelve researchers from six wildlife conservation organisations were trained on topics including river hydrology, population estimation and ecology, acoustics, threat assessment, and conservation approaches for dealing with diverse threats at multiple scales (e.g. fisheries, pollution, irrigation, water demands). The workshop was supported by industry, academic institutions and conservation NGOs. It offered a good opportunity for direct dialogue with officials of the National Thermal Power Corporation Ltd., one of the main industry stakeholders of the waterways project, and to increase awareness of the potentially harmful impacts of the waterways plans on dolphins.

Khanala *et al.* (2016) reported on how abrupt river channel changes following flood events can intersect with social systems of land and water management (e.g. agriculture, fisheries) to generate significant consequences for river dolphins. Their study in the Karnali River basin in Nepal investigated 'trade-offs' between changing habitat availability for dolphins and their exposure to intense fishing activity (and the associated risk of entanglement) following a major natural flood in 2010 when the main river channel

[3]*http://www.iucn-csg.org/index.php/2017/05/08/lost-indus-dolphins-in-the-beas-river-india/.*

shifted from the Geruwa to the Karnali branch. The basic finding of the study was that at low river water levels intensive fishing negatively affected dolphin abundance (at least in part owing to bycatch) while at higher water levels the effects of fishing appeared to be less severe. Water diversions for irrigation in 2012-15 caused a decline in river depth with a corresponding decrease in dolphin counts in the Karnali from 11 in 2012 to 6 in 2015.

Paudel pointed out that dolphins in the Karnali can move freely across the India-Nepal border because unlike in other parts of Nepal where the major rivers are dammed at the border by barrages, the nearest barrage here is located in the Ghaghra River, *c*30km downstream of the border (note: the name of the river is Karnali in Nepal and Ghaghra in India). This means that the decline in dolphin numbers in the Karnali reported above does not necessarily mean that the 'missing' dolphins died as they could have moved across the border into India where they would have been unavailable for observation by the researchers.

The sub-committee welcomed the heightened dialogue with government officials and industry stakeholders on the need for more rigorous environmental assessment of the potential impacts on river dolphins of India's proposed waterways development plans, as reported by Kelkar at this meeting. The sub-committee **encouraged** further systematic monitoring of underwater noise in the river dolphins' habitat, **noted** with grave concern the evidence of local population decline in areas of dredging, and **encouraged** further, larger-scale efforts to monitor the impacts of such developments.

7.5.2 Nepal

SC/67a/SM19 reported that the few remaining Ganges river dolphins (*Platanista gangetica gangetica*) in Nepal are currently limited to only three river systems with a best total estimate of <28 individuals. Both the abundance and range of dolphins have declined sharply in all the river systems of Nepal due to environmental and anthropogenic threats, which include the presence of barrages which have fragmented natural populations and regulated natural flows. The depth and width of regulated river systems as maintained during the post-monsoon season are often below what is understood to be the minimum depth required for dolphins; this has magnified the spatial conflict between river dolphins and artisanal fishing communities. Declining public and official concern over the dolphins' status, reduced awareness of the dolphins' existence in Nepal, and the advancement of investment and development strategies that conflict with the protection of dolphin habitat are detrimentally impacting the dolphins continued survival in Nepal. The complete disappearance of Ganges dolphins from Nepal is inevitable unless meaningful conservation measures are initiated and sustained.

There is no comprehensive management plan for river dolphins in Nepal and a paucity of recent rigorous scientific studies (Khanala *et al.*, 2016; Smith *et al.*, 1994). Regular monitoring through non-invasive and cost-effective methods such as photo-identification, the potential of which was presented to this committee, and passive acoustic monitoring have been identified as tools to study these rare and cryptic dolphins and can be used to improve understanding of the abundance, distribution, habitat use and site fidelity in the Sapta Koshi and Karnali river systems of Nepal. International support, both technical and financial, will be required for such work to move forward.

The sub-committee therefore **encourages** further research on the Ganges River dolphin in Nepal, in particular, regular monitoring of the remaining dolphins and all the threats they face in Nepali waterways. The sub-committee strongly encourages the formulation of a comprehensive management and recovery plan for the Ganges River dolphin, with the involvement of Nepali natural resource and waterway management officials.

Furthermore, the committee **recommends**:

- urgent action and communication of recent research findings to the Government of Nepal, mainly to prioritise maintenance of ecological flow regimes, river restoration and community-based fishery regulations to prevent further habitat degradation and bycatch of the remaining small populations upstream of river barrages on the India-Nepal border; and
- trans-boundary surveys by India and Nepal to assess threats to the meta-population that contributes to Nepal's sub-populations.

7.6 Coastal Irrawaddy dolphins in India, Malaysia and Bangladesh

SC/67a/SM08rev1 provides information on Irrawaddy dolphins (*Orcaella brevirostris*) in India, where their range extends from the coastal waters of Visakhapatnam in south-eastern India to those of West Bengal and the Sundarbans, including an isolated population in Chilika Lagoon, southern Orissa. The largest known 'subpopulation' of Irrawaddy dolphins in India, consisting of somewhat more than 100 individuals, is in Chilika Lagoon, where the dolphins co-exist with fishing communities. Coastal surveys outside the lagoon have not yielded any Irrawaddy dolphin sightings; the nearest documented sightings were about 400km north of Chilika. Photo-identification data indicate long-term site tenacity. Dolphin-watching tourism is fairly intense in this area. A preliminary assessment of dolphin-watching tourism in the Outer Channel showed an increase in intensity (six dolphin watching associations) with an observed reduction in compliance with dolphin-watching guidelines. Moreover, the substrate type and bathymetry in the Outer Channel has changed due to a shift in the location of the mouth to the sea. The dolphins are thus exposed to several stressors in varying degrees from different kinds of fishing gears to dolphin-watching tourism and both natural and man-made changes in the habitat.

In discussion, it was noted that the population is well marked and therefore well suited to photo-identification and mark-recapture studies; this method is likely to yield the most accurate and precise estimates. Dolphin-watching operator training is ongoing, together with development of dolphin-watching guidelines, to reduce impacts of this industry on the local dolphin population. Previous efforts of this kind have shown positive results, but it is important to train new boat operators who do not yet have sufficient experience or knowledge. It was also noted that the local authorities are aware of the dolphins' existence and their value as a tourism resource, and they are supportive of ongoing research and conservation efforts.

Minton presented information on cetacean species encountered during small boat surveys conducted in two of three study sites off the coast of Sarawak from 2008 through 2013 (Minton *et al.*, 2013; Peter *et al.*, 2016). Irrawaddy dolphins were the most commonly observed cetacean species in these surveys. Photographic data collected from July 2007 through October 2010 were used to generate mark-recapture abundance estimates of Irrawaddy dolphins in the Kuching Bay, and provided insights into ranging patterns and site fidelity. The best mark-recapture estimate for Irrawaddy dolphins based on a weighted mean of estimates derived from photographs of left sides and right sides of dorsal fins was 233 (CV=22.5%, 95% CI 151-360). Re-sighted individuals showed a high degree of site-fidelity, with less than 10km between sighting locations over a period of four years for some individuals. A smaller proportion of re-sighted individuals ranged further, with a maximum straight-line distance of 26km between sighting locations (Minton *et al.*, 2013).

Between April 2010 and October 2011, line transect surveys were conducted in the Kuching Bay, and abundance estimates for Irrawaddy dolphins and Indo-Pacific finless porpoise were generated using distance sampling. The best line-transect estimate resulting from for Irrawaddy dolphins was 149 individuals (CV=28%, 95% confidence interval 87-255) demonstrating a reasonable degree of overlap with the confidence intervals of the mark-recapture estimates (Minton *et al.*, 2013).

In an analysis of fine scale distribution and habitat preferences of Irrawaddy dolphins in the Kuching Bay, Kruskal-Wallis tests confirmed a statistically significant relationship between the presence of Irrawaddy dolphins and salinity ($\chi2=4.694$, $p=0.03$), and Fisher's exact test indicated that Irrawaddy dolphins were statistically more likely to be present in waters within a 6km radius of river mouths. Dolphins were also more likely to move inshore during high tide events (Peter *et al.*, 2016). As discussed previously in this report, this is considerable overlap between primary fishing areas and the preferred habitats of Irrawaddy dolphin and finless porpoise in Kuching Bay (see Annex M).

In a study examining the presence of cutaneous nodules in over 5,700 images of Irrawaddy dolphins taken between 2004 and 2013 in Malaysia (Kuching, Bintulu-Similajau, Kinabatangan-Segama and Penang Island), India (Chilika Lagoon) and Bangladesh (Sundarbans), nodules were found to be present in the populations in both the Bintulu-Similajau and Kuching regions of Sarawak. One of the most severe cases identified in the study was from Kuching (Van Bressem *et al.*, 2014).

The committee **recommends** continued dedicated surveys to monitor distribution, habitat use, threats and population trends of Irrawaddy dolphins on areas such as Sarawak and Chilika lagoon. Survey effort should be extended to cover gap areas, such as other coastlines in the Indo-Malay Archipelago, the Sunderbans of West Bengal, and the coast of Orissa and West Bengal in India. Passive acoustics and or photo-identification should be used where feasible.

At Chilika lagoon, India, the committee **recommends** heightened cooperation between local authorities, researchers, and the tourist industry. Dolphin protection should be strengthened through better documentation of dolphin occurrence and movements, training of dolphin watch operators on dolphin watch guidelines, as well as management efforts to address the impact of fishing on the dolphins.

The waterways of the Sundarbans Reserved Forest in Bangladesh are the only place where Irrawaddy and Ganges River dolphins (*Platanista gangetica*) occur in the same habitat. In 2002, the abundance of Irrawaddy dolphins there was estimated at 451 (CV=9.6%) (Smith *et al.*, 2006). The cause of death for 67% of 49 Irrawaddy dolphins found dead over the past ten years was believed to be entanglement, mostly in gillnets. In 2012 the Government of Bangladesh declared three Wildlife Sanctuaries for the protection of freshwater dolphins in the eastern Sundarbans. These Wildlife Sanctuaries were established in areas known to have high dolphin concentrations. While these sanctuaries are mainly intended to protect Ganges dolphins, they encompass areas where the two species co-occur most often (WWF and FiA, 2017).

7.7 Australian snubfin dolphin

SC/67a/SM21 summarises available information on the biology, ecology and threats to the Australian snubfin dolphin (*Orcaella heinsohni*), which was described in 2005 as a new species in northern Australia and possibly southern Papua New Guinea (PNG). Knowledge of population structure, population sizes and trends across the species' geographical range is generally lacking. Studied 'populations' are typically smaller than 100 individuals and no population studied to date is estimated to contain more than 250 mature individuals. Genetic studies indicate that Australian snubfin dolphins live in small, relatively isolated populations with limited gene flow among them. Habitat degradation and loss are ongoing and expected to increase across the species range. Bycatch in the Queensland shark control program and in commercial fisheries is also known to continue, although its extent is unknown. A continuing decline in the number of mature individuals is anticipated. Given the available evidence and following a precautionary approach, the authors of SC/67a/SM21 consider the species to qualify for Vulnerable status under IUCN Red List criterion C2a(i): the total number of mature individuals is plausibly fewer than 10,000, there is an inferred continuing decline due to cumulative impacts, and each of the populations studied to date is estimated to contain fewer than 1,000 mature individuals.

Allen *et al.* (2012) summarised sightings of Australian snubfin, humpback and Indo-Pacific bottlenose dolphins during boat-based surveys at seven sites across north-western Australia. These surveys confirmed the presence of all three species in coastal waters adjacent to urban centres across north-western Australia, and suggested all three species are affected by coastal developments.

SC/67a/SM23 provided information on the genetic identity of the *Orcaella* sp. in southern PNG. Nineteen *Orcaella* samples were used in the analysis, including 11 from PNG and 8 from northern Australia (including the type specimen of *O. heinsohni*). The mtDNA dataset was analysed using Neighbor-Joining, Maximum Likelihood and Bayesian Inference clustering algorithms to infer phylogenetic relationships. Phylogenetic reconstruction showed that the PNG samples clustered with *O. heinsohni*, thereby confirming the species' occurrence in at least southern PNG. There are no confirmed records of *Orcaella* sp. from other regions of the Pacific Islands or other parts of New Guinea. The demarcation between *O. heinsohni* and *O. brevirostris* therefore remains unknown, although it is located within the Wallacea region. The viability of the small, apparently isolated snubfin dolphin population in southern PNG is uncertain. The most significant threat to inshore dolphins in southern PNG appears to be bycatch in subsistence fisheries, with anecdotal reports of directed catch. Conservation strategies for coastal cetaceans in PNG are expected to focus on reducing anthropogenic mortality and habitat loss, and maintaining corridors to preserve gene flow and prevent further population fragmentation and loss of genetic diversity.

There is no evidence of sympatry of the two *Orcaella* species (*brevirostris* and *heinsohni*) but this cannot be ruled out given that there are large unstudied expanses between PNG and Indonesia.

In discussion, participants emphasised the importance of completing reassessments of the species' conservation status under the IUCN Red List and at the national level in Australia and PNG (both IUCN and the Australian Mammal Action Plan 2012 currently list snubfin dolphins as Near Threatened). Snubfin dolphins are not listed as threatened in the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act), the Australian Government's central piece of environmental legislation. If uplisting is warranted, this could help justify EPBC Act listing and greater protection of small 'subpopulations' of these dolphins.

The sub-committee **encourages** several research and other actions for the Australian snubfin dolphin. This includes dedicated multi-year studies on the distribution, abundance and habitat use of this species; an expansion of current biopsy sampling efforts and collection of samples from stranded carcasses; organisational and nation-wide collaborations for the timely retrieval and necropsy of stranded and by-caught specimens; capacity building and partnerships with Australian and PNG Indigenous communities; and an evaluation of the efficacy and safety of tag attachment procedures for snubfin dolphins and once determined to be effective and safe, the use of satellite tagging to determine movements, home range and habitat preferences.

Furthermore, the committee **recommends** that baseline surveys be conducted of specific areas (judged to be ecologically similar to known areas known to be inhabited by the species in Australia and southern PNG) around New Guinea and the eastern Indonesian Archipelago (particularly Sulawesi, Maluku and Nusa Tenggara) and northern Timor-Leste to determine the extent of occurrence of snubfin dolphins.

7.8 Conclusions and recommendations

The committee **recognises** that fisheries bycatch, particularly in gillnets continues to compromise the survival of cetaceans in freshwater, estuaries and restricted coastal habitats. In addition, for freshwater cetaceans, waterways development projects, such as the construction of dams, barrages and waterways, can lead to fragmentation, degradation or total destruction of their habitat.

The committee **expresses** deep concern that the continuation and projected increases of these threats will likely lead to regional decline and extirpation of some Asian cetacean populations.

The committee **recommends** that targeted conservation actions be directed toward reducing the impact of fisheries bycatch and water development projects on Asian freshwater, estuarine, and coastal cetaceans to ensure their long-term survival.

The committee **encourages** integrated research on habitat loss (declining dry-season flows from dams/barrages, waterways development, pollution, etc.), stranding in irrigation canals, fisheries bycatch mortality, and possible combined impacts of these threats.

The committee **encourages** that collection of specimens and samples from stranded or bycaught cetaceans be used for morphometric and genetic studies to assist in clarifying taxonomy and population structure. This committee further **encourages** increased liaison with other committees, such as the Sub-Committee on Environmental Concerns, to determine what additional samples may be of interest to their work.

8. POORLY DOCUMENTED HUNTS OF SMALL CETACEANS FOR FOOD, BAIT OR CASH AND CHANGING PATTERNS OF USE

Through consultation with researchers and IGO's who work on similar issues involving terrestrial wildlife use and trade, it was noted that the term 'wild meat' is currently the most commonly used term for both terrestrial and aquatic wildlife species that are consumed, or used for other purposes. As such, the term 'wild meat' was used throughout this sub-committee's discussions and into the future.

8.1 Progress on the work plan

The use of small cetacean wild meat is poorly documented and, to address this issue, the first in a series of regional workshops, focusing on data sharing and investigative technique toolkits, was conducted in November 2016, Thailand. This workshop provided an additional opportunity to conduct the first Asian IWC Entanglement Response Training Workshop (led by Mattila). During this and other meetings, collaborations have been established with scientists who work on the terrestrial wild meat issue in both Asia and Africa. To highlight lessons learned from the current work on terrestrial wild meat, a presentation was given by Ingram, the database developer of OFFTAKE[4], a project that compiles data on the harvest, consumption and sale of terrestrial wild species. These data are then used to track wildlife exploitation, build statistical models to investigate the drivers of this take and to develop spatial models that predict hunting pressure. A discussion followed on how a similar database might assist this committee's work towards understanding the wild meat issue for small cetacean species globally and the potential of such a multi-layered and cross disciplinary database was acknowledged. Cosentino then presented a web-based interactive map and database which comprised information from literature and the public realm on the occurrence of wild meat. It was again noted that the quality of the information used to populate databases must be evaluated and protocols established to ensure consistency of data input. Both presenters were thanked for their information and insights. In particular, Cosentino's efforts in producing a database intersessionally for this committee to consider were acknowledged.

The discussion that followed focused on the ways in which further documentation, and particularly the establishment of a regularly updated and expanded database, might contribute to the understanding of the wild meat issue. The Convenor of the ad hoc working group on IWC Global Database Repositories (GDR) also provided comment on the logistical and maintenance implications such a database would have and noted that these should also be considered when any database aims are discussed.

It was **agreed** that the intersessional group would work, with the input of the GDR Convenor, to develop an overarching aim for any future cetacean wild meat database, and to provide specific questions that such a database might address, and present these at the Scientific Committee meeting in 2018.

Other progress on the work plan included the provision of new information from Asia, which suggested that the use of marine mammals was increasing and that, in some areas, the trade of marine mammals was becoming commercialised (Porter and Hong Yu, 2017). Following the Thailand workshop, a market survey questionnaire was developed with the view to obtain more specific information

[4]Via Skype.

on cetacean wild meat availability to further inform these findings. This questionnaire will be tested in two projects in 2018.

Parsons noted that the report of the Focus Group Session on the use of social science to explore the consumption and other uses of marine mammal products, held at the International Marine Conservation Congress (IMCC) in October 2016, would be presented at SC/67b.

Further to the SC/66b recommendation that working relationships between the IWC and other international bodies be pursued, it was noted that this committee now provides updates from this committee to the Aquatic Working Group of the Convention on Migratory Species, who also works on wild meat and related issues.

8.2 Future plans

It is anticipated that two workshops will be conducted interessionally and that both the IWC Thailand workshop report as well as the ICCB Social Science in Wild Meat Issues will be published. As such, an extensive body of new information will be available to the 2018 Scientific Committee meeting where the continuing work plan for this agenda item will be reviewed and formulated.

9. SMALL CETACEAN TASK TEAM

Simmonds provided an update on Task Teams. This approach was first discussed in the Scientific Committee in 2014 and was intended to enable intersessional 'fast response' action on critical issues. Specifically, Task Teams are created to provide timely advice on situations where a population of cetaceans is known or suspected to be in danger of significant decline that could lead to extirpation or extinction, with the ultimate aim of ensuring that this does not occur.

The first Task Team was established for the franciscana in 2015-16. The process involved the following steps. First the Franciscana Task Team was established consisting of local experts under the coordination of Alex Zerbini; this group produced a draft proposal specifying urgent actions that then went through a review process with the Task Team Steering Committee; finally an agreed project description helped to attract significant funding from the governments of Brazil and Italy. The sub-committee agreed that this first trial of the Task Team approach had proven effective. A Conservation Management Plan was also produced for this species and work outlined in the plan is currently going forward. The Franciscana Task Team is now closed.

Last year, at SC/66b the sub-committee agreed that the situation facing South Asian river dolphins is a matter of grave concern and requires immediate attention. It further agreed that the South Asian river dolphin should be the next candidate for development of a Task Team, given the ongoing and new threats to the survival of the species.

The Steering Committee agreed to establish a team of experts to develop a project description and report back on progress at SC/67a. Simmonds briefly reported on the initiation of this second Task Team, the South Asian River Dolphin Task Team, which had taken place in the margins of this year's SC meeting. The process of identifying and establishing a team of regional species experts is now underway. Advice will be provided to the team by the Steering Committee and it is anticipated that this Task Team will progress in a similar manner to its franciscana predecessor although it was noted that the geopolitical and other challenges in the case of South Asian river dolphins are significant and differ substantially from those encountered in the franciscana experience. The Task Team approach has been designed to accommodate the diversity of situations facing small cetaceans and those who work on them in different parts of the world.

10. PROGRESS ON PREVIOUS RECOMMENDATIONS

10.1 Māui dolphin

SC/67a/SM15 is the requested annual update of New Zealand's management measures as well as data collection and research activities over the past year for Māui dolphins (*Cephalorhynchus hectori maui*). Further background on the status of Māui dolphins can be found in updates presented to the Scientific Committee in previous years. Measures to protect Māui dolphins as part of the Threat Management Plan include a range of regulations and prohibitions that cover threats such as set net, trawl and drift net fishing, seismic surveying, and seabed mining. A program of on-going research is underway in order to inform a review of the Threat Management Plan, scheduled to commence in 2018.

Forty-six sightings of Māui (or Hector's) dolphins were reported in the 12 months to the end of January 2017. The majority of sightings were between South Kaipara and Raglan on the west coast of the North Island of New Zealand. In the reporting period, there were no observer or fisherman-reported captures in commercial or recreational fisheries, no beach-cast dolphins and no ship-strikes. As a result, no necropsies were conducted. Observer coverage for the set net fishery in Taranaki was 96% over the reporting period. For the inshore trawl fishery, observer coverage was 54%, an increase from 24% the previous year.

One of the highest priorities identified by the Māui Dolphin Research Advisory Group was abundance surveys conducted at intervals of not more than five years. In response to the advice of the group, an abundance project was commissioned and undertaken in 2015-16. Results are contained in Baker *et al.* (2017); see Annex (ASI) for a review of estimates. Last year, New Zealand reported on a pilot study to use CPODs as a means of investigating the offshore extent of Māui dolphin distribution. Following the successful conclusion of the pilot study, the New Zealand Government has undertaken a project to deploy CPODs in a line running offshore out to 12 n.miles from Hamilton's Gap (where Māui dolphins are regularly sighted) for at least one full year from May 2017. In addition to the offshore deployment, a small number of CPODs have been deployed near shore in northern and southern Taranaki to explore the southern extent of Māui dolphin distribution. A final priority identified by the Research Advisory Group was investigation of the alongshore distribution in the south of the sub-species range. Monthly aerial surveys were undertaken in Taranaki from January-April 2016. No Māui dolphins were observed on these surveys.

The Ministry for Primary Industries is also finalising an updated marine mammal risk assessment, which estimates a much lower level of fishing-related mortality than had been estimated in a 2012 risk assessment. This change is due to fisheries management interventions put in place since 2012, improved sources of data, and the application of an improved quantitative risk assessment methodology that does not rely on subjective expert estimation of dolphin mortality levels. This methodology will undergo international peer review in June 2017. Details of this risk assessment methodology, and relevant results, will be submitted to the Scientific Committee in 2018.

With respect to fishing techniques used within the range of Māui dolphins, the fishing companies Sanford and Moana NZ have announced plans to stop leasing annual catch quotas to fishermen using set nets inshore of the 100m depth contour north of New Plymouth from October 2017, and will eliminate conventional trawling methods by December 2022. Further details are in SC/67a/HIM12 (see Annex J). The Government is encouraged by the recent commitment of these companies. The Ministry for Primary Industries is currently working with industry on their proposal and will provide advice to Ministers in due course.

The sub-committee **welcomes** the update on research on Maui dolphins provided and looks forward to receiving the final report on the updated marine mammal risk assessment in 2018. It also **notes** with interest the reported fishing industry initiatives to reduce the use of potentially entangling gear in the range of Māui dolphins which are discussed in SC/67a/HIM12.

Nonetheless, the sub-committee noted that no new management action has been enacted since 2013 and concludes, as it has repeatedly in the past, that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expresses continued grave concern over the status of this small, severely depleted subspecies. The human-caused death of even one individual would increase the extinction risk. The sub-committee:

(a) re-emphasises that the critically endangered status of this subspecies and the inherent and irresolvable uncertainty surrounding information on most small populations point to the need for precautionary management;
(b) reiterates its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins including closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries); and
(c) notes that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20 n.miles, and it includes harbours - within this defined area, fishing methods other than set nets and trawling should be used.

The sub-committee again respectfully urges the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation, and again respectfully requests that reports be provided annually on progress towards the conservation and recovery goals.

10.2 Vaquita

Rojas-Bracho reviewed developments in vaquita (*Phocoena sinus*) conservation in Mexico since SC/66b. Two meetings of the Comité Internacional para la Recuperación de la Vaquita (CIRVA) have been held since SC/66b, CIRVA-8 in November 2016 (SC/67a/SM11) and CIRVA-9 in April 2017 (SC/67a/SM14rev1), both in La Jolla, California, USA. The reports of these two meetings, held only 6 months apart, are briefly summarised in sequence below to illustrate the rapid deterioration of the conservation status of the vaquita since SC/66b.

CIRVA-8

Results from the sixth consecutive year of systematic acoustic monitoring (2011-16) showed that the vaquita population had declined by 50% from the previous year and by 90% over the entire duration of the acoustic monitoring program from 2011-16. The population size was estimated at only 30 individuals at the end of the June-August monitoring period in 2016. Continued acoustic monitoring was judged to be a critical component to estimate success of conservation actions. CIRVA recommended that the regular acoustic monitoring program continue in summer 2017.

Following a CIRVA-7 recommendation, the first phase of a multi-institutional program to find and remove illegal and abandoned fishing gear in the range of the vaquita spanned the period from early October to early December 2016 during which time there were only 15 days of acceptable weather conditions for this work. It covered 9,318km during 1,280 hours of effort. A total of 58 gillnets were recovered of which 31 were totoaba nets, and 23 of these were 'active' (i.e. set to catch fish and to be retrieved by the fishermen). CIRVA recommended that this important gear-removal program should continue.

Brief updates on enforcement were received from PROFEPA (the environmental enforcement agency) and the Sea Shepherd Conservation Society (SSCS). The 50% decline in vaquita abundance over the past year and the frequent recovery of gillnet gear in the region demonstrated that illegal fishing for totoaba and other species remained widespread. CIRVA thanked SEMAR and SSCS for their collaboration and reiterated its recommendation that this important work of removing illegal gear be continued.

CIRVA repeated its previous recommendations that there should be a permanent ban all gillnets throughout the range of the vaquita and that the sale and possession of gillnets on land and at sea should be illegal. In addition, CIRVA reiterated that existing laws must be strengthened and penalties increased so that they act as a real deterrent to illegal fishing. CIRVA expressed concern that the development of alternative fishing gear has been too slow and emphasised the need for the Mexican Government to follow the recommendations and protocols of the International Expert Committee for Fishing Technologies in the Upper Gulf of California. CIRVA also reiterated the need to accelerate development of viable alternative fishing methods and to train fishermen in their use.

Given the dire situation, dramatic population decline and illegal fishing for totoaba, CIRVA recommended that attempts be made as a matter of urgency to place some vaquitas into a temporary sanctuary with the goal of protecting these animals until they can be returned into a gillnet-free environment. The Vaquita Conservation Protection and Recovery (VaquitaCPR) programme was asked to move ahead with planning for such an effort.

CIRVA-9

Although the full annual acoustic monitoring program within the Vaquita Refuge normally takes place in June-August, in 2017 it was decided to also monitor six sites out of the usual 46 from 6 March to 17 April. Only two vaquita detections were recorded among these six sites during the 42-day monitoring period, far fewer than expected based on detection levels in 2016. Although these data collected from a sub-set of the sampling grid outside the usual summer monitoring period cannot be considered comparable to the detections made during the full summer sampling period, the very small number of detections was judged to be a cause for concern. CIRVA emphasised the importance of fully sampling the core area from 19 June to 19 August, as has been done every year since 2011. CIRVA recommended that the expert group on acoustic monitoring be consulted to determine the optimal design of a supplemental acoustic monitoring program (in addition to the regular summer program) to determine whether vaquitas continue to exist outside the Refuge. [At SC/67a Rojas-Bracho reported on additional detections from this effort obtained from the six sites since the CIRVA-9 meeting in April. In the last 17 days of the study, there were 6 acoustic encounters at one of the sites, with a detection rate of 0.0882 encounters/day. This increased the detection rate by a factor of ten compared to the rate reported at the CIRVA-9 meeting (0.0086 encounters/day).]

A total of six dead vaquitas has been reported since December 2016. CIRVA-9 reviewed the necropsy reports on five of these (including one near-term foetus) recovered in March and April 2017. It was confirmed that at least three of these animals had died from gillnet entanglement.

At the CIRVA-9 meeting the report on the second phase of the Ghost Fishing Gear Removal Program in the Upper Gulf of California was received. This phase had been planned to start in February 2017 but was postponed three times because the fishermen involved did not want to participate during the curvina/totoaba fishing season due to security issues. They agreed to participate again in the program in early May as the totoaba migrate southward and into deeper waters. However, SSCS continued the programme to retrieve fishing gear, again in collaboration with SEMAR. So far in this fishing season, they had retrieved 150 active totoaba nets and observed a considerable amount of illegal fishing activity. The Mexican Navy reported the results, through April 2017, of SEMAR's enforcement efforts since the President's announcement of the Integrated Strategy in April 2015. During this period over 900 pieces of illegal fishing gear were recovered or seized. SEMAR and the SSCS reported that totoaba poachers were operating openly both day and night in the Upper Gulf.

CIRVA was advised of and welcomed new amendments to the Mexican criminal code establishing stronger penalties for totoaba trafficking, including stronger imprisonment provisions and elevation of such offenses to a felony equivalent to engaging in organised crime. CIRVA recommended that Mexico act immediately to prosecute totoaba poachers to the full extent allowed under this new law.

News was received at the CIRVA-9 meeting of the Government of Mexico's 'Agreement Prohibiting the Use of Gillnets for Commercial Fishing in Waters of Federal Jurisdiction in the Northern Gulf of California'[5]. However, CIRVA considered that this agreement fell short in a number of ways, particularly in that it did not prohibit the possession of gillnets. CIRVA reiterated its previous recommendation that the sale or possession of gillnets on land and at sea should be illegal in the area of the current gillnet ban and on adjacent lands.

Given the deaths of at least six vaquitas since CIRVA-8 in late 2016, and the high levels of illegal fishing activity in the Upper Gulf, CIRVA concluded that the only hope for the survival of the species in the short term is to capture vaquitas and bring them into human care. Therefore, CIRVA strongly endorsed the VaquitaCPR plan and recommended that as many individuals as possible be captured in October-November 2017 and held until the Upper Gulf is safe for their return. Based on current conditions, it may be many years before it is possible to return vaquitas safely to the wild. CIRVA recognised that the risks of capture and captive maintenance are high, but these are greatly outweighed by the risk of entanglement in illegal gillnets in the wild.

The status of the vaquita continues to be regarded as a primary concern for this sub-committee. The sub-committee expressed its disappointment and frustration that, despite almost two decades of repeated warnings, the vaquita continues to be on a rapid path towards extinction as a result of ineffective conservation measures. As such, the sub-committee **re-emphasises** the concerns it has raised on the status of the vaquita over many years, **repeats the recommendations** it made in 2016, and unreservedly **endorses and adopts the recommendations** made in the CIRVA-8 and CIRVA-9 reports (see SC/67a/SM11 and SC/67a/SM14).

The sub-committee **commended** the Government of Mexico for its attention and response to the CIRVA findings and respectfully **requested** that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards conservation and recovery goals for the vaquita.

However, the sub-committee concluded that, despite significant efforts to protect vaquitas and the grave concerns regularly raised over its status, current measures are still not sufficient to prevent extinction, which now appears inevitable. The sub-committee is gravely concerned about the estimate that only 30 individuals remained as of November 2016, and about the news that five dead vaquitas were recovered during March/April 2017.

Given the extreme urgency of the situation, and the immediate extinction risk to the vaquita, the sub-committee **recommended** that the Government of Mexico ensure that the current ban on gillnets in the northern Gulf of California does not lapse and is made permanent, and that this ban is extended to include the possession and sale of gillnets throughout the immediate area. The sub-committee also **recommended** that the appropriate authority in Mexico further develop and permit the use of 'vaquita safe' fishing gears as a matter of urgency, and provide incentives for their immediate and full uptake.

The sub-committee again **noted** that the demise of the vaquita is being driven by the high demand for totoaba swim bladders in international markets. Therefore, the sub-committee **requested** that the Secretariat write to all IWC Commissioners to: provide an update on the vaquita situation (including describing the species' current status based on information reviewed by the SC at SC/67a); re-emphasise the commitments made under IWC Resolution 2016-5; summarise the recommendations made by the SC over the last 20 years; and urge them to raise this issue as a matter of urgency through the appropriate diplomatic channels. The sub-committee also **requested** that the IWC Secretariat send a written appeal to the CITES Secretariat to facilitate immediate action in addressing the illegal international trade in swim bladders from totoaba, an Appendix I species, as a matter of utmost urgency.

The sub-committee **noted** that time was running out for the vaquita. It expressed concern that its recommendations were not being effectively implemented and discussed the urgent need to find alternative approaches to address the problem. As a result, the sub-committee **agreed** that all Committee members should liaise with their Governments to raise the profile of the vaquita and identify and pursue wider international engagement opportunities such as through efforts to achieve the UN Sustainable Development

[5]While it is understood that finalisation of this Agreement is still on track, at the time of SC/67a it had removed from the Mexican Government's official regulatory review portal to undergo 'legal review'.

Goals (SDG14). The sub-committee also **recommended** that a small group led by Rendell works intersessionally to consider and implement alternative approaches, including the establishment of an international team of influential envoys charged with visiting China, Mexico, and the US (including high-level representation from the IWC and CITES, academia, ambassadors, ministers and other high-profile public figures) to raise the concerns and recommendations for action expressed by the Scientific Committee in relation to the dire situation of the vaquita.

10.3 Boto and piracatinga

At SC/66b, the sub-committee requested that the Brazil Government continue to provide progress reports to the Scientific Committee on its efforts to combat the use of Amazon River dolphins (botos *Inia geoffrensis* and tucuxis *Sotalia fluviatilis*) as bait for the piracatinga (*Calophysus macropterus*) fishery in the Amazon Basin.

The Brazilian Government provided a progress report on implementation of the Evaluation Monitoring Plan which has been designed and implemented to evaluate the effects of the five-year moratorium (from 1 January 2016) on fishing and commercialisation of piracatinga in Brazilian waters. The report focused on the first of five priority areas of the plan, i.e. monitoring trends in abundance of Amazon River dolphins. Four expeditions to collect sighting data on these two species occurred during the months of September, October and November 2016 in the following areas: Alto Rio Solimões, Rio Japurá, Auati-Paraná (Mamirauá), Rio Purus, Rio Negro and Low-Medium Rio Solimões (Manaus-Coari). Following the expeditions, the ICMbio convened a workshop in Manaus (April 2017), which brought together 12 scientists who study river dolphins in Brazil to estimate population densities. Estimated densities of botos were similar on the Solimões, Japura and Negro rivers, while densities were much higher in the Purus and Auati-Paraná rivers. For tucuxis, the results were more heterogeneous, but the Purus stood out as the river with the highest density of this species. According to the progress report, the data compiled at the Manaus workshop can be used as a baseline for comparisons with future abundance or density estimates for the populations and areas sampled.

While the progress report focused on design and implementation of the dolphin monitoring expeditions, there was considerable interest in the sub-committee to receive updated information on all five components of the evaluation plan, including the identification of sustainable fishing methods for the piracatinga fishery, inspection and control strategies, and efforts to understand and curtail the international market demand for piracatinga. The sub-committee thanked the Brazilian Government for this update and respectfully requested that it provide detailed information to the next meeting of the Scientific Committee on the implementation of all five elements of the Evaluation Monitoring Plan. Recalling the recommendation from SC/66b, the sub-committee again encouraged collaborative efforts among the range states, and respectfully requested information from Bolivia, Colombia, Ecuador, Peru and Venezuela, which had not been provided to the current meeting. Further, the sub-committee endorsed the proposal to conduct an intersessional workshop to facilitate communication and corroboration between those countries where the boto/piracatinga issue is escalating, with a view to assist in the process.

11. REVIEW TAKES OF SMALL CETACEANS

11.1 Directed catches

Funahashi summarised catch limits (quotas) and actual reported catches from the Japan Progress Report on Small Cetaceans, a public document that can be freely downloaded from the website of the Fisheries Agency of the Government of Japan (JFA)[6]. This document reports on directed fisheries for small cetaceans as well as research programs of the National Research Institute of Far Seas Fisheries in cooperation with other organisations. These JFA documents cover information on small cetaceans which is not included in the IWC Scientific Committee progress reports on the worldwide web. The table can be found in Appendix 2.

In discussion of Japanese takes it was noted that two new species had been proposed for quotas and a public review process is currently in place. These species are the rough-toothed dolphin *Steno bredanensis* (proposed annual quota is 46) and the melon-headed whale *Peponocephala electra* (proposed quota 704) (Government of Japan, 2017).

SC/67a/SM06rev1 reviewed available information of southern form short-finned pilot whales which are smaller than the northern form. Two areas of high density are the coastal waters between Honshu and the Kuroshio Current and in the Kuroshio Countercurrent. The Kuroshio Current separates these areas and it is thought that they are inhabited by two different populations of southern form short-finned pilot whales, similar to the common bottlenose dolphins in these areas. Current abundance estimates ignore the possibility of such population structure. If they were to take such structure into account, this would significantly complicate the Japanese pilot whale and bottlenose dolphin fisheries assessment.

Most of southern form short-finned pilot whale quota is currently allocated to the Taiji drive fishery in Wakayama and this is the most important species for this fishery. A voluntary quota was adopted by the fishermen in 1982, a Fisheries Agency quota started in 1993, and the quota began to be reduced in 2007. The catch:quota ratio has been in the range of 33 to 62%, which suggests that the quota did not limit the catches but simply tracked the downward trend in catches.

Taiji 's drive fishery catch of short-finned pilot whales increased in the latter half of the 1970's prior to the sighting surveys which started in 1993 and have been used for abundance and distribution estimation. The average catch for 5-year periods since 1985 has shown a clearly declining trend and it is unlikely that this is due to a decline in demand for dolphin meat because catches of Risso's dolphins and false killer whales have been increasing since 1990 and the catch of bottlenose dolphins remained high until at least the early 2000s. The authors of SC/67a/SM06rev1 therefore interpret the trends in catches by the Taiji drive fishery as an indication of a decline of the southern form short-finned pilot whale coastal population.

11.2 Live captures

SC/67a/SM24 reports that 21 killer whales were captured in the western Okhotsk Sea during 2012-16, according to official reports. Thirteen whales were exported to China during 2013-16: nine of them are in Chimelong Ocean Park and four in Shanghai. Three whales are in Mosquarium in Moscow. The fate of the remaining animals is unknown; some of them were reported to have escaped or been released, which is considered unlikely.

[6]*http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h26.pdf*; *http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-4.pdf.*

Table 1

Summary of projects commissioned by the Voluntary Fund for Small Cetacean Research, and their Principal Investigators (PI).

PI	Project title
Heinrich	First region-wide estimates of population size and status of endemic Chilean dolphins (*Cephalorhynchus eutropia*) in southern Chile (I).
Lai	Assessment of online information as a tool to improve the documentation of the availability of marine mammals for consumption and other uses in Southern China (I).
Khan	Abundance survey for Indus River dolphin (I).
Weir	Assessing the conservation status of the Atlantic humpback dolphin (*Sousa teuszii*) in the Saloum Delta, Senegal (P).
Sanjurjo	Business model to save vaquita from extinction while improving fishermen livelihoods in the Upper Gulf of California (P).

Key: I=work has been initiated; P=work is pending.

No killer whales were officially reported to have died during the capture or in captivity in 2012-16. However, lack of any regulatory monitoring of the operations means that companies could easily conceal evidence of incidents during or immediately after capture, with anecdotal reports suggesting that such incidents are not uncommon. Furthermore, the mortality rate of killer whales during the acclimation period is typically quite high, so it should not be assumed that none of the killer whales captured in the Okhotsk Sea died within the first weeks or months in captivity.

The live captures of killer whales raise concerns because the same local stock of transient (mammal-eating) killer whales is targeted in the western Okhotsk Sea. Russian fisheries institutes calculate allowed catches from the estimated abundance of all killer whales in the Okhotsk Sea, ignoring their division into reproductively isolated resident (fish-eating) and transient populations. The estimated abundance of the targeted transient stock based on mark-recapture is about 250 animals (260±54 animals for the closed population model and 240±72 animals for the open population model (Shpak *et al.*, 2016)). The recent rate of removals from a killer whale population of this size would almost certainly be unsustainable.

In discussion, it was noted that Russian fisheries authorities do not currently recognise different ecotypes of killer whales in the Sea of Okhotsk. According to Filatova the Ministry of Natural Resources is reviewing the Russian Red Book listing and the status of Russian Far East killer whales is currently under discussion. A question was raised as to how the total allowable catch of killer whales is calculated but no explanation could be provided by those in attendance. The Russian delegation noted that as SC/67a/SM24 was presented by an Invited Participant, it does not reflect the official position of the Russian Federation.

The sub-committee **reiterates** its long-standing recommendation that no small cetacean removals (live capture or directed harvest) should be authorised until a full and complete assessment has been made of their sustainability. This is especially true for killer whales because populations are generally small and have strong social bonds and removals have unknown effects on their demographic structure.

The sub-committee **expressed concern** that removals have continued from this population since it received its last update on this situation (Filatova *et al.*, 2014). The sub-committee **recommended** that future steps with regard to killer whales in Russia consist of: (a) recognising the two ecotypes of killer whales; and (b) managing them as distinct units.

12. STATUS OF THE VOLUNTARY FUND FOR SMALL CETACEANS

12.1 Status of funds and review progress of funded projects

In 2016, donations for the Voluntary Fund for Small Cetacean Conservation Research totaling £76,908 were received from the Governments of France, Italy, the Netherlands, Switzerland and the United Kingdom as well as from the Animal Welfare Institute, Cetacean Society International, Environmental Investigation Agency, Humane Society International, International Fund for Animal Welfare, Legaseas, OceanCare, ProWildlife and Whaleman Foundation. At the end of the financial year 2016, this brought the total of the fund to GBP£161,824.

The sub-committee expressed its sincere gratitude for these contributions and noted that these funds support critical conservation research projects of direct relevance to the work of this sub-committee.

Following the 2016 call for proposals, at SC/66a funding was confirmed for five of the seven projects identified by the review panel in 2016 (see Table 1). The overall review process is explained in detail in IWC (2012) and on the IWC website (*https://iwc.int/sm_fund*).

The Chair gave short summaries, provided by Principal Investigators Heinrich and Lai, detailing progress on their respective projects. The main objective of Heinrich's project is to estimate the population size of the Chilean dolphin in six areas of known and predicted occurrence in the Ecoregion Chiloense. Between February and March 2017, two of these areas were successfully surveyed. A total of 415 n.miles was surveyed and 47 groups of Chilean dolphins, 23 groups of Peale's dolphins and one group of Burmeister's porpoise were encountered. The main objectives of Lai's project are to search relevant information posted on Chinese social media platforms and visit a sample of the fish markets identified during this search to obtain additional data on marine mammals in markets in southern China. Between February and March 2017, 60 hours of online effort resulted in over 200 posts that contained evidence of marine mammals for sale and/or consumption. Two of the markets frequently identified during online searches were visited – Shenjaimen, Zheijing and Qinzhou, Guangxi. Cetacean meat was identified at one of these markets. Progress on the abundance survey for Indus River dolphin (Khan) was presented under one of the priority topics of this sub-committee (SC/67a/SM22rev1) (see Item 17.2.4). Full reports shall be provided to this sub-committee upon each project's completion.

Depending on available funds, it is planned to spend the remaining balance of the Fund on IP support for SC/67b, Task Team initiatives and other such work that might facilitate the work of this sub-committee. In the meantime, effort to build up the Fund will continue intersessionally so that a new call for proposals can be announced after the 2018 Commission Meeting.

13. WORK PLAN

The sub-committee discussed ongoing priorities and agreed to continue the development of these intersessionally. The list of intersessional email groups can be found in Annex W.

Table 2

Summary of the work plan for the Sub-committee on Small Cetaceans.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Global *Tursiops* taxonomy	Intersessional Workshop on *Tursiops* taxonomy.	Report to sub-committee
Boto	Intersessional Workshop on boto/piracatingua.	Report to sub-committee
Poorly documented takes	Email group to plan and conduct South American and African Workshop.	Report to sub-committee
Small Cetacean Task Team	Work on south Asian river dolphins.	Report to sub-committee

It was concluded that this sub-committee would:
- discuss in detail small cetacean taxa and review the status, taxonomy and abundance of particular species/ species groups/regions as prioritised by the scientific committee;
- identify ongoing and emerging threats to these taxa, and provide conservation advice for these;
- integrate scientific advice from the other sub-committees and working groups of the Scientific Committee, as appropriate;
- encourage collaborative research on small cetaceans, including provision of expert advice, identification of funds and other required support;
- expand current collaboration with national researchers to develop relevant conservation strategies that address local issues;
- review regularly progress on standing recommendations;
- manage the small cetacean Task Teams and the Voluntary Fund for Small Cetacean Conservation Research and associated projects; and
- explore avenues of engagement with the Conservation Committee and other Commission groups, on priority conservation issues for small cetaceans.

12. ADOPTION OF REPORT

The report was adopted at 21:09 on 17 May 2017.

REFERENCES

Acevedo-Gutierrez, A. and Burkhart, S. 1998. Seasonal distribution of bottlenose (*Tursiops truncatus*) and pantropical spotted (*Stenella attenuata*) dolphins (Cetacea: Delphinidae) in Golfo Dulce, Costa Rica. *Rev. Biol. Trop.* 6(46): 91-101.

Allen, S., Cagnazzi, D., Hodgson, A., Loneragen, N. and Bejder, L. 2012. Tropical inshore dolphins of north-western Australia: Unknown populations in a rapidly changing region. *Pac. Conserv. Biol.* 18: 56-63.

Arreola, A.A.C., Wolford, J.S.O., Figueroa, M.F.C. and Corona, V.M.G. 2014. Cetáceos del pacífico de Guatemala: Cincuenta años de historia. *Ciencia, Tecnología y Salud* 11: 51-63.

Baker, C.S., Steel, D., Hamner, R.M., Hickman, G., Boren, L., Alridge, W. and Constantine, R. 2017. Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2015–16, with retrospective matching to 2001-16. Department of Conservation, Auckland. 75pp.

Bayas-Rea, R.A., Felix, F. and Montufar, R. Unpublished. Genetic divergence and fine scale population structure of the bottlenose dolphins (*Tursiops truncatus*, Montagu) in the Gulf of Guayaquil, Ecuador. *Plos ONE*. [Available from authors].

Brownell Jr, R.L., Reeves, R., Thomas, P.O., Smith, B. and Ryan, G.E. 2017. Dams threaten rare Mekong dolphins. *Science* 355(6327): p805.

Campbell, I. 2014. The effects of physical, biological and anthropogenic noise on the occurrence of dolphins in the Pacific region of the Panama Canal. Doctoral thesis, University of St Andrews.

Carretta, J., Forney, K., Lowry, M.S., Barlow, J., Baker, J., Johnston, D., Hanson, B., Muto, M., Lynch, D.R. and Carswell, L. 2008. US Pacific Marine Mammal Stock Assessments: 2008. *NOAA Technical Memorandum* NMFS SWFSC-434. [Available at *http:www.nmfs.noaa.gov/pr/pdfs/sars/po2008.pdf*].

Carretta, J.V., Oleson, E.M., Weller, D.W., Lang, A.R., Forney, K.A., Baker, J., Muto, M.M., Hanson, B., Orr, A.J., Huber, H., Lowry, M.S., Barlow, J., Moore, J.E., Lynch, D., Carswell, L. and Brownell, R.L., Jr. 2015. US Pacific Marine Mammal Stock Assessments: 2014. US Department of Commerce. *NOAA Tech. Mem.* NOAA TM-NMFS-SWFSC- 549: 414.

Charlton-Robb, K., Gershwin, L., Thompson, R., Austin, J., Owen, K. and McKechnie, S.W. 2011. A new dolphin species, the Burrunan dolphin *Tursiops australis* sp. nov., endemic to southern Australian waters. *PLoS ONE* 6(9). *e24047.doi:10.1371/journal.pone.0024047*.

Costa, A.P.B., Rosel, P.E., Daura-Jorge, F.G. and Simoes-Lopes, P.C. 2016. Offshore and coastal common bottlenose dolphins of the western South Atlantic face-to-face: what the skull and the spine can tell us. *Mar. Mamm. Sci.* 32(4): 1433-57.

D'Lima, C., Marsh, H., Hamann, M., Sinha, A. and Arthur, R. 2014. Positive Interactions Between Irrawaddy Dolphins and Artisanal Fishers in the Chilika Lagoon of Eastern India are Driven by Ecology, Socioeconomics, and Culture. *AMBIO* 43: 614-24.

Defran, R.H. and Caldwell, E.M., Aimée R. Lang, Megan G. Rice, and David W. Weller. 2015. Possible stock structure of coastal bottlenose dolphins off Baja California and California revealed by photo-identification research. *Bull. South. Calif. Acad. Sci.* 114(1): 11p.

Díaz-Aguirre, F., Navarrete, S., Salinas, C., Hiriart, L., Castillo, V., Zerega, A., Ritter, R. and Castilla, C. 2009. First report on the long-term presence of common bottlenose dolphins (*Tursiops truncatus*) off central Chile. *Latin Am. J. Aquat. Mamm.* 7: 85-87.

Diaz-Gamboa, R.E. 2003. Diferenciacion entre tursiones *Tursiops truncatus* costeros y oceanicos en el Golfo de California por medio de analisis de isotopos estables de carbono y nitrogeno. M.Sc. thesis, Centro Interdisciplinario de Ciencias Marinas, IPN.

Doyle, J.J. 1992. Gene trees and species trees: molecular systematics as one-character taxonomy. *Systematic Botany* 17: 144-63.

Félix, F. 1994. Ecology of the bottlenose dolphin, *Tursiops truncatus*, in the Gulf of Guayaquil, Ecuador. *Invest. Cetacea* XXV: 235-56.

Filatova, O.A., Shpak, O.V., Ivkovich, T.V., Borisova, E.A., Burdin, A.M. and Hoyt, E. 2014. Killer whale status and live-captures in the waters of the Russian Far East. Paper SC/65b/SM07 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 5pp. [Paper available from the Office of this Journal].

Fruet, P., Secchi, E., Daura-Jorge, F., Vermeulen, E., Flores, P., Simoes-Lopes, P., Genoves, R., Laporta, P., Di Tullio, J.C., Freitas, T., Dalla Rosa, L., Valiati, V.H., Beheregaray, L. and Moller, L. 2014. Remarkably low genetic diversity and strong population structure in common bottlenose dolphins (*Tursiops truncatus*) from coastal waters of the Southwestern Atlantic Ocean. *Cons. Genet.* 15: 879-95.

García, C., Ávila, I.C., Palacios, D., Gerrodette, T., Suárez, M., Soler, G., Rasmussen, K., May-Collado, L., Parson, C., Trujillo, F. and Bessudo, S. 2008. Presence, distribution and threats of *Stenella attenuata* and *Tursiops truncatus* in the Pacific waters of Panamá and Colombia. Resumen 310 en Memorias XIII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur y 7° Congreso SOLAMAC. Montevideo, Uruguay. Octubre 13-17 de 2008. [In Spanish].

García, C. and Dawson, S.M. 2003. Distribution of pantropical spotted dolphins in Pacific coastal waters of Panama. *Latin Am. J. Aquat. Mamm.* 2: 29-38.

Gaspari, S., Scheinin, A., Holcer, D., Fortuna, C., Natali, C., Genov, T., Frantzis, A., Chelazzi, G. and Moura, A.E. 2015. Drivers of population structure of the bottlenose dolphin (*Tursiops truncatus*) in the Eastern Mediterranean Sea. *Evol. Biol.*: 177-90.

Government of Japan. 2017. Government of Japan public consultation website. *http://search.e-gov.go.jp/servlet/Public?CLASSNAME=PCMMSTDETAILandid=550002463andMode=1*.

Guevara-Aguirre, D. and Gallo-Reynoso, J.P. 2015. Relative abundance and seasonality of two populations of bottlenose dolphins (*Tursiops truncatus*) in the Guaymas, Sonora region, Gulf of California. *Therya* 62: 315-28.

Hale, P.T., Barreto, A.S. and Ross, G.J.B. 2000. Comparative morphology and distribution of the *aduncus* and *truncatus* forms of bottlenose dolphin *Tursiops* in the Indian and Western Pacific Oceans. *Aquat. Mamm.* 26(2): 101-10.

Hoelzel, A.R., Potter, C.W. and Best, P.B. 1998. Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of the bottlenose dolphin. *Proc. Roy. Soc. London B Biol. Sci.* 265(1402): 1177-83.

Hucke-Gaete, R., Aguayo-Lobo, A., Yancovic-Pakarati, S. and Flores, M. 2014. Marine mammals of Easter Island (Rapa Nui) and Salas y Gómez Island (Motu Motiro Hiva), Chile: a review and new records. *Latin Am. J. Aquat. Mamm.* 42: 743-51.

Hwang, A., Defran, R.H., Bearzi, M., Maldini, D., Saylan, C.A., Lang, A.R., Dudzik, K.J., Guzon-Zatarain, O.R., K., D.L. and Weller, D.W. 2014. Coastal range and movements of common bottlenose dolphins off California and Baja California, Mexico. Bull. *Southern Calif. Acad. Sci.* 113: 1-13.

International Whaling Commission. 2012. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 13:263-91.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 18:340-86.

Jackson, A., Gerrodette, T., Chivers, S., Lynn, M., Rankin, S. and Mesnick, S. 2008. Marine mammal data collected during a survey in the eastern tropical Pacific ocean aboard NOAA ships *David Starr Jordan* and *McArthur II*, July 28-December 7, 2006. National Marine Fisheries Service *Southwest Fisheries Science Center Technical Memo* NOAA-TM-NMFS-SWFSC-421. [Available from SWFSC, 8604 La Jolla Shores Drive, La Jolla, CA 92037].

Jedensjö, M., Kemper, C., Allen, S., Bejder, L., Parra, G.J., Cagnazzi, D., Palmer, C. and Krützen, M. 2013. Osteological and genetic variation question the occurrence of three species of bottlenose dolphins (*Tursiops* spp.) in Australia. Presented to the 20th Biennial Conference on the Biology of Marine Mammals, 9-13 December 2013, Dunedin, New Zealand.

Kaiya, Z. and Weijuan, Q. 1985. Distribution of dolphins of the genus *Tursiops* in the China Sea. *Aquat. Mamm.* 1: 16-19.

Kamaruzzan, A.S., Jaaman, S.A. and Saleh, E. 2011. Effect of water parameters on the behaviour of Indo-Pacific humpback and Irrawaddy dolphins in Cowie Bay, Sabah, Malaysia. *Borneo Sci.* 28: 1-7.

Kelkar, N., Dey, S. and Choudhary, S.K. 2017. Report on the Training Workshop on South Asian river dolphins: ecology and conservation at Kahalgaon, Bihar, India. (March 17 to 21, 2017).

Kemper, C.M. 2004. Osteological variation and taxonomic affinities of bottlenose dolphins, *Tursiops* spp., from South Australia. *Aust. J. Zool.* 52: 29-48.

Khan, M., Panda, S., Kumar Pattnaik, A., Guru, B.C., Kar, C., Subudhi, M. and Samal, R. 2011. Shark attacks on Irrawaddy dolphin in Chilika lagoon, India. *J. Mar. Biol. Ass. India* 53(1): 27-34.

Khanala, G., Suryawanshid, K.R., Awasthia, K.D., Dhakale, M., Subedif, N., Natha, D., Kandele, R.C. and Kelkarg, N. 2016. Irrigation demands aggravate fishing threats to river dolphins in Nepal. *Biol. Cons.* 8pp. (In press).

Kim, H.W., Choi, S.G., Kim, Z., An, Y.R. and Moon, D.Y. 2010. First record of the Indo-Pacific bottlenose dolphin, *Tursiops aduncus*, in Korean waters *Animal Cells and Systems* 14(3): 213-19.

Kingston, S.E., Adams, L.D. and Rosel, P.E. 2009. Testing mitochondrial sequences and anonymous nuclear markers for phylogeny reconstruction in a rapidly radiating group: molecular systematics of the *Delphininae* (Cetacea: Odontoceti: Delphinidae). *BMC Evol. Biol.* 9: 245.

Kita, Y.F., Hosomichi, K., Suzuki, S., Inoko, H., Shiina, T., Watanabe, M. and Kulski, J.K. 2013. Genetic and family structure in a group of 165 common bottlenose dolphins caught off the Japanese coast. *Mar. Mamm. Sci.* 29(3): 474-96.

Kurihara, N. and Oda, S.I. 2006. Cranial variation and taxonomic revision of bottlenose dolphins (*Tursiops* spp.) from Japanese waters. *Aquat. Mamm.* 23(3): 289-300.

Louis, M., Fontaine, M., Spitz, J., Schlund, E., Dabin, W., Deaville, R., Caurant, F., Cherel, Y., Guinet, C. and Simon-Bouhet, B. 2014a. Ecological opportunities and specializations shaped genetic divergence in a highly mobile marine top predator. *Proc. Roy. Soc. B.* 281: 20141558.

Louis, M., Viricel, A., Lucas, T., Peltier, H., Alfonsi, E., Berrow, S., Brownlow, A., Covelo, P., Dabin, W., Deaville, R., De Stephanis, R., Gally, F., Gauffier, P., Penrose, R., Silva, M.A., Guinet, C. and Simon-Bouhet, B. 2014b. Habitat-driven population structure of bottlenose dolphins, *Tursiops truncatus*, in the North-East Atlantic. *Mol. Ecol.* 23: 857-74.

Lowther-Thieleking, J.L., Archer, F.I., Lang, A.R. and Weller, D.W. 2015. Genetic differentiation among coastal and offshore common bottlenose dolphins, *Tursiops truncatus*, in the eastern North Pacific Ocean. *Mar. Mam. Sci.* 31: 1-20. [Available at: *doi:10.1111/mms.12135*].

Majluf , P., Babcock, E., Riveros, J., Schreiber, M. and Alderete, W. 2002. Catch and bycatch of seabirds and marine mammals in the small-scale fishery of Punta San Juan, Peru. *Cons. Biol.* 16: 1333-43.

Mangel, J.C., Alfaro-Shigueto, J., Van Waerebeek, K., Cáceres, C., Bearhop, S., Witt, M.J. and Godley, B.J. 2010. Small cetacean captures in Peruvian artisanal fisheries: high despite protective legislation. *Biol. Cons.* 143: 136-43.

May-Collado, L.J., Gerrodette, T., Calambokidis, J., Rasmussen, K. and Sereg, I. 2005. Patterns of cetacean sighting distribution in the Pacific Exclusive Economic Zone of Costa Rica based on data collected from 1979-2001. *Rev. Biol. Trop.* 53: 249-63.

Mead, J.G. and Potter, C.W. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic coast of North America: Morphological and ecological considerations. *Int. Bio. Res. Inst. Rep.* 5: 31-43.

Meraz, J. and Sánchez-Díaz, V.M. 2008. Los mamíferos marinos en la costa central de Oaxaca. *Rev. Mexicana de Biodiversidad* 79: 143-51.

Minton, G., Peter, C., Poh, A.N.Z., Ngeian, J., Braulik, G.T., Hammond, P.S. and Tuen, A.A. 2013. Population estimates and distribution patterns of Irrawaddy dolphins (*Orcaella brevirostris*) and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in the Kuching Bay, Sarawak. *Raffles Bull. Zool.* 61(2): 877-88.

Minton, G., Peter, C. and Tuen, A.A. 2011. Distribution of small cetaceans in the nearshore waters of Sarawak, East Malaysia. *Raffles Bull. Zool.* 59: 91-100.

Moura, A.E., Nielsen, S.C.A., Vilstrup, J.T., Moreno-Mayar, J.V., Gilbert, T.P., Gray, H.W.I., Natoli, A., Moller, L. and Hoelzel, A.R. 2013. Recent diversification of a marine genus (*Tursiops* spp.) tracks habitat preference and environmental change. *Systematic Biology Advance Access* 0(0): 1-13.

Natoli, A., Birkun, A., Aguilar, A., Lopez, A. and Hoelzel, A.R. 2005. Habitat structure and the dispersal of male and female bottlenose dolphin (*Tursiops truncatus*). *Proc. Roy. Soc. Lond. B Biol. Sci.* 272: 1217-26.

Natoli, A., Peddemors, V.M. and Hoelzel, A.R. 2004. Population structure and speciation in the genus *Tursiops* based on microsatellite and mitochondrial DNA analyses. *J. Evol. Biol.* 17: 363-75.

Olavarría, C., Acevedo, J., Vester, H.I., Zamorano-Abramson, J., Viddi, F.A., Gibbons, J., Newcombe, E., Capella, J., Hoelzel, A.R., Flores, M. and Hucke-Gaete, R. 2010. Southernmost distribution of common bottlenose dolphins (*Tursiops truncatus*) in the eastern South Pacific. *Aquat. Mamm.* 36: 288-93.

Palacios, D.M., Herreira, J.C., Gerrodette, T., García, C., Soler, G.A., Avila, I.C., Bessudo, S., Hernandez, E., Trujillo, F., Florez-Gonzalez, L. and Kerr, I. 2012. Cetacean distribution and relative abundance in Colombia's Pacific EEZ from survey cruises and platforms of opportunity. *J. Cetacean Res. Manage* 12(1): 45-60.

Palacios, D.M., Salazar, S.K. and Day, D. 2005. Cetacean remains and strandings in the Galpagos Islands, 1923-2003. *Latin Am. J. Aquat. Mamm.* 3: 127-50.

Paudel, S., Pal, P., Cove, M.V., Jnawali, S.R., Abel, G., Koprowski, J.L. and Ranabhat, R. 2015. The Endangered Ganges River dolphin *Platanista gangetica gangetica* in Nepal: abundance, habitat and conservation threats. *Endang. Species Res*. 29: 59-68. [Available at: 10.3354/esr00702].

Perrin, W., Robertson, K.M., Van Bree, P.J.H. and Mead, J.G. 2007. Cranial description and genetic identity of the holotype specimen of *Tursiops aduncus* (Ehrenberg, 1832). *Mar. Mamm. Sci.* 23(2): 343-57.

Perrin, W., Thieleking, J.L., Walker, W., Archer, F. and Robertson, K. 2010. Common bottlenose dolphins (*Tursiops truncatus*) in California waters: Cranial differentiation of coastal and offshore ecotypes. *Mar. Mamm. Sci.* doi:10.1111/j.1748-7692.2010.00442.x.

Perrin, W.F., Rosel, P.E. and Cipriano, F. 2013. How to contend with paraphyly in the taxonomy of the delphinine cetaceans? *Mar. Mamm. Sci.* 29(4): 567-88.

Peter, C., Poh, A.N.Z., Ngeian, J., Tuen, A.A. and Minton, G. 2016. Identifying habitat characteristics and critical areas for Irrawaddy dolphin, *Orcaella brevirostris*: Implications for conservation. pp.225-38. In: Das, I. and Tuen, A.A. (eds). *Naturalists, Explorers and Field Scientists in South-East Asia and Australasia*. Springer International Publishing, Switzerland.

Ponnampalam, L., Hines, E., Monanunsap, S., Ilangakoon, A., Junchompoo, C., Adulyanukosol, K. and Morse, L. 2013. Behavioral observations of coastal Irrawaddy dolphins (*Orcaella brevirostris*) in Trat Province, eastern Gulf of Thailand. *Aquat. Mamm.* 39(4): 401-8.

Porter, L. and Hong Yu, L. 2017. Marine Mammals in Asian Societies; Trends in Consumption, Bait, and Traditional Use. Front. *Mar. Sci.* 4: 47pp. [Available at: *https://doi.org/10.3389/fmars.2017.00047*].

Reeves, R.R., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y. and Zhou, K. 2008. *Orcaella brevirostris*. The IUCN Red List of Threatened Species.

Reeves, R.R., Perrin, W.F., Taylor, B.L., Baker, C.S. and Mesnick, M.L. 2004. Report of the Workshop on shortcomings of cetacean taxonomy in relation to needs of conservation and management, 30 April to 2 May 2004, La Jolla, California. *NOAA Tech. Mem.* NMFS SWFSC-363: 93pp. 17pp. [Available from *rreeves@total.net*].

Rosel, P.E., Hansen, L. and Hohn, A. 2009. Restricted dispersal in a continuously distributed marine species: common bottlenose dolphins *Tursiops truncatus* in coastal waters of the western North Atlantic. *Mol. Ecol.* 2009(18): 5030-45.

Sanino, P.G., Van Waerebeek, K., Van Bressem, M.F. and Pastene, L.A. 2005. A preliminary note on population structure in eastern South Pacific common bottlenose dolphins, *Tursiops truncatus*. *J. Cetacean Res. Manage.* 7(1): 65-70.

Santillán, L., Félix, F. and Haase, B. 2008. A preliminary morphological comparison of skulls of common bottlenose dolphins *Tursiops truncatus* from Peru and Ecuador. Paper SC/60/SM10 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 5pp. [Paper available from the Office of this Journal].

Sarnblad, A., Danbolt, M., Dalen, L., Amir, O.A. and Berggren, P. 2011. Phylogenetic placement and population structure of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) off Zanzibar, Tanzania. *Mar. Mamm. Sci.* 27: 431-48.

Scott, M.D. and Chivers, S.J. 1990. Distribution and herd structure of bottlenose dolphins in the eastern tropical Pacific Ocean. pp.387-402. In: Leatherwood, S. and Reeves, R.R. (eds). *The Bottlenose Dolphin*. Academic Press, San Diego. 653pp.

Seguraa, I., Rocha-Olivaresa, A., Flores-Ramírez, S. and Rojas-Brachoc, L. 2006. Conservation implications of the genetic and ecological distinction of *Tursiops truncatus* ecotypes in the Gulf of California. *Biol. Cons.* 133: 336-46.

Shirakihara, M., Shirakihara, K., Tomonaga, J. and Takatsuki, M. 2002. A resident population of indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in Amakusa, western Kyushu, Japan. *Mar. Mamm. Sci.* 18(1): 30-41.

Shirakihara, M., Yoshida, H. and Shirakihara, K. 2003. Indo-Pacific bottlenose dolphins *Tursiops aduncus* in Amakusa, western Kyushu, Japan. *Fish. Sci.* 69(3): 654-56.

Shpak, O.V., Filatova, O.A., Volkova, E.V. and Paramonov, A.Y. 2016. Preliminary population size estimation of mammal-eating killer whales (Orcinus orca) in the Okhotsk Sea. Abstract book of the 9th conference 'Marine Mammals of Holarctic', Astrakhan, Russia.

Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B. and Mansur, R. 2006. Abundance of Irrawaddy dolphins (*Orcaella brevirostris*) and Ganges river dolphins (*Platanista gangetica gangetica*) estimated using concurrent counts made by independent teams in waterways of the Sundarbans mangrove forest in Bangladesh. *Mar. Mamm. Sci.* 22: 527-47.

Smith, B.D., Sinha, R.K., Regmi, U. and Sapkota, K. 1994. Status of Ganges river dolphins, *Platanista gangetica* in the Karnali, Mahakali, Narayani and Sapta Kosi rivers of Nepal and India in 1993. *Mar. Mamm. Sci.* 10(3): 368-75.

Somany, P., Narouen, R. and Channa, P. 2016. The impacts of the illegal fishing practices and current construction of Don Sahong Dam on the transboundary aquatic fisheries biodiversity and eco-system. *WWF Report:* 20pp.

Song, K.J. 2014. Status of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around Jeju Island, Korea. *Pacific Sci.* 68: 555-62.

Sutaria, D. and Marsh, H. 2011. Abundance estimates of Irrawaddy dolphins in Chilika Lagoon, India, using photo-identification based mark-recapture methods. *Mar. Mamm. Sci.* 27: E338–E48. [Available at: *doi:10.1111/j.1748-7692.2011.00471.x*].

Taylor, B.L., Archer, F.I. and Martien, K.K. 2017a. Guidelines and quantitative standards to improve consistency in cetacean subspecies and species delimitation relying on molecular genetic data. *Mar. Mamm. Sci.* 33(Special Issue): 132-55.

Taylor, B.L., Perrin, W.F., Reeves, R.R., Rosel, P.E., Wang, J.Y., Cipriano, F., Baker, C.S. and Brownell, R.L., Jr. 2017b. Why we should develop guidelines and quantitative standards for using molecular genetic data to delimit subspecies for data-poor organisms like cetaceans. *Mar. Mamm. Sci.* 33(Special Issue): 12-26.

Van Bressem, M., Minton, G., Sutaria, D., Kelkar, N., Rodriguez Vargas, L. and Rajamani, L. 2014. Cutaneous nodules in Irrawaddy dolphins: an emergency disease in vunerable populations. *Dis. Aquat. Organisms* 107: 181-9.

Van Waerebeek, K., Alfaro-Shigueto, J., Montes, D., Onton, K., Santillan, L., Van Bressem, M.F. and Vega, D. 2002. Fisheries related mortality of small cetaceans in neritic waters of Peru in 1999-2001. Paper SC/54/SM10 presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). 9pp. [Paper available from the Office of this Journal].

Van Waerebeek, K., Reyes, J.C., Read, A.J. and McKinnon, J.S. 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America. pp.143-54. In: Leatherwood, S. and Reeves, R.R. (eds). *The Bottlenose Dolphin*. Academic Press, San Diego. 653pp.

Van Waerebeek, K., Van Bressem, M.F., Félix, F., Alfaro-Shigueto, J., García-Godos, A., Chávez-Lisambarth, L., Ontón, K., Montes, D. and Bello, R. 1997. Mortality of dolphins and porpoises in fisheries off Peru and southern Ecuador in 1994. *Biol. Cons.* 81: 43-49.

Viaud-Martinez, K.A., Brownell, R.L., Komenou, A. and Bohonak, A.J. 2008. Genetic isolation and morphological divergence of Black Sea bottlenose dolphins. *Biol. Cons.* 141: 1,600-11.

Vidal-Hernandez, L.E. 1993. Variacion biogeografica de las dimensiones craneanas en toninas, (*Tursiops truncatus*), Del Mar de Cortes, Mexico. B.Sc. thesis, Faculad de Ciencias, Universidad Nacional Autonoma de Mexico.

Viloria-Gómora, L. and González, L.M. 2015. Population ecological traits of *Tursiops truncatus* putative morphotypes in the transitional region of the Mexican Pacific Ocean. *Therya* 6: 351-70.

Walker, W.A. 1981. Geographical variation in morphology and biology of bottlenose dolphins (*Tursiops*) in the eastern North Pacific. *NMFS SWFC Admin. Rep.* LJ-81-23C. 19pp.

Wang, J.Y., Chou, L.-S. and White, B.N. 2000a. Differences in the external morphology of two sympatric species of bottlenose dolphins (genus *Tursiops*) in the waters of China. *J. Mammal.* 81(4): 1157-65.

Wang, J.Y., Chou, L.S. and White, B.N. 2000b. Osteological differences between two sympatric forms of bottlenose dolphins (genus *Tursiops*) in Chinese waters. *J. Zool. (London)* 252: 147-62.

Weller, D.W., Campbell, G.S., Debich, A., Kesaris, A.G. and Defran, R.H. 2016. Mark-recapture abundance estimate of California coastal stock bottlenose dolphins: November 2009 to April 2011. *NOAA Tech. Mem.* NOAA-TM-NMFS-SWFSC-563.

WWF and FiA. 2014. Report of the international workshop on the conservation of Irrawaddy dolphins in Mekong River.

WWF and FiA. 2017. Report of the international workshop on the conservation of Irrawaddy dolphins in the Mekong river.

Zulkifli Poh, A.N. 2013. Habitat characteristic and overlap of small cetaceans in Kuching Bay, Sarawak, Malaysia. MSc thesis, University of Malaysia, Sarawak, Kuching.

Appendix 1

AGENDA

1. Global *Tursiops* taxonomy review
    1.1 Review populations from areas of the Pacific Ocean not previously covered.
    1.2 Work plan to complete *Tursiops* review
2. A review of small cetaceans in rivers, estuaries and restricted coastal habitats in Asia, *Platanista* spp., *Orcaella* spp. and *Neophocaena*
3. Poorly documented takes food, bait or cash and changing patterns of use
    3.1 Review report from workshop in Thailand
    3.2 Future plans
4. Small cetacean task team
5. Progress on previous recommendations
    5.1 Māui dolphin: update on New Zealand Government's management and research approach
    5.2 Vaquita: update on CIRVA progress
6. Review takes of small cetaceans
    6.1 Directed catches
    6.2 Live captures
7. Status of the Voluntary Fund for Small Cetacean Conservation Research
    7.1 Status of funds and review progress of funded projects
8. Work plan

Appendix 2

DIRECT TAKES OF SMALL CETACEAN IN JAPAN BY TYPE OF FISHERY AND PREFECTURE OF DEPARTURE PORT, 2002 TO 2015

		Quota																			
	Prefecture	2007/08	2009/10	2011/12	2013/14	2014/15	2015/16	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Baird's beaked whale																					
SW	Hokkaido	14	14	14	14	14	14	10	10	10	14	12	14	13	14	14	30	14	14	14	12
SW	Miyagi+Chiba	52	52	52	52	52+4*1	52	26/26	26/26	26/26	26/26	25/26	27/26	25/26	27/26	26/26	5/26	31/26	26/22	26/30	21/24
Short-finned pilot whale (northern form)																					
SW	Miyagi	36	36	36	36	36	36	47	42	13	22	7	-	-	-	-	-	-	-	-	-
Short-finned pilot whale (southern form)																					
SW	Chiba+Wakayama	36	36	36	36	36	36	1/35	27	29	24	-/10	-/16	-/20	-/22	-/10	-/-	1/15	-/10	1/2	5/15
D	Wakayama	277/254	230/207	184/161	196	185	151	55	55	62	40 (2)	198 (8)	243 (5)	99 (1)	219 (1)	-	74 (6)	172 (7)	88 (1)	41 (2)	80
H	Okinawa	92/85	77/69	61/53				38	36	72	90	56	79	62	54	34	46	25	47	18	9
Risso's dolphin					**487**	**478**	**469**														
SW	Wakayama	20/-	-	-	-	-	-	12	19	7	8	7	20	-	-		-	-	-	-	-
D	Wakayama	295/290	285/280	275/270	-	-	-	221 (1)	191 (5)	444 (7)	340	232	312 (8)	216 (8)	336 (8)	271 (10)	273 (17)	188 (24)	298 (12)	260 (7)	211
H	Wakayama	246/242	238/234	230/226	-	-	-	154	168	60	46	105	185	122	94	126	104	52	38	103	13
False killer whale																					
SW	Wakayama	-/20	20	20	20	20	20		-	-	-	-	-	-	-	-	-	-	1	3	-
D	Shizuoka	10	10	10	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	70	70	70	-	-	-	7	17 (5)	-	-	30 (24)	-	-	-	-	17 (10)	-	-	-	-
H	Okinawa	20	20	20	-	-	-	-	4	3	1	5	4	5	1	-	3	-	-	-	1
Striped dolphin					**595**	**580**	**565**														
D	Shizuoka	63/56	49/42	35/28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	450	450	450	-	-	-	565	382	554	397 (2)	479	384	535 (5)	321	458 (2)	406 (8)	508 (2)	498 (1)	367	353
H	Chiba	72/64	56/48	40/32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Wakayama	100	100	100	-	-	-	77	68	83	60	36	86	65	98	100	96	94	67	63	22
Bottlenose dolphin					**673**	**615**	**558**														
D	Shizuoka	71/67	63/59	55/51	-	-	-	-	-	24(15)	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	842/795	747/700	652/604	-	-	-	760 (72)	121 (16)	570 (95)	285 (36)	285 (80)	300 (77)	297 (57)	352 (98)	395 (168)	76 (25)	186 (131)	190 (84)	172 (78)	181
H	Wakayama	95/89	84/79	73/68	-	-	-	38	52	43	66	75	97	93	77	38	40	73	68	35	43
H	Okinawa	9	8	7	-	-	-	3	7	10	10	12	4	1	4	1	3	3	3	-	-
Pantropical spotted dolphin					**606**	**560**	**515**														
D	Shizuoka	409/365	318/272	227/181				-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	400	400	400				400	102	-	-	400 (13)	-	329 (6)	-	125 (16)	106 (2)	98	126 (45)	145 (35)	59
H	Wakayama	70	70	70				18	30	2	13	5	16	-	3	7	2	12	4	18	-
Pacific white-sided dolphin					**360**	**360**	**360**														
D	Shizuoka	36	36	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	134	134	134	-	-	-	-	-	-	-	-	-	21 (16)	14 (13)	27 (17)	24 (21)	2 (2)	39 (29)	5 (4)	7
H	Iwate	154	154	154	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Wakayama	36	36	36	-	-	-	-	-	-	-	-	-	-	7	-	-	2	-	-	-
Dall's porpoise (Dalli type) *2					**6,837**	**6,524**	**6,212**														
H	Hokkaido	1,451/1,399	1,348/1,296	1,244/1,192				1,328	1,655	647	1,240	719	841	467	308	116	-	-	-	-	-
H	Aomori	18/16	14/12	10/8				-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Iwate	6,969/6,721	6,472/6,224	5,975/5,726				6,057	6,427	3,796	5,394	3,312	2,975	1,947	1,362	1,140	89	29	77	14	11
H	Miyagi	269/260	250/241	231/221				229	226	171	246	181	254	180	103	-	-	-	18	2	4

	Prefecture	Quota 2007/08	2009/10	2011/12	2013/14	2014/15	2015/16	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Dall's porpoise (Truei type) *2					**6,656**	**6,404**	**6,152**														
H	Hokkaido	98/95	92/89	86/83				89	84	66	51	44	44	66	-	2	-	-	-	-	-
H	Iwate	8,054/7,805	7,557/7,308	6,860/6,611				8,243	7,325	9,109	7,733	7,758	7,243	4,566	7,767	3,532	1,855	376	1,198	1,588	1,549
H	Miyagi	16	15	214				3	3	-	-	-	-	-	-	129	8	-	-	32	28

Key: (N) shows number sold alive within all catch, and including research use.
SW=small type whaling; D=drive fishery; H=hand harpoon fishery.
Year for quota is for each season, actual catch is for calendar year.
*1For Baird's beaked whale, carryover is permitted.
*2The great east Japan earthquake and tsunami on 11th March 2011 affected the Dall's porpoise fishery area and caused a drop in the catch to well below pre-earthquake levels.
Sources: Japan. Progress reports on small cetacean research, Japan Fisheries Agency:
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h14_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h15_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h16_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h17_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h18_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h19_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h20_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/110425_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/120516_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/130531_progress_report.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h25.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h26.pdf;
http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-4.pdf
Small cetacean fisheries and resource study (in Japanese), Fisheries Research Agency:
http://kokushi.job.affrc.go.jp/H20/H20_45.pdf;
http://kokushi.job.affrc.go.jp/H22/H22_45.pdf;
http://kokushi.job.affrc.go.jp/H24/H24_45.pdf;
http://kokushi.job.affrc.go.jp/H25/H25_45.pdf

Appendix 3

DATA TABLES COMPLIED FROM NATIONAL PROGRESS REPORTS

Complied by Marion Hughes, IWC Secretariat

Table 1

Non-direct anthropogenic mortality of small cetaceans added to the Progress Report database in 2017.

ID	Large area	Species	Local area	Local taxonomy	Unk: Injured	Unk: Unk	Submitted to Ship Strikes	Contacts	Comments
2017: Australia									
PR/R/7332	Pacific Ocean - South	Indo-Pacific humpback dolphin	Cairns, Queensland	Australian humpback dolphin	1	0	Unknown	PR/C/186: I. Beasley	Observed with debris entanglement tight around neck. Subsequently observed to have freed itself.
2016: Australia									
PR/R/7118	Indian Ocean	Common bottlenose dolphin	Swan River	-	0	1	Unknown	-	Bottlenose dolphin yearling had injuries congruent with coming into contact with a vessel. No information on the vessel and in what location.
PR/R/7444	Pacific Ocean - Coral Sea	Unidentified small whale	Hay Point	-	0	1	Unknown	PR/C/667: *justin.meager@ehp.qld.gov.au*	From StrandNet: Hay Point VTS report of a vessel/whale interaction 12.5nm NE of Hay Point - at approx. 1944hrs on 19 August 2016 a 12m steel hulled sailing vessel (huey) has reported striking a whale approx. 5-6m long. The whale's condition is unknown but injury suspected. No damage to vessel or crew.

ID	Large Area	Species	Local area	Local taxonomy	Females: Dead	RMP Small Area	Submitted to Ship Strikes	Contacts	References	Comments
2016: Spain										
PR/R/7625	Atlantic Ocean - North	Common dolphin	Fisterra Harbour, Fisterra (A Corunha)	Golfinho comun (*Delphinus delphis*)	1	Unknown or N/A	No	PR/C/683 | DXPN (Serv Conservacion Biodiversidade) Xunta de Galicia *elisa.gago.moldes@xunta.gal*	PR/B/690: CEMMA. Agreement between Xunta de Galicia and Cemma for the assistance, rehabilitation and study of stranded marine mammals and reptiles along the Galician coast - 2016 Report. Unpublished.	Screw marks on the peduncle.

ID	Large Area	Species	Unk: Dead	Submitted to Ship Strikes	Contacts	Comments
2015: USA						
PR/R/8214	Pacific Ocean - North	Harbour porpoise	1	Unknown	PR/C/706: J. Carretta	Found freshly dead with 8 substantial transverse cuts on its dorsal side that appeared to be a propeller injury.
PR/R/8215	Pacific Ocean - North	Pacific white-sided dolphin	1	Unknown	PR/C/706: J. Carretta	-

Table 2

Bycatch of small cetaceans added to the Progress Report database in 2017.

ID	Large area	Species	Local area	Local taxonomy	Males: Dead	Fem: Dead	Fem: Inj	Fem: Unk	Unk: Dead	Unk: Inj	Unk: Unk	Targeted species	Gear	How observed	Comments
Australia: 2016															
PR/R/6963	Pacific Ocean - South	Australian snubfin dolphin	Queensland	-	0	0	0	0	0	1	1		GNS	Fisherman	From SOCI logbooks. Dates or locations were not provided by DAF. Both dolphins released alive.
PR/R/6964	Pacific Ocean - South	Unid. dolphin	-	-	0	0	0	0	0	0	1	-	GNS	Fisherman	Location or date not provided. Released alive.
PR/R/6981	Pacific Ocean - South	Indo-Pacific humpback dolphin	-	Australian humpback dolphin	0	0	0	0	0	1	0	-	RG	Scientist	Recreational fishing hook in jaw
PR/R/6982	Pacific Ocean - South	Common dolphin	Queensland	Short-beaked common dolphin	1	0	0	4	0	0	1	White, tiger, bull sharks	MIS; NSC	Fisherman	Four dolphins released alive from drumlines. One killed in shark net.
PR/R/6983	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	-	*Tursiops* sp.	1	1	0	0	1	0	1	-	RG; NSC	-	Three dead in nets, one released alive from drum-line. Not identified to species (*Tursiops* sp.).
PR/R/7066	Indian Ocean	Common bottlenose dolphin	Mandurah	-	0	0	0	0	0	1	0	Crab	RG	Public	Bottlenose calf - cut free.
PR/R/7112	Pacific Ocean - Tasman Sea	Common dolphin	Freshwater, NSW	-	0	1	0	0	0	0	0	Sharks	NSC	Scientist	TARZ-11000/1.
PR/R/7114	Pacific Ocean - Tasman Sea	Common dolphin	Terrigal, NSW	-	0	1	0	0	0	0	0	Sharks	NSC	Scientist	TARZ-11153/1.
PR/R/7115	Pacific Ocean - Tasman Sea	Common bottlenose dolphin	Manly, NSW	-	1	0	0	0	0	0	0	sharks	NSC	Scientist	TARZ-11147/1.
PR/R/7290	Pacific Ocean - Tasman Sea	Common dolphin	NSW	-	3	0	0	0	0	0	0	Shark	NSC	Observer or inspector	-
PR/R/7291	Atlantic Ocean - North	Common bottlenose dolphin	-	-	1	0	0	0	1	0	0	Sharks	NSC	Observer or inspector	-
PR/R/7333	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Moreton Bay	-	0	0	2	0	0	0	0	-	-	Scientist	Hooked in jaw. Hooks removed and released alive.
PR/R/7473	Southern Ocean	Common dolphin	Spencer Gulf, SA	*Delphinus delphis* (short-beaked common dolphin)	0	1	0	0	0	0	0	Sardine	PS1; PS	Scientist, observer or inspector, fisherman	5 May 2016. Known entanglement, SA sardine fishery, SA Museum post-mortem.
PR/R/7474	Southern Ocean	Indo-Pacific bottlenose dolphin	Whyalla, Spencer Gulf	*Tursiops aduncus*	0	0	0	0	0	0	1	-	MIS	Observer or inspector	15 June 2016. Trapped in a swimming net, successfully released by members of public.
PR/R/7475	Southern Ocean	Unidentified dolphin	Two Well, Gulf St Vincent	*Tursiops* sp. (unid. bottlenose dolphin)	0	0	0	1	0	0	0	-	NK	Observer or inspector	16 September 2016. Entangled in an un-specified gear, successfully released by members of public.
PR/R/7476	Southern Ocean	Common dolphin	Glenelg North, Gulf St Vincent	*Delphinus delphis* (short-beaked common dolphin)	0	1	0	0	0	0	0	-	NK	Scientist	21 September 2016. Probable entanglement with several signs to confirm, SA Museum post-mortem.

ID	Large area	Species	Local area	Unk: Dead	Targeted species	Gear	How observed	Contacts	Comments
Germany: 2016									
PR/R/8099	Atlantic Ocean - Baltic Sea	Harbour porpoise	German waters	10	-	GN	Fisherman	PR/C/623 | Prof. Prof. Dr. Ursula Siebert (*Ursula.Siebert@tiho-hannover.de*)	-
PR/R/8265	Atlantic Ocean - Baltic Sea	Harbour porpoise	German waters	5	Cod; flatfish	GN	Fisherman	PR/C/591 | Dr. Christian von Dorrien (*christian.dorrien@thuenen.de*)	To test their practicability and effectiveness, PAL - a new type of acoustic deterrent device (Porpoise ALarm) - were deployed on a small number of German and Danish commercial gill net vessels while carrying out their normal fishing activities in the Baltic Sea for several months in 2016. For the trials, specifically those fisheries were selected that are active in areas where higher bycatch rates of harbor porpoises could be expected. During these trials, bycatch of five individuals in German waters was observed.

ID	Large area	Species	Local area	Unk: Dead	Unk: Injured	Unk: Unk	Targeted species	Gear	How observed	Contacts	Comments
New Zealand: 2012											
PR/R/6886	South Pacific Ocean	Hector's dolphin	East coast, South Island	2	0	0	-	RG	Observer or inspector	-	22/02/12. Entangled in recreational set net.
PR/R/6887	South Pacific Ocean	Hector's dolphin	West coast, South Island	1	0	0	-	GN	Observer or inspector	-	19/04/12. Commercial set net.
PR/R/6888	South Pacific Ocean	Hector's dolphin	East coast, South Island	0	0	1	-	GNS	Fisherman	-	26/10/12. Captured in commercial set net, released alive.
New Zealand: 2014											
PR/R/6889	South Pacific Ocean	Hector's dolphin	Bay of Plenty	0	0	1	-	GNS	Public	-	10/05/14. Captured in recreational set net, released alive.
New Zealand: 2015											
PR/R/7955	Pacific Ocean - NZ	Common dolphin	-40.26667, 173.6	1	0	0	Jack mackerel	TX	Observer or inspector	PR/C/509: K. Ramm, *kramm@doc.govt.nz*	14/12/15. Caught in pelagic trawl for jack mackerel.
New Zealand: 2016											
PR/R/7956	Pacific Ocean - NZ	Common dolphin	-40.1833, 173.33333	1	0	0	Jack mackerel	TX	Observer or inspector	PR/C/509: K. Ramm, *kramm@doc.govt.nz*	02/02/16. Caught in pelagic trawl for jack mackerel.
PR/R/7957	Pacific Ocean - NZ	Dusky dolphin	-45.5498, 170.87761	1	0	0	School shark	GNS	Observer or inspector	As above	16/04/16. Caught in set net for school shark.
PR/R/7958	Pacific Ocean - NZ	Common dolphin	-36.9333, 174.06667	1	0	0	Tarakihi	TX	Observer or inspector	As above	31/03/16. Caught in mid-water trawl for terakihi.
PR/R/7959	Pacific Ocean - NZ	Common dolphin	-36.14833, 175.25333	2	0	0	John Dory	TX	Observer or inspector	As above	07/04/16. Two animals caught in mid-water John Dory trawl.
PR/R/7960	Pacific Ocean - NZ	Common dolphin	-35.75667, 175.405	1	0	0	Tarakihi	TX	Observer or inspector	As above	14/06/16. Caught in mid-water trawl for terakihi.
PR/R/7961	Pacific Ocean - NZ	Hector's dolphin	-44.3166, 171.35	1	0	0	Elephant fish	TX	Fisherman	As above	27/11/16. Reported by skipper. Caught in inshore trawl for elephant fish.
PR/R/8342	Pacific Ocean - NZ	Common dolphin	-42.45, 173.63333	1	0	0	Rig	GNS	Fisherman	As above	07/04/16. Caught in set net for rig.
PR/R/8343	Pacific Ocean - NZ	Common dolphin	-37.6, 176.63333	1	0	0	Tarakihi	TBB	Fisherman	As above	20/04/16. Caught in bottom trawl for terakihi.
PR/R/8344	Pacific Ocean - NZ	Common dolphin	-41.5, 174.55	1	0	0	Hoki	TM	Fisherman	As above	10/00/16. Caught in midwater trawl for hoki.
PR/R/8345	Pacific Ocean - NZ	Common dolphin	-35.3, 176.41667	0	0	1	Bigeye tuna	LL	Fisherman	As above	10/12/16. Caught in surface longline for bigeye tuna, released alive.
PR/R/8346	Pacific Ocean - NZ	Common dolphin	-36.3166, 175.38333	0	0	1	Snapper	LL	Fisherman	As above	18/12/16. Caught on bottom long line for snapper, released alive.
PR/R/8347	Pacific Ocean - NZ	Common dolphin	-37.0833, 178.48333	1	0	0	Tarakihi	TBB	Fisherman	As above	18/02/16. Caught in bottom trawl for terakihi.
PR/R/8348	Pacific Ocean - NZ	Common dolphin	-36.4, 175.45	1	0	0	Snapper	TBB	Fisherman	As above	04/01/16. Caught in bottom trawl for snapper.
PR/R/8349	Pacific Ocean - NZ	Common dolphin	-38.5666, 178.86667	0	0	1	Bigeye tuna	LL	Fisherman	As above	19/03/16. Caught on surface long line for bigeye tuna, released alive.
PR/R/8350	Pacific Ocean - NZ	Common dolphin	-39.1166, 177.41667	1	0	0	Snapper	TBB	Fisherman	As above	11/11/16. Caught in bottom trawl for snapper.
PR/R/8351	Pacific Ocean - NZ	Common bottlenose dolphin	-36.2666, 175.1	1	0	0	Snapper	TBB	Fisherman	As above	06/12/16. Caught in trawl for snapper.
PR/R/8352	Pacific Ocean - NZ	Common bottlenose dolphin	-36.1833, 175.25	1	0	0	Snapper	TBB	Fisherman	As above	16/12/16. Caught in bottom trawl for snapper.
PR/R/8353	Pacific Ocean - NZ	Common bottlenose dolphin	-36.15, 175.26667	1	0	0	Snapper	TBB	Fisherman	As above	17/01/16. Caught in bottom trawl for snapper.
PR/R/8354	Pacific Ocean - NZ	Common bottlenose dolphin	-35.3666, 175.91667	0	1	0	Swordfish	LL	Fisherman	As above	13/05/16. Caught in surface long line for swordfish; released alive but injured.
PR/R/8355	Pacific Ocean - NZ	Dusky dolphin	-42.4833, 175.55	1	0	0	Ling	GNS	Fisherman	As above	20/10/16. Caught in set net for ling.
PR/R/8356	Pacific Ocean - NZ	Short-finned pilot whale	-44.4, 171.53333	1	0	0	Barracouta	TBB	Fisherman	As above	12/11/16. Caught in bottom trawl for barracoota.
PR/R/8357	Pacific Ocean - NZ	Short-finned pilot whale	-44.45, 171.53333	0	0	1	Barracouta	TBB	Fisherman	As above	18/11/16. Caught in bottom trawl for barracouta; released alive.
PR/R/8358	Pacific Ocean - NZ	Unidentified dolphin	-41.5666, 174.6	1	0	0	Hoki	TM	Fisherman	As above	15/08/16. Caught in midwater trawl for hoki.
PR/R/8359	Pacific Ocean - NZ	Unidentified dolphin	-39, 178.56667	0	0	1	Southern bluefin tuna	LL	Fisherman	As above	14/06/16. Caught in surface long line for southern bluefin tuna; released alive.
PR/R/8360	Pacific Ocean - NZ	Unidentified dolphin	-34.5666, 174.16667	0	0	1	Bigeye tuna	LL	Fisherman	As above	09/03/16. Caught in surface long line for bigeye tuna; released alive.

ID	Large area	Species	Local area	Local taxonomy	M: Dead	F: Dead	F: seriously injured	Unk: Dead	Gear	How observed	References/comments
Spain: 2016											
PR/R/7138	Atlantic Ocean - North	Atlantic spotted dolphin	Canary Islands	-	0	1	0	0	NK	Scientist	Deep cuts in right lobe of caudal fin. Abundant gastric content. Interaction with fishing: indications
PR/R/7151	Atlantic Ocean - North	Dwarf sperm whale	Canary Islands	Cachalote enano	0	1	0	0	HAR	Scientist	-
PR/R/7163	Atlantic Ocean - North	Striped dolphin	Canary Islands	Delfin listado	0	1	0	0	HAR	Scientist	Sharp wound, it fractures vertebrae and of ribs. Trauma compatible with fishing interaction
PR/R/7402	Atlantic Ocean - North	Common dolphin	Canary Islands	Delfin comun	0	2	0	0	NK	Scientist, observer or inspector	-
PR/R/7627	Atlantic Ocean - North	Common dolphin	Rio Azor Beach, Ribeira (A Corunha)	Golfinho comun (*Delphinus delphis*)	0	0	0	1	NK	Observer or inspector	PR/B/690: CEMMA. Agreement between Xunta de Galicia and Cemma for the assistance, rehabilitation and study of stranded marine mammals and reptiles along the Galician coast - 2016 Report. Unpublished.
PR/R/7628	Atlantic Ocean - North	Common bottlenose dolphin	Boleira de Prado, Nigran (Pontevedra)	Arroaz (*Tursiops truncatus*)	0	1	0	0	NK	Observer or inspector	
PR/R/7629	Atlantic Ocean - North	Common dolphin	O Can de Penedo, Bueu (Pontevedra)	Golfinho comun (*Delphinus delphis*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7630	Atlantic Ocean - North	Common dolphin	Xilloi Beach, O Vicedo (A Corunha)	Golfinho comun (*Delphinus delphis*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7631	Atlantic Ocean - North	Common dolphin	Silgar Beach, Sanxenxo (Pontevedra)	Golfinho comun (*Delphinus delphis*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7632	Atlantic Ocean - North	Common dolphin	Calzoa Beach, Vigo (Pontevedra)	Golfinho comun (*Delphinus delphis*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7633	Atlantic Ocean - North	Common dolphin	Ladeira Beach, Ribeira (A Corunha)	Golfinho comun (*Delphinus delphis*)	0	0	0	1	NK	Observer or inspector	PR/B/690 as above
PR/R/7634	Atlantic Ocean - North	Striped dolphin	Vilela Beach, Manhon (A Corunha)	Golfinho riscado (*Stenella coeruleoalba*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7635	Atlantic Ocean - North	Common dolphin	Arnelas Beach, Cangas (Pontevedra)	Golfinho comun (*Delphinus delphis*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7636	Atlantic Ocean - North	Common dolphin	-	-	0	1	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7637	Atlantic Ocean - North	Common bottlenose dolphin	Bens Beach, A Corunha	Arroaz (*Tursiops truncatus*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7638	Atlantic Ocean - North	Common bottlenose dolphin	Sabon Beach, Arteixo (A Corunha)	Arroaz (*Tursiops truncatus*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7639	Atlantic Ocean - North	Striped dolphin	Baldaio Beach, Carballo (A Corunha)	Golfinho riscado (*Stenella coeruleoalba*)	1	0	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7640	Atlantic Ocean - North	Striped dolphin	Razo Beach, Carballo (A Corunha)	Golfinho riscado (*Stenellla coeruleoalba*)	0	0	1	0	N	Observer or inspector	PR/B/690 as above. Died during rescue procedure.
PR/R/7641	Atlantic Ocean - North	Common dolphin	Arnela Beach, Carballo (A Corunha)	Golfinho comun (*Delphinus delphis*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above
PR/R/7642	Atlantic Ocean - North	Common dolphin	Louro Beach, Muros (A Corunha)	Golfinho comun (*Delphinus delphis*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above. Pregnant female carrying a foetus (32cm long).
PR/R/7643	Atlantic Ocean - North	Long-finned pilot whale	Donios Beach, Ferrol (A Corunha)	Caldeiron comun (*Globicephala melas*)	0	1	0	0	NK	Observer or inspector	PR/B/690 as above

ID	Large area	Species	Local area	Local taxonomy	Females: Dead	Gear	How observed	Contacts
Spain: 2017								
PR/R/7402	Atlantic Ocean - North	Common dolphin	Canary Islands	Delfin comun	2	NK	Scientist, observer or inspector	PR/C/663: A. Fernandez (*antonio.fernandez@ulpgc.es*); PR/C/664: M. Arbelo (*manuel.arbelo@ulpgc.es*)

ID	Large area	Species	Local area	M: Dead	F: Dead	How observed	Contacts	References	Comments
UK: 2016									
PR/R/8433	Atlantic Ocean - North	Harbour porpoise	-	3	1	Scientist	PR/C/247: R. Deaville, *rob.deaville@ioz.ac.uk*	PR/B/709: Deaville, R. CSIP Annual Report to UK Government for 2016. Unpublished	Diagnosed as bycatch through necropsies carried out under the UK strandings scheme.
PR/R/8434	Atlantic Ocean - North	Common dolphin	-	3	4	Scientist	PR/C/247: R. Deaville, *rob.deaville@ioz.ac.uk*	PR/B/709 as above	Diagnosed as bycatch through necropsies carried out under the UK strandings scheme.
PR/R/8435	Atlantic Ocean - North	Killer whale	Scotland	0	1	Scientist	PR/C/248: A. Brownlow, *andrew.brownlow@sac.co.uk*; PR/C/249: N. Davison, *nick.davison@sac.co.uk*	PR/B/709 as above	Diagnosed as bycatch through necropsies carried out under the UK strandings scheme.

ID	Large Area	Species	Local area	M: Dead	F: Dead	Unk: Dead	Unk: Seriously injured	Targeted species	Gear	How observed	Contacts
USA: 2014											
PR/R/8025	Atlantic Ocean - North	Risso's dolphin	-	0	0	0	1	Tuna/swordfish	LL	Observer or inspector	PR/C/53: L. Garrison (*Lance.Garrison@noaa.gov*)
PR/R/8026	Atlantic Ocean - North	Short-finned pilot whale	-	0	0	0	19	Tuna/swordfish	LL	Observer or inspector	PR/C/53: L. Garrison (*Lance.Garrison@noaa.gov*)
PR/R/8027	Atlantic Ocean - North	Long-finned pilot whale	-	0	0	0	1	Tuna/swordfish	LL	Observer or inspector	PR/C/53: L. Garrison (*Lance.Garrison@noaa.gov*)
PR/R/8028	Atlantic Ocean - North	Unidentified dolphin	-	0	0	0	1	Tuna/swordfish	LL	Observer or inspector	PR/C/53: L. Garrison (*Lance.Garrison@noaa.gov*)
PR/R/8029	Atlantic Ocean - Gulf of Mexico	Rough-toothed dolphin	-	0	0	0	2	Tuna/swordfish	LL	Observer or inspector	PR/C/53: L. Garrison (*Lance.Garrison@noaa.gov*)
PR/R/8327	Atlantic Ocean - North	Risso's dolphin	-	0	0	3	0	-	TBB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8328	Atlantic Ocean - North	Risso's dolphin	-	0	0	0	1	-	LLS	Observer or inspector	PR/C/712: L. Garrison (*lance.garrison@noaa.gov*)
PR/R/8329	Atlantic Ocean - North	Long-finned pilot whale	-	0	0	0	1	-	LLS	Observer or inspector	PR/C/712: L. Garrison (*lance.garrison@noaa.gov*)
PR/R/8330	Atlantic Ocean - North	Long-finned pilot whale	-	0	0	4	1	-	TBB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8331	Atlantic Ocean - North	Long-finned pilot whale	-	0	0	4	0	-	TM	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8332	Atlantic Ocean - North	Atlantic white-sided dolphin	-	0	0	4	0	-	TBB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8333	Atlantic Ocean - North	Atlantic white-sided dolphin	-	0	0	2	0	-	GN	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8334	Atlantic Ocean - North	Common dolphin	-	0	0	38	3	-	TBB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8335	Atlantic Ocean - North	Common dolphin	-	0	0	12	0	-	GN	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8336	Atlantic Ocean - North	Common bottlenose dolphin	-	0	0	3	0	-	OTB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8337	Atlantic Ocean - North	Harbour porpoise	-	0	0	29	0	-	GN	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
PR/R/8338	Atlantic Ocean - North	Harbour porpoise		0	0	1	0	-	TBB	Observer or inspector	PR/C/122: M. Rossman (*marjorie.rossman@noaa.gov*)
USA: 2015											
PR/R/8216	Pacific Ocean - North	Common dolphin	California	0	0	6	0		NK	Observer or inspector	PR/C/706: J. Carretta
PR/R/8217	Pacific Ocean - North	Harbour porpoise	N Oregon – Washington coast	1	4	6	0		NK	Scientist	PR/C/706: J. Carretta
PR/R/8218	Pacific Ocean - North	Pacific white-sided dolphin		0	0	2	0		TBB	Observer or inspector	PR/C/706: J. Carretta
PR/R/8219	Pacific Ocean - North	Striped dolphin		0	0	1	0		NK	Scientist	PR/C/706: J. Carretta

Gear list

[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
[LL] HOOKS AND LINES - Longlines (not specified)
[LLS] HOOKS AND LINES - Set longlines
[MIS] MISCELLANEOUS GEAR
[NK] GEAR NOT KNOWN OR NOT SPECIFIED
[NSC] SHARK CONTROL NETS
[OTB] TRAWLS - Beam trawl
[PS] SURROUNDING NETS - With purse lines
[PS1] SURROUNDING NETS - One-boat operated purse seines
[RG] RECREATIONAL FISHING GEAR
[TX] MIDWATER TRAWLS - Other trawls (not specified)
[TBB] TRAWLS - Bottom trawls
[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
[HAR] GRAPPLING AND WOUNDING – Harpoons

Annex N

Report of the Sub-Committee on Whalewatching

Members: Suydam (Chair), Baldwin, Bell, Brockington, Cosentino, Elwen, Fortuna, Freitas, Frey, Funahashi, Holm, Iñíguez, Kato, Kaufman, Lee, Lundquist, Minton, New, Parsons, Rendell, Reyes, Ritter, Robbins, Rodriguez-Fonseca, Rojas-Bracho, Rose, Ryeng, Sequeira, Simmonds, Stachowitsch, Štrbenac, Vermeulen, Weinrich, Willson.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Suydam welcomed members of the sub-committee. He noted the recent passing of our long-time colleague Carole Carlson and encouraged the sharing of memories and reminiscences as the sub-committee toasted her memory. She will be greatly missed.

1.2 Election of Chair
Suydam was elected Chair.

1.3 Appointment of rapporteur
Rose was appointed rapporteur.

1.4 Adoption of Agenda
The adopted Agenda is given as Appendix 1.

1.5 Review of available documents
The documents available to the sub-committee were identified as: SC/67a/WW01-05, SC/67a/WW07-08, Vail (2016), and Pagel *et al.* (2016).

2. ASSESS THE IMPACTS OF WHALEWATCHING ON CETACEANS

2.1 Review work plan on Modelling and Assessment of Whalewatching Impact (MAWI)
SC/67a/WW08 reported that the upcoming workshop proposed by the MAWI intersessional working group in 2016 to be funded by the IWC will be scheduled sometime late in 2017 or early 2018. The main focus of the workshop will be to identify the potential impacts of whalewatching that are of concern globally. The workshop will define the key research questions that are required to understand those impacts. A number of potential workshop participants were identified, and the intended outcomes of the workshop were described, including a report to this sub-committee and peer-reviewed articles and presentations to other conferences.

In discussion, it was suggested that workshop attendance could be maximised if the chosen venue coincided with a major marine mammal science meeting, such as the biennial meeting of the Society for Marine Mammalogy scheduled for October 2017 or the 2018 meeting of the European Cetacean Society. Holding a workshop in conjunction with one of those meetings could reduce travel costs because potential workshop attendees might already be at those meetings. In addition, it was noted that individuals should be invited to participate in the workshop who work in or represent countries or regions with emerging whalewatching industries where MAWI might initiate studies, such as Oman, Africa or Brazil. One suggestion was to announce the workshop on listserves and other outreach tools, asking potential participants to indicate their interest and expertise via a web-based application such as Survey Monkey. In response to concern about the ambitious nature of the intended workshop outcomes, New noted that determining the key research questions would be the central and most important outcome, which she considered a reasonable goal for this workshop.

The discussion also referred back to SC/65b (IWC, 2016b, p.390) when a list was compiled of critically endangered cetacean populations that were subject to whalewatching (Gleason and Parsons, 2015). That list could be used to inform the sub-committee's recommendations about the Commission's Strategic Plan for Whalewatching. The Plan's guiding principles discouraged whalewatching on such populations; however, it was noted that the list of populations might also serve to identify candidate populations for potential research sites under MAWI.

The sub-committee subsequently **recommended** a list compiled at SC/65b (Gleason and Parsons, 2015) of IUCN endangered and critically endangered cetaceans subjected to whalewatching should be included in the Whalewatching Handbook and forwarded promptly to the Conservation Committee for that purpose.

2.2 Review specific papers assessing impacts
SC/67a/WW04 reported on a land-based theodolite study conducted from two sites in Maui, Hawaii, USA to determine whether local vessel traffic, including whalewatching activities, affects the behaviour of humpback whale pods in this important breeding area. Pods changed aspects of their behaviour, including swim speed and dive time, during interactions with vessels. Linear mixed-effect models suggested the presence of vessels caused an increase in whale's swim speed and decreased dive times, and vessel distance had a variable effect on directness of travel. The authors discussed the implications of these changes in terms of biological effects on pods and detectability of whales by subsequent vessels. A continued precautionary approach was recommended in relation to vessel traffic and whalewatching activities for this region, including reduced overall speed and slower speeds when approaching groups of cetaceans.

In discussion, several questions were asked about the analysis and modelling. It was noted that interpreting the results could depend on the answers to these questions. The authors clarified that these results were preliminary, with plans to continue the study over the next two years; these concerns will be addressed in subsequent work, using multivariate analyses and generalised linear models. Discussions will continue between the authors and sub-committee members intersessionally.

It was also noted in discussion that longer dives indicated resting behaviour for some large whales when on their breeding grounds, which may mean that the shorter dives in the presence of vessels observed in this study indicate disrupted resting behaviour. Other variables that could be examined in future work include heart rate (with suitable tags) and stress hormones measured from blow samples. The study will consider these possibilities as it proceeds.

Table 1

Summary of studies on the impacts of whalewatching on cetaceans (SC/67a/WW05). Note that inclusion in this table does not imply endorsement of the findings or recommendations of the various studies by the sub-committee.

Species	Location	Methodology	Key findings	Reference
Humpback whales	Praia do Forte, Brazil	Acoustic recording, boat-based observations	Whalewatching boat noise ranged from 20 Hz to >20kHz, concentrated at ~15kHz. As this overlaps with humpback whale song (20-24 kHz), acoustic masking may be a problem. Whalewatching boat noise was recorded >1 mile from vessel.	Rossi-Santos (2016)
Humpback whales	Bahía Málaga, Colombia	Land-based surveys	Land-based surveys observed an average of four humpback whales/hour (0-15 whales/hr), with an average of 4.5 whalewatching vessel trips to watch these whales. Seventy-one % of the boats travelled at high speeds (≥16 knots).	Avila *et al.* (2017)
Sperm whales	Andenes, Norway	Boat-based observations, whalewatching vessel platform of opportunity	No effect of whalewatching vessel presence on surface and foraging dive durations, but 'near-surface events' (submerging without bringing the tail flukes out of the water) increased. Sperm whales with boats spent 75% more time at the surface.	Cosentino (2016)
Killer whales	Orcas Island, Washington, USA	Fractal analysis, land-based survey	No effect of kayaks on whale directional changes.	Seuront and Cribb (in press)
Killer whales	British Colombia, Canada	Metabolic modelling	Increase in speed from disturbance resulted in a 0.7-1.4% increase in energy expenditure over a 12-hour period.	Noren *et al.* (2016)
Spinner dolphins	Hawaii, USA	Mixed land-based and boat based observations	Resting was the main observed behavioural state for dolphins in the morning. Human activities were highest during this resting period.	Tyne *et al.* (2017)
Spinner dolphins	Hawaii, USA	Acoustic recording, boat-based	There was no relationship between tourist activity (swimmers, kayaks and vessels present) and dolphin whistle rates in one Hawaiian bay, but there was between the number of swimmers/snorkelers and whistle rates in a second bay. Likewise, there was an effect of human activity in one bay (specifically numbers of boats and swimmers/snorkelers), and not another. The researchers concluded that it was not necessarily the total numbers of boats and swimmers influencing changes in cetacean behaviour, but rather what those humans and vessels were doing, i.e. trying to pursue and interact with animals.	Heenehan *et al.* (2017)
Indo-Pacific bottlenose dolphins	Kisite-Mpunguti Marine Protected Area, Kenya	Markov chain models, boat-based observations	Dolphins spent more time diving and less time travelling as the result of boat exposure. Average time dolphins spent resting and travelling significantly decreased as the result of boat exposure. Behavioural changes occurred at 400m. Dolphin-watching guidelines in the location proscribe 100m approach distances.	Pérez-Jorge *et al.* (2017)
Common bottlenose dolphins	Walvis Bay, Namibia	Acoustic recording, boat-based	Dolphins increased the frequency of several whistle components in response to research vessel tourism boats. Duration and frequency ranges of whistles did not change.	Heiler *et al.* (2016)
Common bottlenose dolphins	Sarasota Bay, Florida, USA	Pre-existing data, including data collected via capture-recapture studies and photo-ID	Dolphin-human interactions occurred in 3.5% of dolphin sightings, with 42 individuals showing signs of 'conditioning' with respect to humans hand-feeding dolphins. There was a relationship between interacting with humans and injuries, and the likelihood of being injured increased with age in conditioned animals.	Christiansen *et al.* (2016)
Common bottlenose dolphin	Savannah, Georgia, USA	Boat-based observations, photo-ID	Wild bottlenose dolphins observed 'begging' for food from humans spent significantly less time foraging than non-beggars (26% *vs* 45%). Begging dolphins spent significantly more time travelling (53% *vs* 40%). Provisioning changed the ecology of the conditioned dolphins.	Hazelkorn *et al.* (2016)

The sub-committee welcomed the overall design of the study, as land-based observations of vessel disturbance are preferred over boat-based observations (due to the potential for the research vessel to confound results).

In 2004 at SC/56, a paper summarising recent whalewatching research was presented to the sub-committee (Parsons *et al.*, 2004). It was recognised that there was a wealth of recent research on impacts of whalewatching activities on cetaceans and other related studies. This was deemed to be a useful review, so similar digests were requested in following years. SC/67a/WW05 is the 14th in this series of reviews and it summarises whalewatching research published since SC/66b. Those studies related to impacts of whalewatching on cetaceans are summarised in Table 1. The sub-committee welcomed this paper and thanked Parsons for presenting the information.

In discussion, the issue of how to define 'high speed' in relation to whalewatching vessels was raised. Laist *et al.* (2001) considered 'high speed' to be greater than 14 knots, as collisions at speeds greater than this were more likely to be lethal. It was recalled that the sub-committee agreed its own definition of 'high speed' in relation to whalewatching vessels at SC/57 (IWC, 2005, p.331), which was confirmed at last year's meeting (Currie *et al.*, 2015) as 13 knots or greater.

The sub-committee **agreed** that its SC/57 definition of 'high speed' in relation to whalewatching vessels should be used when referring to high speed vessels within the framework of MAWI and subsequent sub-committee discussions.

Ritter presented Pagel *et al.* (2016) to the sub-committee. This paper provides insights on interactive behaviours displayed by wild and unhabituated killer whales (*Orcinus orca*) toward human divers and snorkelers in northern Norway. Observations were made from 2000-15 and analysed from opportunistic underwater video recordings, as well as data collected from waters off Senja Island (Norway). Based on 58 video recordings, eight different interactive behaviours were identified, all considered by the authors to be affiliative in nature, with 'calling' and 'eye contact' being the most frequently observed. No aggressive, threatening or sexual behaviours were identified. However, the authors cautioned that absence of agonistic behaviours during this study could be due to small sample size. The use of footage not originally taken for scientific purposes nevertheless gave important insights into a species' behavioural repertoire. This can be especially valuable when the study area is remote and/ or data collection is challenging due to restrictive weather conditions and short daylight hours. However, the absence of a consistent or systematic sampling protocol limits the scientific application of the data.

In discussion, it was noted that the ethogram might be improved. For example, the first behaviour described as 'belly-up approach', would in many species, including killer whales, be considered by experienced observers to be sexual in nature. Alternatively, the 'belly-up approach' might be a foraging behaviour (exposing the white of the belly to potential prey), which also suggests it is not affiliative as the authors concluded. It was also noted that in many mammals, including cetaceans, direct eye contact is considered threatening. Ritter will communicate these comments and concerns to the authors.

2.3 Consider documented emerging areas of concern (e.g. new areas/species, new technologies, in-water interactions) and how to assess them

Simmonds presented Vail (2016), which compiled a comprehensive compendium of negative interactions, occurring within the past 15 years, between people and bottlenose dolphins around the Florida panhandle region (USA) of the Gulf of Mexico. Recorded impacts included fatal injuries resulting from gunshots, arrows and sharp implements. Vail suggested that the increasing proximity and encouragement of direct interaction and close encounters with wild dolphins through commercial and recreational activities has had a profound effect on eroding the 'protective barriers that once existed between wild dolphins and the general public'.

In discussion, it was noted that these types of serious, human-inflicted injuries, some fatal, could be considered a newly identified, if indirect, whalewatching impact. Whalewatching and dolphin feeding may have resulted in habituation of dolphins to people, which might have contributed to negative interactions of dolphins with people involved in other pursuits. While the motivation for inflicting injuries and mortalities on dolphins was likely complex in most cases, the growing familiarity some people feel toward wild cetaceans, due at least in part to the increasing prevalence of whalewatching, is a possible factor.

Vail (2016) identified negative impacts on dolphins, which may have arisen indirectly from whalewatching activities. Because of the impacts and the potential management implications, the sub-committee **recommended** that Vail (2016) be brought to the attention of the Conservation Committee and that the Standing Working Group on Whalewatching should include the potential for these types of injurious and fatal interactions in its discussion about management actions. Given the welfare implications, this paper should also be brought to the attention of the Working Group on Whale Killing Methods and Welfare Issues.

It was noted that papers such as Vail (2016) may also provide details on data collection methods for these types of incidents, which is of interest to the sub-committee. The discussion further noted that the incidence of human violence directed toward cetaceans might also be attributed to the habituation of some cetaceans to human presence and activity, making them easier 'targets' for this type of human behaviour and encouraging them to exhibit 'nuisance' behaviours that antagonise public sectors such as the recreational fishing industry. Previous studies found that dolphins subject to dolphin-watching were more likely to be injured by boats or other human activity, at least in part because they were habituated to human approach.

The sub-committee **agreed** that cetacean habituation to humans, given its potential to lead to fatal negative interactions such as described in Vail (2016), was a conservation concern for whalewatching activities and a better understanding of habituation was relevant to its work. The sub-committee therefore **agreed** to form an intersessional correspondence group to assess the issue of cetacean habituation (and sensitisation, a related condition), especially as it relates to whalewatching, and report back to the sub-committee next year at SC/67b. Simmonds was appointed Convenor (see Annex W for membership).

SC/67a/WW02 was not presented in this sub-committee (it was presented in the Sub-Committee on Southern Hemisphere Whales; see Annex H), but it was noted that one of this paper's objectives was to identity areas along the Chilean coast where whalewatching could be developed. The study reported the results of movements of six fin whales (*Balaenoptera physalus*) tagged in November and December 2015. The late spring and summer space use patterns indicated a preference for coastal habitats likely associated with strong upwelling areas. Some of the areas used by whales along the coast, such as near Coquimbo and Valparaiso, may be suitable for the development of whalewatching.

SC/67a/WW03 offered an update on a previously identified emerging issue of concern: whalewatching targeting the endangered Arabian Sea humpback whales. Guidelines for whalewatching in Oman were developed in 2013/14 as part of an IWC-supported project, which also included awareness-raising and initial training of tour operators and vessel captains in key locations. This formed the basis of the current study, which aimed to identify requirements to minimise negative impacts of whalewatching on Arabian Sea humpback whales and to highlight business approaches for achieving responsibly-managed whalewatching in Oman (an objective relevant to the Conservation Committee). A workshop is planned in Oman to address the requirements of a responsible and sustainable whalewatching industry in the country. In addition, outreach materials providing information on Arabian Sea humpback whales designed to raise levels of awareness and knowledge of operators are in preparation. This work is meant to be completed by December 2017.

In Oman's whalewatching industry, most operators target coastal and offshore dolphins off Muscat, Musandam and Dhofar. The Arabian Sea humpback whale has recently become a target of small-scale, unregulated and opportunistic whalewatching at the Hallaniyat Islands in southern Oman. Only one operator currently targets humpback whales, while another reports regular opportunistic encounters. Clearly the industry has potential for growth, as indicated by coastal development, including improved access and infrastructure in regions that host high densities of Arabian Sea humpback whales (e.g. Duqm, Masirah Island and Dhofar). Interest and demand to observe this species is also growing. Minimal advances in standards and attitudes toward whalewatching in Oman suggests that further management intervention is required, based on scientific evidence, to ensure minimal impacts from the industry.

The current level of impacts is considered to be very low based on review of literature on populations elsewhere in the world and the currently low levels of whalewatching. However, no scientific data regarding whalewatching impacts specific to this population has yet been collected.

The single dedicated operator that targets Arabian Sea humpback whales was provided with a week of training by Baldwin, Kaufman and Carlson. The training focused on practical boat handling, interpretation of Oman's whalewatching guidelines, Arabian Sea humpback general biology, ecology and behaviour (including signs of potential disturbance/impacts due to the presence of whalewatching vessels), use of whalewatching vessels as platforms of opportunity for scientific data collection, business approaches and standards, and client interaction and expectation management. To facilitate the collection of data from the whalewatching vessels, a Canon digital SLR camera was donated to the single operator, with the aim of receiving photographs suitable for ongoing photo-identification studies in Oman.

Based on existing guidelines which were published in 2013 with the support of the IWC Scientific Committee, draft national regulations for whalewatching in Oman have been prepared in collaboration with Oman's Ministry of Environment and Climate Affairs. Those guidelines have been submitted for internal government review. Further steps will include development of a road map of actions for stakeholders towards a more sustainable whalewatching industry to be delivered at a future workshop.

The authors made six key recommendations.

(1) Apply precaution by limiting whalewatching on Arabian Sea humpback whales to current levels until dedicated research on the effects of whalewatching can be conducted (including taking advantage of available cliff top observations points at the Hallaniyat Islands).
(2) Provide further specific training to operators on the subject of sustainable business planning and development, as well as field training on practical boat handling for vessel captains.
(3) Encourage government offices to finalise and ratify legislation for whalewatching in Oman and more fully engage government stakeholders in the sustainable development of the industry.
(4) Use whalewatching operations as platforms of opportunities for collection of scientific data.
(5) Estimate carrying capacity of whalewatching in locations where the activity is on-going or likely to emerge in Oman. This may also require further information from on-going scientific research, for example to define critical habitats, and calving and calf survival rates.
(6) Apply lessons learned to other target species. Priorities include Indo-pacific humpback dolphins in Musandam and Dhofar, spinner dolphins and long-beaked common dolphins in Muscat, sperm whales in Dhofar and Muscat, and bottlenose dolphins at Hasik/Ras Nuss, Dhofar.

The sub-committee welcomed this update on the whalewatching activities in Oman targeting endangered Arabian Sea humpback whales and noted the substantial progress. That progress was responsive to previous requests and recommendations made by the Scientific Committee (IWC, 2016a, p.68; 2017, p.395). It also expressed appreciation to the Commission for providing funding for the initiatives described in the update. The sub-committee **agreed** that the update was highly relevant to the work of the Conservation Committee and **recommended** that it be forwarded to the Standing Working Group on Whalewatching. The sub-committee also **strongly endorsed** the authors' key recommendations and **agreed** that this area and species should be included in the upcoming MAWI workshop.

Baldwin was asked whether dolphin-watching operators were likely to shift to humpbacks. It was noted that the industry in the region has remained relatively consistent in its practices for the past decade. Unfortunately that includes operators not adopting many of the best practices communicated during past training workshops and other outreach, but also includes not shifting to other species or increasing vessel size. Nevertheless, it was noted that more tourists interested in viewing humpbacks should be expected, as the endangered status of this population becomes more widely known and dedicated whalewatchers seek to add these whales to their 'life list'. Those familiar with the region observed that the most likely reason for many operators 'harassing' cetaceans was ignorance rather than disregard and the deliberate involvement of the whalewatching community in the current development of management proposals was key to improving the situation. However, it was also suggested that limiting the number of operators through regulation might become necessary, as the most effective current way to mitigate impacts on cetaceans. A final point was that this region could be suitable for developing methods to assess cumulative impacts from anthropogenic activities on an endangered population of large whales.

3. CONSIDER INFORMATION FROM PLATFORMS OF OPPORTUNITY OF POTENTIAL VALUE TO THE SCIENTIFIC COMMITTEE

3.1 Provide advice and recommended practice

SC/67a/WW07 reported on one year of cetacean sighting data from Maui, Hawaii, USA, in order to demonstrate the capabilities of the 'Whale and Dolphin Tracker' application. Six species were sighted from one company's eco-tour vessels for a total of 4,649 encounters. These data provide valuable information on distribution of sightings at a scale impossible to achieve from a single research platform. Updates to the application itself were described, including an improved live sightings map and an upcoming smartphone application release. Whale and Dolphin Tracker is scalable and will likely encourage collaboration among research groups, as well as between researchers and citizen scientists.

In discussion, it was clarified that only dedicated, trained observers were using Whale and Dolphin Tracker during these trips; no data from citizen scientists were collected. However, eventually Whale and Dolphin Tracker could be used by citizen scientists, but appropriate caveats, such as the possible misidentification of species, would need to be considered. Nevertheless, it was noted that the principal advantage of this application over line transect surveys is that there will be a far greater number of observer-hours, which will result in a greater number of detections of more species inhabiting a large, mixed-species area.

4. FIVE YEAR STRATEGIC PLAN AND JOINT WORK WITH THE CONSERVATION COMMITTEE

4.1 Develop procedures to provide scientific advice as requested in the plan (including the online handbook) and make the Scientific Committee more effective at providing information to the Commission

4.1.1 Addressing management within the Scientific Committee and synergy with the Conservation Committee

The IWC passed Resolutions 1993-9 (IWC, 1993) and 1994-14 (IWC, 1995), generally directing Member States to submit information on whalewatching. With Resolution

1996-2 (IWC, 1997a), it directed the Scientific Committee to begin examining whalewatching and its impacts. Over the next few years, the Commission and Scientific Committee received whalewatching information somewhat on an *ad hoc* basis – only a few papers were submitted each year and the work of the Scientific Committee relied mainly on outside reports. The first full report (from the whalewatching working group when it was not yet a sub-committee) was from SC/48 in 1996 (IWC, 1997b). At SC/49 in 1997, most whalewatching information was presented as 'O' papers; only one paper had the WW designation. The first report from the sub-committee was from SC/50 in 1998 (in Oman), as Annex J of the Scientific Committee report (published in 1999 in the first Supplement of the *Journal of Cetacean Research and Management* – IWC, 1999b).

Early Terms of Reference for the sub-committee were described at SC/50 (IWC, 1999a, p.5). The sub-committee was to examine:

(1) scientific protocols for research on the effects of whalewatching;
(2) the scientific basis for management;
(3) research on the effectiveness of management; and
(4) criteria for selection of suitable areas for long-term studies on the effects of whalewatching on cetaceans.

Therefore, it is clear that the sub-committee was intended to address the scientific basis for management and to pursue research on the effectiveness of management (e.g. mitigation measures) from its inception.

Despite this, several long-time members of the sub-committee noted that in the past, it was actively discouraged from presenting results of studies focusing on management, compliance or enforcement. Based on these original terms of reference, however, it seems clear that science-related aspects of these topics are well within the remit of the sub-committee. There has also been the suggestion of shifting management-related topics to the Conservation Committee, with the long-standing sub-committee agenda item on addressing whalewatching regulations and guidelines omitted from this year's agenda (see Strategic Plan, Appendix 1).

Several members of the sub-committee have expressed concern with prematurely shifting management-related topics from the sub-committee to the Conservation Committee Standing Working Group on Whalewatching, before the latter has capacity to address these topics. The Conservation Committee has the necessary membership to address policy, but lacks broad expertise in natural science. More significantly, it meets for very brief periods (often just half a day) once every two years to discuss its agenda. The Conservation Committee may soon transition to annual, multi-day meetings and might also in the future expand its membership and composition and conduct more work intersessionally. At present it is limited in time and expertise when addressing certain topics, such as the impacts on cetaceans from whalewatching due to ineffective guidelines, regulations, or enforcement, and the science underpinning those guidelines and regulations. These topics can and should, in the meantime, continue to be addressed by this sub-committee, especially given its historic Terms of Reference. These topics might also be addressed in joint (Conservation Committee/Scientific Committee) intersessional workshops or 'pre-meetings' before the annual Scientific Committee meeting (see below).

Both the Committee and sub-committee Chairs concurred that topics related to the science of whalewatching, including assessments of the effectiveness of mitigation measures, can and should be addressed by the sub-committee and encouraged sub-committee members to move forward in pursuit of research on these topics, to identify experts from outside the Scientific Committee and invite them to present their research results at the annual Scientific Committee meetings. It was noted that this is the approach used in other sub-committees; for example, if research on the effectiveness of management and mitigation during seismic surveys is lacking within the Scientific Committee, outside experts would be invited to present their work. Therefore it is not only reasonable but essential for the sub-committee to pursue such studies for whalewatching and bring in outside experts to assist. The results of these studies can then be communicated to the Conservation Committee, which has the ability to carry forward any decisions or recommendations on management implementation with Member States.

Some issues and studies addressing management and mitigation of impacts of whalewatching will be solidly within the realm of social science because whalewatching involves people. Therefore, the sub-committee **recommended** pursuing periodic joint intersessional workshops with the Conservation Committee Standing Working Group on Whalewatching, to which social scientists would be invited to participate in discussions about relevant topics. The sub-committee **agreed** to begin planning and pursuing an initial workshop of this nature within two years.

It was emphasised that a valuable application of the sub-committee's expertise would be, *inter alia*, to assess and ground-truth global guidelines and regulations, which are often precautionary and without direct empirical basis. Such a compilation could help managers tailor guidelines or regulations for each target species and habitat. Many management regimes are based on information that is specific for one species or area, and it may be that what works for one species does not work for another. The Conservation Committee might be able to use the work of the sub-committee to help recommend and facilitate needed adjustments to management regimes.

4.1.2 Next iteration of the Conservation Committee's Five Year Strategic Plan for Whalewatching

SC/67a/WW01 and the Vice-chair of the Conservation Committee presented an update on the Five Year Strategic Plan for Whalewatching. The Conservation Committee's Standing Working Group on Whalewatching developed this Strategic Plan to cover the period 2011-16. When it was developed, some core principles were considered:

(1) the IWC should play an advisory role, with management responsibility remaining with national governments or their subsidiaries;
(2) the Strategic Plan should recognise that local issues require local solutions;
(3) the Strategic Plan should help facilitate responsible whalewatching practises; and
(4) the Strategic Plan should be a resource for industry, governments, and stakeholders.

The Strategic Plan has five equally important objectives: (1) Research; (2) Assessment (Monitoring); (3) Capacity Building; (4) Development; and (5) Management. Within the framework provided by these objectives, the Strategic Plan identifies a suite of short and medium-term actions, time lines and responsible parties, which are summarised in Appendix I of the first Five Year Strategic Plan (*https://iwc.int/whalewatching*). The Scientific Committee is identified as being a responsible party for addressing the objectives of Research, Assessment, Capacity Building and Management.

These key elements would assist countries, communities and stakeholders in building and maintaining responsible whalewatching industries, supported by the IWC's guiding principles for whalewatching. These principles include managing the overall development of whalewatching to minimise the risk of adverse impacts to cetaceans and conducting whalewatching activities in such a way that the natural behaviour of the targeted cetaceans is not adversely impeded.

The original time period for the Strategic Plan closed last year. At IWC/66, the Commission agreed to develop a revised Strategic Plan for the period 2018-24, building on and replacing the existing 2011-16 Strategic Plan, and asked the sub-committee to review the existing Strategic Plan and provide advice on whether these actions remain valid or require revision or additions.

Initial discussion considered whether the objectives and actions of the Strategic Plan should be changed or updated. It was emphasised that several of the plan's actions, including some that were not already associated with the sub-committee, were clearly within its remit. To adequately review and comment on the Strategic Plan, the sub-committee concluded that an intersessional or pre-meeting would be needed. The revision to the plan appears imminent and any feedback from the sub-committee should happen soon. It was suggested that a joint intersessional meeting of 2-3 days' duration, with results to be presented at SC/67b, would be able to produce structured, specific recommendations for the Strategic Plan for full sub-committee consideration. These recommendations could then be forwarded to the Conservation Committee as it pursues an update of its Strategic Plan. A focused, dedicated process, which could also identify gaps in the current plan and offer suggestions for filling them, might be the best way forward to produce timely and constructive recommendations and advice from the sub-committee, while still leaving the Strategic Plan's revision process squarely within the hands of the Conservation Committee. There was an urgent suggestion that this process be expedited as much as possible, as the process of producing a new Strategic Plan and especially the Whalewatching Handbook (see next Item) has been slow.

The sub-committee **recommended** that a joint intersessional meeting be organised and funded well in advance of SC/67b, with the participants drawn from the sub-committee and the Standing Working Group on Whalewatching, to discuss and draft structured and specific recommendations and advice on any revisions for the 2018-24 Five Year Strategic Plan for Whalewatching. These draft recommendations would then be presented at SC/67b and approved by the sub-committee and SC, and submitted to the Joint Meeting of the Conservation and Scientific Committees to be held directly after SC/67b. The sub-committee **agreed** that a pro forma request for funding for this meeting would be prepared and submitted to the Secretariat.

4.1.3 Online Whalewatching Handbook

SC/67a/WW01 and the Vice-chair of the Conservation Committee provided an update on development of the online Whalewatching Handbook. The online 'living' Handbook is to be placed on the IWC website. The Handbook will provide advice on governance, capacity building, monitoring, compliance, business, community and education/training/ communication. It will also identify, on a regional basis, examples of demonstrated best practice within the whalewatching sector.

The Commission endorsed a series of recommendations from the Conservation Committee's Standing Working Group on Whalewatching at IWC/66, including to secure a dedicated individual to complete the Handbook by the 2018 Commission meeting (IWC/67). In February 2017, funding was secured to complete the Handbook through voluntary contributions from the UK and USA, and an offer came from the Convention on Migratory Species to translate the Handbook into French and Spanish.

The recruitment process attracted a large, diverse and high quality field (23 applications from individuals, groups and consultancies) and used a set of agreed competences, weighted according to importance, to assess applications. The successful candidate was Gianna Minton, a member of the sub-committee. The project is a big task with a tight timeframe. Detailed planning is now underway and support from the sub-committee will be crucial to its success.

There are now a number of requests to the sub-committee to support development of the Handbook. These include:

(1) provide advice on the relevant material to include in the Handbook;
(2) identify experts, including from industry, to directly contribute to the Handbook;
(3) provide photos for use in the Handbook (thanks to Ritter and Parsons, who have already provided several);
(4) review and comment on the content of the Handbook once completed; and
(5) provide support, and promote and disseminate the Handbook.

4.1.4 Voluntary Conservation Fund

There was discussion about funding whalewatching initiatives, including intersessional workshops and meetings, directed research responsive to the sub-committee agenda and the attendance of invited participants. It was noted that the funds for invited participants are available equally to all sub-committees and working groups and requests for funding for experts to attend the sub-committee should be made every year. As for directed research, the Commission has recently established the Voluntary Conservation Fund, to which, *inter alia*, whalewatching researchers could apply for research funding. In addition, any entities or Member States that would like to support whalewatching research can contribute to this fund.

The late Carole Carlson once said 'It is my goal to encourage and facilitate a continued legacy of innovative education, outreach and research in a collective effort to promote the protection and conservation of cetaceans and marine environments for future generations'.

In her memory, to help enshrine her legacy and in recognition of Carole's long and important association with whalewatching work at the IWC, the sub-committee **strongly recommends** the establishment of the 'Carole Carlson Memorial Whalewatching Fund'. The fund would be used to support research, education and outreach in the context of whalewatching activities and aimed at ensuring that whalewatching is sustainable, educational and humane. The fund would be administered by the Secretariat, with the Sub-committee on Whalewatching acting in an advisory capacity.

4.1.5 Invited Participants

The discussion recalled that one reason the annual digest of whalewatching research (Parsons *et al.*, 2004; SC/67a/WW05) was instituted was because the sub-committee has rarely received funding for invited participants. The digest was meant to inform the sub-committee of recent research on whalewatching relevant to its agenda without bringing invited participants to the meeting. However, the digest could also be used as a tool to identify potential invited participants. It was suggested that the sub-committee be more active in future in soliciting the participation of whalewatching researchers. The Commission has prioritised whalewatching and therefore funding for invited participants essential to the work of the sub-committee may become more available. Regardless, the digest could continue to be prepared and be made available to the Conservation Committee, where it would be very useful in keeping its members informed of studies taking place within the wider whalewatching research community.

4.1.6. Terms of Reference for the sub-committee
At SC/66b, the sub-committee agreed it would seek to enhance its capacity to address scientific and technical aspects of whalewatching and closely coordinate and cooperate with the Conservation Committee and its Standing Working Group on Whalewatching, including through the Joint Conservation Committee and Scientific Committee Working Group. The sub-committee concluded that its Terms of Reference (ToR) should be reviewed, clarified and aligned more directly to the objectives and actions of the Conservation Committee's Strategic Plan for Whalewatching. This process would also aid in clearly distinguishing the roles and responsibilities of the two groups.

The following draft ToR for the sub-committee align with the Strategic Plan (SP). The sub-committee proposed to seek comment from the full Scientific Committee and then forward these to the Conservation Committee for their review and comment.

(1) Review and suggest scientific studies and methods of research on the effects of whalewatching on target species and their habitats to address: [SP Action 1.1]
    (a) population-level effects including impacts on demographic parameters [SP Action 1.3];
    (b) whalewatching vessel strikes (with HIM);
    (c) underwater noise (with E);
    (d) impacts on survival, fitness, and health, including stress effects (with E); and
    (e) impacts on cetacean habitats.
(2) Review and suggest needed research to evaluate the effectiveness of mitigation measures for reducing impacts on cetaceans from whalewatching activities. [SP Action 1.3]
(3) Develop scientific monitoring protocols that maximise the identification of adverse impacts to cetaceans [SP Actions 2.0 and 5.0], including:
    (a) data collection by whalewatching operators or other platforms of opportunity that could be used to monitor possible impacts from whalewatching activities on cetaceans [SP Action 2.1];
    (b) science-based metrics for impact assessments that could be used to monitor or assess the sustainability of the whalewatching industry in a specific location [SP Action 2.2]; and
    (c) monitoring plans that are cost effective and meet the needs of specific areas [SP Action 5.4].
(4) Support the use of quantitative approaches (e.g. modelling) to help achieve items (1), (2) and (3) of the Terms of Reference. (This is a major component of the existing MAWI project.)
(5) Review and identify suitable areas, to support the development and implementation of research and monitoring protocols for long-term studies on the effects of whalewatching on cetaceans [SP Action 1.3 and 2].
(6) Identify areas that are data deficient or have cetacean populations of concern that may be subject to impacts from whalewatching and provide advice to the Conservation Committee on mitigation measures that may be necessary to help conserve such populations [SP Actions 1.2 and 3.2].
(7) Consider information from whalewatching platforms of opportunity of potential value to the Scientific Committee.
(8) Develop synergies with the Conservation Committee to enhance communication and collaboration on areas of overlap.

In discussion, it was noted that, if adopted, these draft ToR would create a substantial workload for the sub-committee. One way to focus discussions at annual meetings would be to deal only with a subset of these each year, similar to the way the Sub-Committee on Small Cetaceans or the Standing Working Group on Environmental Concerns handle their expansive agendas. Priorities to be addressed intersessionally or at subsequent meetings would be determined when developing the work plan at the end of each sub-committee meeting. Another idea would be to form the work plan around the four Terms of Reference from SC/50, identified in Item 4.1.1, keeping the broader final ToR in mind. Clearly to finalise these draft ToR, work must be done intersessionally and at next year's meeting. The draft ToR above are a good starting point for those intersessional discussions, which could fit into the agenda of the joint intersessional meeting proposed in Item 4.1.2. The first step would be to present these draft ToR to the Scientific Committee for comment and the second to send them to the Joint Meeting of the Conservation and Scientific Committees, which is scheduled for 22 May, for consideration within the context of the 2018-24 Strategic Plan for Whalewatching. Finalisation of the ToR would not occur until at least 2018.

Finally, it was pointed out that the interchange between the sub-committee and the Standing Working Group on Whalewatching of the Conservation Committee is a positive example of building collaborations and synergies between the two committees.

The sub-committee **agreed** to seek comment from the Scientific Committee and the Joint Meeting of the Conservation and Scientific Committees on the draft ToR.

5. REVIEW REPORTS FROM INTERSESSIONAL CORRESPONDENCE GROUPS

5.1 Swim-with-whale operations
Rose provided an update on the intersessional correspondence group. The group had suggested that additional data on the capacity of swim-with-whale operations globally should be collected, as a follow-up to the IWC questionnaire-based survey on swim-with-whale operations, due to the initial survey's low return (Gero *et al.*, 2016). The intersessional group could work with the Conservation Committee to contact the ministries/secretaries of tourism or environment in each Member State. The IWC Secretariat also has an email list for all Commissioners and could assist in increasing questionnaire returns by contacting them with a request for assistance.

In discussion, it was noted that the Convention on Migratory Species (CMS) is doing a review of swim-with-marine life tourism and this will include swim-with-whale operations. This review will consider how such activities may disrupt species behaviour, biology and ecology. The sub-committee looks forward to hearing a report from that forum at a future meeting and suggested that the intersessional group should contact the CMS Secretariat to request assistance in collecting additional information on swim-with-whale operations. The same suggestion was made regarding contacting the Secretariats of IORA and ACCOBAMS; the latter also has a whalewatching working group. The intersessional group will pursue these contacts, with assistance from the IWC Secretariat, and will report back on any additional questionnaire results at SC/67b.

The intersessional group also reported on a survey currently being conducted by the World Cetacean Alliance (WCA), which also focuses on swim-with-whale tours. The WCA survey has been disseminated online and thus is open to virtually anyone to respond. In general, given the phrasing of questions, it would be difficult for a survey respondent to express concerns or negative views of this activity. The WCA did ask respondents for contact information, which might enable the intersessional group to identify interested parties willing to discuss these issues. The intersessional group will follow-up with the WCA to learn the results of its survey and discuss contacting respondents.

The intersessional group also considered how and where new field studies might be initiated to evaluate the short- and long-term impact of swim-with-whale operations on the behaviour of the target species. Dominica, where some whalewatching operations target sperm whales, was considered, as there is an active whalewatching industry, swim-with activity is just beginning, and researchers are in place so a project could be initiated quickly. Land-based studies would be preferred, using theodolites, drones and other remote technologies. Proposed study goals could include determining impacts on individuals, groups, and populations of targeted species and their habitat; risks for swimmers and target species; and nature (and impact) of swim-with interactions.

Several research funding sources were considered. Possible sources include the Committee's general research funds; development of a specific fund for whalewatching, similar to the research fund for small cetaceans; the Commission's Voluntary Conservation Fund; and the Global Environment Facility (*http://www.theGEF.org*), under their Healthy Oceans and Wildlife for Sustainable Development focuses. Whalewatching operators themselves could also be a funding source.

In discussion, it was noted that the Dominica industry targets sperm whales, which are not typical species for swim-with operations for large whales (humpbacks are a more common target). Therefore, it might be better to focus on potential research sites and projects where humpbacks are targeted, as it may not be possible to extrapolate sperm whale reactions to mysticetes. It was noted that the governments of Australia and New Zealand include whalewatching activities in their national progress reports. They should be approached directly to provide any available information on swim-with activities within their jurisdictions. It was suggested that every effort should be made to identify relevant government contacts, as they are more likely to respond with the requested information than a higher level ministry official.

In addition, it was noted that new permits are being issued for swim-with activity in Hervey Bay, Australia, and this makes it an ideal location to conduct swim-with impacts research, as the activity is new and baseline data can be collected. Kaufman reported that his research team has been issued a research permit to study whale reactions to swimmers and will report initial results as soon as possible, most likely in 2019 (SC/68a). Other projects could be pursued in this location and the Australian government may have some funding available.

It was noted that MAWI should also consider research on impacts from swim-with-whale activities in its discussions and planning.

The sub-committee **agreed** to elevate the topic of swimming with large whales to an agenda item for SC/67b (see Item 7, Work Plan). It also **agreed** to continue the intersessional correspondence group to pursue updates on: (1) efforts to increase the response to the IWC questionnaire survey; (2) the WCA survey; and (3) progress on field research on the impacts of swim-with activities on large whales from sites in Australia. The sub-committee **recommended** that funding be made available from the Voluntary Conservation Fund for pursuing well-designed impact studies by qualified researchers on swim-with-whale programmes. Finally, the sub-committee **agreed** to work closely with Gianna Minton, who has been contracted to work on the IWC's online Whalewatching Handbook, to ensure all IWC outreach efforts to whalewatching operators and other parties regarding the questionnaire survey or other swim-with inquiries are coordinated.

5.2 Communication with the Indian Ocean Rim Association (IORA)

Simmonds provided an update on the Indian Ocean Rim Association (IORA) whalewatching network initiative (previously discussed at SC/66b). In February 2016, a Workshop was conducted in Sri Lanka to build sustainable whale and dolphin watching in the Indian Ocean region. The Workshop was organised by a partnership amongst the Australian and Sri Lankan Governments, the IORA Secretariat, the IWC Secretariat and Murdoch University's Cetacean Research Unit. Workshop participants called for the establishment of an IORA sustainable whale and dolphin watching tourism network. The purpose of the network is to foster regional cooperation on sustainable whale and dolphin watching tourism, including through sharing information about best practices, capacity building and providing access to expertise.

At the meeting of IORA in October last year, ministers from IORA member countries endorsed the establishment of a tourism network about sustainable whale and dolphin watching. At IWC/66, the Commission welcomed work undertaken in collaboration with the IORA Secretariat and others to conduct the February 2016 workshop. The Commission also endorsed recommendations that the IWC support the IORA network by sharing information and expertise, providing capacity building and training, providing guidelines of best practices and other IWC resources, seeking to engage through scientific and technical cooperation, and, where appropriate, seeking funding to support sustainable whalewatching in the IORA region.

Simmonds noted that now that the network has been formally established, the Scientific Committee and its sub-committees should give consideration to how to support it and notes that this would be discussed further at the Joint CC/SC Working Group meeting at the end of SC/67a.

In discussion, it was noted that many members of IORA are not members of the IWC, making communication and linkages more challenging. The Secretariat noted the importance of this regional effort and will continue to work to improve linkages and synergy between IORA and the IWC, especially within the Conservation Committee, which currently does not have liaising with IORA on its agenda. It was noted that scientists participating in the IORA effort should be invited to participate in the sub-committee. In addition, the convenorship of the intersessional advisory group should transfer to someone on the sub-committee from the region, to improve coordination and communication with the sub-committee. Sarah Ferriss of the Secretariat volunteered in the interim to serve as Convenor (see Annex W). Regarding the tourism network, regional representatives believe that, as the network gains experience, sightings data reported to the Scientific Committee will improve.

5.3 ACCOBAMS

Under ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area), several resolutions and actions dealing with whalewatching activities have been approved in recent years. These include the following.

(1) Approval and implementation of Guidelines on Commercial Cetacean Watching in the ACCOBAMS Area.
(2) Creation of a 'High Quality Whale-Watching®' Certificate and associated regulations governing the use of this Certificate by whalewatching operators.
(3) Adoption of the Guidelines for Monitoring Programmes aimed at maximising the chance of detecting potential adverse impacts of whalewatching activities on individual cetaceans and on populations, as developed by the IWC Scientific Committee's Sub-Committee on Whalewatching. (If necessary, and in close cooperation with this sub-committee, these guidelines will be subject to revision.)
(4) Adoption of the common procedure (data collection system) developed by the IWC Scientific Committee's Sub-Committee on Whalewatching. This data collection form will be tested in three pilot areas (the Liguro-Provençal Basin, Gibraltar Strait, and south Portugal) with a variety of operation types. It is expected that preliminary results will be available in time for SC/67b.

A closer cooperation between ACCOBAMS and the sub-committee is expected to be developed in the near future. The sub-committee welcomed this update and especially the news that its data collection form is being used in ACCOBAMS projects.

6. REVIEW PROGRESS ON SCIENTIFIC RECOMMENDATIONS

6.1 Update on dolphin-watching in Bocas del Toro, Panama

Iñíguez presented an update on dolphin-watching in Bocas del Toro, Panama. In 2015, May-Collado and her colleagues initiated a number of projects to evaluate the population status of the common bottlenose dolphins (*Tursiops truncatus*) in Bocas del Toro, and the impact of boat traffic associated with dolphin-watching activities on the dolphins' behaviour and communication (Barragán-Barrera *et al.*, 2015; Kassamali-Fox *et al.*, 2015; Lasso and May-Collado, 2015; May-Collado, 2015; May-Collado *et al.*, 2015a; 2015b; May-Collado and Wartzok, 2015; Sitar *et al.*, 2015a; 2015b; 2015c; 2015d). Their goal was to use multiple lines of evidence to propose a change in the conservation status of this population at the national level.

May-Collado's team initiated skin biopsy collection in 2015 to evaluate the presence of contaminants and monitor stress levels, and to learn about the dolphins' diet using stable isotopes. The results of this work will be presented at SC/67b. In addition, using 13 years of data, they are working on population viability analyses and spatial analyses that can help determine if there have been changes in the dolphins' habitat use over this period.

Regarding management, May-Collado *et al.* (2015b) described a plan, with input from local community members, researchers and boat captains, to build a 'Dolphin Museum' at the main point of entrance to Dolphin Bay, as a control point and information/educational centre. The proposal was approved by the Tourism Authority, which is also providing funds for construction. In addition, the new Ministry of the Environment, along with PNUD-GEF, have funded two independent assessments to identify community needs and to propose strategies for improving dolphin-watching.

In addition, some further issues have been identified that need to be addressed: updating the national whalewatching regulation ADM/ARAP No.01 (2007); evaluating the socio-economic status of the surrounding communities involved in dolphin-watching and the contribution dolphin-watching activities make to their economy; and identifying alternatives to this activity, to diversify tourism offerings. Since SC/66a, the Panama government has been more responsive, with several agencies showing commitment to protecting the local dolphin population by providing resources and engaging in discussions of how best to protect the Bocas dolphins, e.g. by minimising negative impacts from dolphin-watching. With support from SENACYT, training efforts will continue this year, as a follow-up to a three-month workshop series in 2015.

In discussion, concern was expressed regarding the impact the 'Dolphin Museum', with its location at the main point of entrance to Dolphin Bay, might have on tourist behaviour. Previously, tourists tended to stop in Bocas del Toro as one of several stops on an itinerary. Dolphin-watching was somewhat constrained simply because during short visits, tourists might not have time to swim with dolphins. Now, if Dolphin Bay, with a museum, becomes a focal point for a visit, perhaps even more tourists will go dolphin-watching. A location in the centre of town might have been better. Iñíguez responded that the research team intends to work to minimise the potential impact on bottlenose dolphins, but will also communicate these concerns to the researchers.

6.2 Tracking progress on previous recommendations

In previous meetings, the sub-committee identified the need to follow up (and to establish a procedure for doing so) on the implementation, or lack thereof, of the sub-committee's recommendations and advice. At SC/66b, Gleason (2016) reviewed the implementation of previous sub-committee recommendations and the dissemination of the IWC's guiding principles for whalewatching. Gleason (2016) concluded overall that community awareness of the IWC's guiding principles was relatively high and the principles were frequently utilised when developing management regimes, but that communication regarding the sub-committee's work could be improved. The recent inclusion in the sub-committee's agenda of this present Item 6, 'Review progress on scientific recommendations', was an effort to continue and improve tracking of the efficacy of its advice and recommendations. However, the swim-with-dolphin situation with spinner dolphins in Hawaii, USA, was offered as a case study illustrating when recommendations have not been effective. After many years of many governmental and inter-governmental bodies expressing concern about this situation, and with a considerable body of science available to inform management, the harassment situation there, where the public swims with resting dolphins, continues.

Therefore, concern among members of the sub-committee that science-based management recommendations and advice might have no discernible influence remains substantial, despite the conclusions of Gleason (2016).

Table 2

Summary of the work plan for the sub-committee on whalewatching. Many of these items have intersessional correspondence groups (ICG) or an intersessional advisory group (IAG). Those groups will work intersessionally and provide updates at SC/67b (see Annex W).

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Impacts to cetaceans from whalewatching	ICG on swim-with-cetacean	Review new information
Modelling and Assessment of Whalewatching Impacts (MAWI)	MAWI Workshop	Review report from the intersessional Workshop
Collection of cetacean data from platforms of opportunity	-	Review new information
Whalewatching in east Africa and wider Indian Ocean	-	Review available information
Strategic Plan on Whalewatching and whalewatching handbook	Meeting and ICG to conduct reviews	Finalise review and provide recommendations
Emerging issues of concern	ICG on habituation of cetaceans to whalewatching activities	Review new information
Previous recommendations	ICG with Conservation Committee	Update on intersessional work
Provide scientific and technical advice to external organisations, as requested	IAG with Conservation Committee on IORA	Update on intersessional work

The sub-committee **agreed** that it should receive regular updates, at a minimum biennially, on the progress of previous recommendations and the utility of the IWC Guiding Principles on Whalewatching. Parsons volunteered to bring such an update to SC/67b. The Compilation of Worldwide Whalewatching Guidelines and Regulations also needs regular updating. The sub-committee **agreed** to ask the Secretariat about the best way forward for this undertaking.

The sub-committee **agreed** that it should form a joint intersessional correspondence group with the Conservation Committee to discuss and develop better methods for disseminating recommendations and advice on whalewatching. The Conservation Committee could request updates or reports from the relevant governmental authorities on how or whether they have implemented sub-committee recommendations, which would assist the sub-committee in formulating more effective recommendations.

7. WORK PLAN

The sub-committee concluded that its work plan for SC/67b should include a review of possible whalewatching impacts to cetaceans along the east coast of Africa and the wider Indian Ocean, given that Kenya is the proposed location for next year's meeting. It was also suggested that the sub-committee liaise with IORA intersessionally to inform the regional review. In addition, the work plan below reflects certain items in the draft ToR to be emphasised at SC/67b, while those items not on the work plan will return to the agenda at future meetings of the sub-committee, similar to the cycle of emphasis of certain agenda items in the Sub-Committee on Small Cetaceans. The items to be discussed and emphasised at SC/67b are included in the work plan, below. Intersessional correspondence and advisory groups were established for several of the work plan items (see Annex W).

The sub-committee prioritised and **agreed** major items of the work plan as listed below (see Table 2).

(1) Review and suggest scientific studies and methods of research on the effects of whalewatching on target species and their habitats, reviewing: (a) population-level effects including impacts on demographic parameters; (b) whalewatching vessel strikes; (c) underwater noise; (d) impacts on survival, fitness and health, including effects of stress; (e) impacts on cetacean habitats; and (f) swim-with-whale operations. The intersessional correspondence group on swim-with-whale impacts will continue its work.

(2) Review the report and results from the intersessional workshop on the Modelling and Assessment of Whalewatching Impacts (MAWI) project. An intersessional steering group will continue with planning the workshop.

(3) Consider information from platforms of opportunity of potential value to the Scientific Committee.

(4) Review whalewatching in the region of East Africa, with reference to the wider Indian Ocean region.

(5) Review the Conservation Committee's Strategic Plan for Whalewatching and the IWC's draft Whalewatching Handbook. An intersessional meeting is tentatively planned for review of the Strategic Plan and a correspondence group was formed for both of these reviews.

(6) Consider emerging issues of concern (e.g. new areas/species, new technologies, in-water interactions, 'habituation'). An intersessional correspondence group will investigate what is known about 'habituation' of cetaceans to whalewatching activities.

(7) Review progress on previous recommendations. An intersessional correspondence group on communication with the Conservation Committee was formed.

(8) Provision of scientific and technical advice to external bodies that request assistance (i.e. IORA). An intersessional advisory group on communication with IORA will continue.

The sub-committee discussed the work plan and set priorities for the next year as listed.

The sub-committee **agreed** to terms of reference and membership of Intersessional Correspondence, Advisory and Steering Groups as listed in Annex W.

8. ADOPTION OF REPORT

The report was adopted at 17:05hrs on 17 May 2017. The sub-committee thanked Suydam for his helpful guidance during the discussions and Rose for her efficient rapporteuring.

REFERENCES

Ávila, I.C., Correa, L.M. and Van Waerebeek, K. 2017. Where humpback whales and vessel traffic collide, a Colombian case study. *Boletín del Museo Nacional de Historia Natural, Chile* 66: 85-99.

Barragán-Barrera, D.C., May-Collado, L.J., Islas-Villanueva, V. and Caballero, S. 2015. Isolated in the Caribbean: low genetic diversity of bottlenose dolphin population in Bocas del Toro, Caribbean Panama. Paper SC/66a/SM13rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 13pp. [Paper available from the Office of this Journal].

Christiansen, F., McHugh, K.A., Bejder, L., Siegal, E.M., Lusseau, D., McCabe, E.B., Lovewell, G. and Wells, R.S. 2016. Food provisioning increases the risk of injury in a long-lived marine top predator. *Roy. Soc. Open Sci.* 3: 160560.

Cosentino, A.M. 2016. Effects of whale-watching vessels on adult male sperm whales off Andenes, Norway. *Tour. Mar. Environ.* 11(4): 215-27.

Currie, J.J., Stack, S.H., Easterly, S.K., Kaufman, G.D. and Martinez, E. 2015. Modelling whale-vessel encounters: the role of speed in mitigating collisions with humpback whales (*Megaptera novaeangliae*). Paper SC/66a/HIM03 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

Gero, S., Pace, S., Kaufman, G., Parsons, E.C.M., Ritter, F., Sironi, M. and Rose, N.A. 2016. Initial survey of global commercial swim-with-whale operations. Paper SC/66b/WW02 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Gleason, C. 2016. The impacts of the International Whaling Commission's Whalewatching Sub-committee. Paper SC/66b/WW12 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Gleason, C. and Parsons, E.C.M. 2015. An initial review of whalewatching guidelines for endangered and critically endangered cetaceans. Paper SC/66a/WW09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 12pp. [Paper available from the Office of this Journal].

Hazelkorn, R.A., Schulte, B.A. and Cox, T.M. 2016. Persistent effects of begging on common bottlenose dolphin (*Tursiops truncatus*) behavior in an estuarine population. *Aquat. Mamm.* 42(4): 531-41.

Heenehan, H.L., Van Parijs, S.M., Bejder, L., Tyne, J.A. and Johnston, D.W. 2017. Differential effects of human activity on Hawaiian spinner dolphins in their resting bays. *Glob. Ecol. Conserv.* 10: 60-69.

Heiler, H., Elwen, S.H., Kriesell, H.J. and Gridley, T. 2016. Changes in bottlenose dolphin whistle parameters related to vessel presence, surface behaviour and group composition. *Anim. Behav.* 117: 167-77.

International Whaling Commission. 1993. Chairman's Report of the Forty-Fourth Meeting, Appendix 9. Resolution on small cetaceans. *Rep. int. Whal. Comm.* 43:51.

International Whaling Commission. 1995. Chairman's Report of the Forty-Sixth Annual Meeting, Appendix 15, IWC Resolution 1994-14. Resolution on whalewatching. *Rep. int. Whal. Comm.* 45:49-50.

International Whaling Commission. 1997a. Chairman's Report of the Forty-Eighth Annual Meeting, Appendix 2. IWC Resolution 1996-2. Resolution on whalewatching. *Rep. int. Whal. Comm.* 47:48.

International Whaling Commission. 1997b. Report of the Scientific Committee, Annex Q. Report of the whalewatching working group. *Rep. int. Whal. Comm.* 47:250-56.

International Whaling Commission. 1999a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 1:1-52.

International Whaling Commission. 1999b. Report of the Scientific Committee. Annex J. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 1:227-32.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 7:327-32.

International Whaling Commission. 2016a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 17:1-92.

International Whaling Commission. 2016b. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 17:385-98.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex N. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 18:387-97.

Kassamali-Fox, A., Christiansen, F., Quiñones-Lebrón, S.G., Rusk, A., May-Collado, L.J. and Kaplin, B. 2015. Using Markov chains to model the impacts of the dolphin watching industry on the dolphin community of Dolphin Bay, Bocas del Toro, Panama. Paper SC/66a/WW11 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 8pp. [Paper available from the Office of this Journal].

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. 2001. Collisions between ships and whales. *Mar. Mamm. Sci.* 17(1): 35-75.

Lasso, L.T. and May-Collado, L.J. 2015. Bottlenose dolphins *Tursiops truncatus* strandings in Bocas del Toro caused by boat strikes and fishing entanglement. Paper SC/66a/WW07 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 6pp. [Paper available from the Office of this Journal].

May-Collado, L.J. 2015. The acoustic behaviour of Bocas del Toro dolphins varies with watercraft activity. Paper SC/66a/WW06 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 4pp. [Paper available from the Office of this Journal].

May-Collado, L.J., Quiñones-Lebrón, S.G., Barragán-Barrera, D.C., Palacios, J.D., Gamboa-Poveda, M. and Kassamali-Fox, A. 2015a. The Bocas del Toro's dolphin watching industry relies on a small community of bottlenose dolphins: implications for management. Paper SC/66a/WW10rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 6pp. [Paper available from the Office of this Journal].

May-Collado, L.J., Trejos, L., Perez, B., Gamboa-Poveda, M., Casas, J.J., Jacome, G. and Gonzalez, A. 2015b. Panacetacea efforts for a participatory conservation planning of the dolphin watching industry in Bocas del Toro, Panama. Paper SC/66a/WW01rev4 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 7pp. [Paper available from the Office of this Journal].

May-Collado, L.J. and Wartzok, D. 2015. The effect of dolphin watching boat noise levels on the whistle acoustic structure of dolphins in Bocas del Toro, Panama. Paper SC/66a/WW05 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 4pp. [Paper available from the Office of this Journal].

Noren, D.P., Holt, M.M., Dunkin, R.C., Thometz, N.M. and Williams, T.M. 2016. Comparative and cumulative energetic costs of odontocete responses to anthropogenic disturbance. *Proc. Meet. Acoust.* 27(040011): 1-12.

Pagel, C.D., Scheer, M. and Lück, M. 2016. Swim encounters with killer whales (*Orcinus orca*) off Northern Norway: interactive behaviours directed towards human divers and snorkellers obtained from opportunistic underwater video recordings. *J. Ecotour.* doi: 10.1080/14724049.2016.1273939.

Parsons, E.C.M., Classen, J.M. and Bauer, A. 2004. Recent advances in whale-watching research. Paper SC/56/WW6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 13pp. [Paper available from the Office of this Journal].

Pérez-Jorge, S., Louzao, M., Daniel Oro, D., Pereira, T., Corne, C., Wijtten, Z., Gomes, I., Wambua, J. and Christansen, F. 2017. Estimating the cumulative effects of the nature-based tourism in a coastal dolphin population from southern Kenya. *Deep-Sea Res. II.* 140: 278-289.

Rossi-Santos, M.R. 2016. Whale-watching noise effects on the behavior of humpback whales (*Megaptera novaeangliae*) in the Brazilian breeding ground. *Proc. Meet. Acoust.* 27(040003): 1-11.

Seuront, L. and Cribb, N. In press. Fractal analysis provides new insights into the complexity of marine mammal behavior: A review, two methods, their application to diving and surfacing patterns, and their relevance to marine mammal welfare assessment. *Mar. Mamm. Sci.*

Sitar, A., May-Collado, L.J., Wright, A., Peters-Burton, E., Rockwood, L. and Parsons, E.C.M. 2015a. Tourists' perspectives on dolphinwatching in Bocas del Toro, Panama, support sustainable and educational tourism. Paper SC/66a/WW15 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 40pp. [Paper available from the Office of this Journal].

Sitar, A., May-Collado, L.J., Wright, A.J., Peters-Burton, E., Rockwood, L. and Parsons, E.C.M. 2015b. The effects of whalewatching vessels on the behaviour of common bottlenose dolphins (*Tursiops truncatus*) in Bocas del Toro, Panama. Paper SC/66a/WW12 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 34pp. [Paper available from the Office of this Journal].

Sitar, A., May-Collado, L.J., Wright, A.J., Peters-Burton, E., Rockwood, L. and Parsons, E.C.M. 2015c. Low levels of compliance with national whalewatching regulations in dolphinwatching boat operators in Bocas del Toro, Panama. Paper SC/66a/WW14 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 28pp. [Paper available from the Office of this Journal].

Sitar, A., May-Collado, L.J., Wright, A.J., Peters-Burton, E., Rockwood, L. and Parsons, E.C.M. 2015d. Opinions and perspectives of the dolphinwatching boat operators in Bocas del Toro, Panama. Paper SC/66a/WW16 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 30pp. [Paper available from the Office of this Journal].

Tyne, J.A., Johnston, D.W., Christiansen, F. and Bejder, L. 2017. Temporally and spatially partitioned behaviours of spinner dolphins: implications for resilience to human disturbance. *Roy. Soc. Open Sci.* 4: 160626.

Vail, C.S. 2016. An overview of increasing incidents of bottlenose dolphin harassment in the gulf of Mexico and possible solutons. *Front. Mar. Sci.* 3(110). doi: 10.3389/fmars.2016.00110.

Appendix 1

AGENDA

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Review of available documents
2. Assess the impacts of whalewatching on cetaceans
   - 2.1 Review work plan on Modelling and Assessment of Whalewatching Impact (MAWI)
   - 2.2 Review specific papers addressing impacts
   - 2.3 Consider documented emerging areas of concern (e.g. new areas/species, new technologies, in-water interactions) and how to assess them
3. Consider information from platforms of opportunity of potential value to the Scientific Committee
   - 3.1 Provide advice and recommended practice
4. 5-year strategic plan and joint work with the Conservation Committee
   - 4.1 Develop procedures to provide scientific advice as requested in the plan (including the online handbook) and make the SC more effective at providing information to the Commission
5. Review reports from intersessional working groups
   - 5.1 Swim-with-whale operations
   - 5.2 Communication with the Indian Ocean Rim Association (IORA)
6. Review progress on scientific recommendations
7. Work plan
8. Adoption of Report

Annex O

Report of the Sub-Committee on Cetacean Stocks That Are or Might Be the Subject of Conservation Management Plans (CMPs)

Members: Walløe (co-Convenor), Urbán-Ramirez (co-Convenor), Al Jabri, Arguedas, Baker, Baldwin, Bell, Bjørge, Bickham, Brandão, Brockington, Brownell, Burkhardt, Collins, Cooke, Crespo, de Freitas, de la Mare, Doherty, Donovan, Double, Enmynkau, Ferris, Fortuna, Frey, Fruet, Funahashi, Galletti Vernazzani, Gonzalez, Greig, Haug, Herr, Holm, Hubbell, Iñíguez, Isoda, Jackson, Jelić, Johnson, Kato, Kim, Konan, Lang, Langerock, Lauriano, Leaper, Lee, Leslie, A., Leslie, M., Litovka, Long, Lovell, Lundquist, Mallette, Mattila, Minton, Morita, H., Morita, Y., Moronuki, Nakamura, Nelson, Øien, Palka, Panigada, Parsons, Pierce, Punt, Redfern, Reeves, R., Reeves, S., Rendell, Reyes, Robbins, Rojas-Bracho, Rose, Rosel, Rosenbaum, Rowles, Santos, Scordino, Simmonds, Slugina, Stachowitsch, Stimmelmayr, Strbenac, Suydam, Sutaria, Thomas, Van Waerebeek, Vermeulen, Wade, Weinrich, Weller, Willson, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Walløe welcomed the participants. This is a new sub-committee this year. It will consider stocks (with a focus on progress with scientific work and information) that are:

(1) the subject of existing CMPs; or
(2) high priority candidates for a CMP.

It will also consider stocks that have previously been considered as potential CMPs, recognising that the Commission has stressed the need for Range States to support any IWC CMPs. Items related to the stock structure and abundance of these stocks are considered by the sub-groups on SD&DNA and ASI.

1.2 Election of Chair and Co-Chair

Walløe was elected Chair and Urbán-Ramirez was elected co-Chair.

1.3 Appointment of rapporteurs

Johnson was appointed to act as rapporteur.

1.4 Adoption of Agenda

The adopted agenda is given as Appendix 1.

1.5 Review of available documents

The documents available for discussion by the sub-committee included SC/67a/CMP01-03, SC/67a/CMP05-15, SC/67a/HIM14, SC/67a/HIM17, SC/67a/Rep04, SC/67a/NH03, SC/67a/NH11, SC/67a/SM04, SC/67a/SM12, SC/A17/GW07 and Gagnon (2016).

2. STOCKS FOR WHICH CMPS ARE IN PLACE

2.1 Southeast Pacific southern right whales

2.1.1 New information

SC/67a/HIM14 presented information on the entanglement and stranding of a southern right whale in February 2017 in southern Chile (for details see Annex J). The whale was first seen alive with clear scars caused by entanglement in fishing gear and a large number of cyamids with an abnormal distribution. Ten days later, the carcass stranded and was examined, where examiners concluded that although no ropes or nets were found on its body, the pattern of the marks observed suggested that the whale had been entangled and this was among the main factors causing its death. This is the third entanglement reported in Chile since 1986 and the second in the last two and a half years raising concerns about the negative impacts of entanglement to the recovery of this endangered population. The authors suggested that actions are needed to prevent further entanglements.

The sub-committee **reiterated** its previous advice that efforts should be made to avoid anthropogenic mortality for this stock, noting that this was a priority action for the CMP (see below).

SC/67a/CMP13 reported on progress made between December 2016 to April 2017 on the acoustic monitoring of eastern south Pacific southern right whales, first discussed in Suydam *et al.* (2016). The project, supported by the IWC Scientific Committee in 2016, proposed the use of moored hydrophones to investigate the seasonal distribution along the coasts of Chile and Peru. Additionally, a best-case scenario could inform the presence of breeding grounds using reproductive vocalisations (e.g. the 'gunshot' type). The potential information to be gained is crucial to facilitate the implementation of the CMP long-term monitoring programme. To date, a steering group and supporting staff have been established, consisting of experts on acoustics and right whales and governmental representatives and currently available data were reviewed. Consequently, the programme decided to first prioritise expanding temporal and spatial coverage of passive acoustic data and secondly the securing of funding for a postgraduate student to analyse current and future data sets. The project was presented to the CMP international coordination meeting (see Item 2.1.1) and the governments of Chile and Peru committed to supporting it within their capacities. Selection of deployment sites, including identification of existing and available moorings, is pending. Future work will include the selection and acquisition of acoustic devices, planning of their deployment and recovery, data analyses and training.

The sub-committee **welcomed** this information and the progress made. It was confirmed that the primary goal of the programme is to identify breeding areas of southeast Pacific southern right whales and the secondary goal is to use acoustic recordings to inform vessel-survey effort. Historically, vessel-survey effort has been allocated according to previous sightings, a method that has met with limited success.

The sub-committee **commended** the effort being put into finding the breeding grounds. It looks forward to future results from not only passive acoustic monitoring, but all research regarding this population. Furthermore, the sub-committee **thanked** the authors for coordinating work that spans international boundaries.

2.1.2 Progress with the CMP

SC/67a/CMP09 summarised results of the first international coordination meeting to implement the eastern south Pacific southern right whale CMP, held 7-8 March 2017 in Santiago, Chile. During the meeting, a Memorandum of Understanding between Peru and Chile to formalise co-operation on the CMP was agreed upon, a Bi-National Steering Committee for 2017-18 was established, priority actions were reviewed, an implementation strategy was proposed and a second meeting was scheduled for March-April 2018 in Peru. Short-term priority rangewide actions included the identification of a breeding area; increased photo-identification and genetic data; increased capacity regarding entanglement response; increased species identification capacity, with special emphasis on southern right whales; advice on whale watching regulations and the development of a strategy to raise citizens' awareness and increase the capacity of involved range states. Medium- to long-term actions were also discussed, but given the current level of available information, they continue to be difficult to implement, and therefore, they were postponed. The Steering Committee also identified and developed a list of stakeholders, associated experts for specific topics, agreed upon a co-ordination and reporting system, established an agenda of implementation with clear deadlines (Annex 4 of SC/67a/CMP09) and reviewed possible funding strategies in addition to the contributions made by IWC and range states.

The sub-committee **welcomed** this update on the work being undertaken within the CMP framework and the progress on scientific components such as the acoustic programme discussed under Item 2.1.1. It **commended** the work being undertaken and the international co-operation this entailed. It **stressed** its willingness to assist and provide advice on scientific matters.

2.2 Southwest Atlantic southern right whales

2.2.1 New information

SC/67a/CMP01 reported on aerial surveys conducted to estimate the relative abundance of southern right whales from the mouth of Chubut River (42°30') to Puerto Lobos (42°), with long-term efforts to document temporal changes in distribution by age and sex classes. The surveys were carried out along 350 n.miles (620km) of coastline using high-wing single-engine aircrafts (*Cessna B-182*), flown at an altitude of 500ft. A crew of four (pilot, recorder and two observers, one on each side of the plane) were used to cover an effective strip width of 1,500m, where the distance to the coast from the left-hand side of the plane was held constant at 500m. Sightings were recorded as: (a) cow-calf pairs; (b) solitary individuals; or (c) breeding groups, which usually included one adult female and several males. A number of models for the data were explored within the GLIM framework using various explanatory variables. In summary, the authors concluded that the data supports the increasing trend in abundance for southern right whales in the Península Valdés nursing area, while the rate of increase is decreasing. Additionally, it was noted that the rate of increase for calves is much smaller than previously reported and that the numbers of solitary individuals and breeding groups are no longer increasing, suggesting that whales are relocating within and out of the Península Valdés area.

For the discussion of this paper, carrying capacity with respect to the Península Valdés nursing area was defined as the capacity of the area to support whales during the breeding season in terms of space. The authors noted that once whales reach 2.5-3.0 per km^2 they begin to increase in density in less optimal habitat along the coast. Of the 620km of coast surveyed, whales mainly concentrated themselves in three areas, two located in the Golfo Nuevo and one in Golfo San Jose, but it remains unknown why. Feeding has been observed and could play a role. A similar phenomenon, though with higher densities, has been observed in the Auckland Islands, where cow-calf pairs are mainly found inside a sheltered bay and concentrations outside of the bay are mostly comprised of juveniles or cows without calves and additional bays remain unoccupied. Logbooks from whaling data can provide information on where whales used to be, but shifts in distribution have been noted in other areas and for other species, and, at this time, it may not be a fruitful effort to attempt to determine why whales shift in their distribution. Additionally, it was noted that documenting whales in all areas is currently not possible because of less than ideal survey conditions off of the outer coast and additional logistical limitations. Satellite tagging was proposed as a method to overcome these limitations.

The sub-committee **welcomed** this work and **recommended** that the aerial surveys continue noting the importance of long-term monitoring and recognising the value of investigating changes in distribution in the context of environmental and other variables.

SC/67a/CMP06 summarised information on southern right whales in San Matías Gulf, Argentina, from data on their distribution, abundance and social structure. The study area encompassed 354km of coastline from Puerto Lobos (42°00'S, 65°04'W) to the mouth of Río Negro (41°02'S, 62°47'W), in the Río Negro province of Argentina. Whales were observed from August to October, peaking in late August-early September, every year since 2007 during the annual aerial survey, with a maximum of 160 individuals recorded in early September 2015. Solitary whales were always the predominant group, but the proportion of breeding groups and cow-calf pairs typically increased in September and October, respectively. Non-social, active groups were present in every month in similar proportions. Whales were mainly found near the northwest coast of the San Matías Gulf, particularly from San Antonio Este to Caleta de los Loros. Since 2008, the areas in which whales were found concentrated along the coast of Rio Negro changed from mainly around Puerto Lobos (near Península Valdés) to the northern coast of the San Matías Gulf.

The presence, or lack thereof, of kelp gulls in areas utilised by these southern right whales was also discussed. The current kelp gull population abundance in the San Matías Gulf was unknown, but has been increasing. However, kelp gull harassment has not been recorded in areas outside Península Valdés.

SC/67a/CMP08 presented information on opportunistic sightings of southern right whales on the Patagonian shelf and shelf break off Argentina during austral summer, along with satellite-telemetry data from whales tagged off Península Valdés following the Committee's recommendation (IWC, 2017b). Encounter rates in the Patagonian shelf between 42°S to 46°S were substantially higher than south of 46°S and in the shelf break, which is consistent with satellite-telemetry data and indicated a probable feeding ground. The authors suggested that dedicated research efforts within the Patagonian shelf be increased to assess habitat use, estimate the availability and seasonality of food and exposure to biotoxins, pollution and infectious agents along the migratory and feeding grounds.

Traditionally, southern right whales have been photographed using aerial surveys and how to compare these photographs to photographs taken from research vessels was discussed. The authors noted that photographs were being analysed and they welcomed future discussions on how to reconcile these with aerial photographs.

The sub-committee **welcomed** future photo-identifications of whales from this area. Additionally, the sub-committee noted the paucity of biopsy samples from this area and **strongly encouraged** the collection of such samples. The sub-committee also **encouraged** the use and exploration of platforms of opportunity for data collection and **commended** the use of such platforms to collect data on this population, for which little is known.

The sub-committee was updated on actions developed during June 2016-April 2017 in Argentina for the southern right whale CMP for the southwest Atlantic (detailed in Appendix 2). Activities were proposed and carried out to: (1) ensure long-term monitoring of abundance, trends and biological parameters; (2) enhance existing stranding networks including the capacity for undertaking post-mortem examinations; (3) research movements, migration routes and the location of feeding grounds; (4) develop and implement a strategy to minimise kelp gull harassment; and (5) develop a strategy to increase public awareness.

The report highlighted telemetry studies, addressing (3), in particular for whales wintering near Península Valdés. The tagging programme was developed by a large group of collaborating organisations including NOAA, Cascadia Research, Wildlife Conservation Society, Aqualie, Fundación Patagonia Natural, Instituto de Conservación de Ballenas, University of California Davis and Laboratorio de Mamíferos Marinos-Centro Nacional Patagónico. Between 2014-16 ten location-only and six archival transdermal satellite tags were deployed on individuals of both sexes and different maturity/reproductive stages in Golfo Nuevo, Province of Chubut, Bahía San Antonio and Province of Río Negro (Zerbini *et al.*, 2015; 2016). Duration of fully-implanted tags varied between 10 and 237 days (mean=90 days). Data showed substantial individual and yearly variation, providing new insights regarding habitat use and the potential for connections with additional habitat along the coast of Argentina during the breeding and calving season. For instance, some tagged whales visited the outer Patagonian shelf east of Península Valdés, Southwest Atlantic Islands and the South Atlantic basin between 38 and 58°S within the same season. Nevertheless, state-space models suggested that the Patagonian shelf and the subtropical convergence and the continental shelf break around South Georgia Islands/Islas Georgias del Sur were of potential importance for foraging. Additionally, investigations of movement patterns relative to environmental data indicated that whales may be using oceanographic features (e.g. eddies) at the Subtropical Convergence for foraging. Diving profiles indicated potential differences in habitat use between juvenile and adult whales. Future studies are planned to continue the investigation of movement patterns off Península Valdés, with the ultimate goal of understanding their large-scale habitat use in the South Atlantic Ocean.

In discussion, it was noted that although six viable hypotheses have been proposed to explain the recent mortality event, to date, results remain inconclusive. The use of blow samples from drone data collection schemes were suggested as a method to assess health. Additional analyses will be available in 2018 with respect to relatedness of stranded individuals using multi-locus genotyping.

The sub-committee **acknowledged** the importance of the relevant CMP, as well as **recommended** the continued cooperation and collaboration between all research groups and stakeholders to build the knowledge needed to address mortality issues present in this population. The sub-committee **recommended** continuation of the work to understand habitat-use, dispersal and migratory patterns at different scales, in connection to overall population demography. The sub-committee **recommended** continued exploration of methods to encounter and observe live calves prior to death and to gather individual health information on both cows and live and recently deceased calves. The sub-committee **recommended** that more work be done to elucidate the differences between nutritional stress imposed on calves induced from the inability of cows to feed and other types of physiological stress resulting from open wounds (e.g. electrolyte and fluid loss and thermoregulation), energetic expenditure related to avoidance behaviours, and other stressors experienced by whales. Methods to advance such knowledge should include stable isotope analysis, nutritional condition and lipid content analyses, population genetic analysis, oceanography surveys, assessment of biotoxin presence and distribution and the continuation of behavioural observations and satellite tracking.

2.3 North Pacific gray whales

2.3.1 Rangewide assessment

Donovan presented a summary of SC/67a/Rep04, the fourth rangewide Workshop on the Status of North Pacific gray whales held from 27-29 April 2017 in La Jolla, California. This series of workshops originated in the need to consider new telemetry and photo-identification results indicating that the 'traditional' idea of two separate populations in the North Pacific ('eastern' and 'western') needed re-evaluation. The 2017 Workshop's primary focus was to review new information and build upon the excellent intersessional work undertaken by Punt since SC/66b.

The Workshop reviewed the new genetic and photo-identification information presented in the light of the stock structure hypotheses developed at previous workshops. It welcomed updated information on the analyses of whole genome sequences and SNPs presented last year (DeWoody *et al.*, 2016) and news that additional studies were ongoing to compare samples from Sakhalin Island and Mexico. New photo-identification data for PCFG whales was presented and the Workshop encouraged the development of a manuscript (including examples from PCFG and Sakhalin whales) related to affiliative behaviour on migration and potential implications for stock structure. The Workshop also reviewed new information on mixing rates for PCFG whales for use in the modelling framework. An important component of the discussion related to how to develop and include time series of bycatch (and ship strike) data in the assessment. Considerable progress was made and an approach was developed to capture and investigate the effects of the considerable uncertainty in such estimates. The Workshop received new abundance information and this was referred to the ASI working group for discussion at SC67a. Based upon the new information, the Workshop agreed to take four stock structure hypotheses forwards: 3(a), 3(e), 5(a) and 5(b). These are illustrated in fig. 1 and summarised in table 1 of the Workshop report. The revised trial structure is provided in Annex E to the report.

The Workshop agreed on an extremely ambitious workplan to try and provide results for consideration at SC/67a, recognising that this may not be possible given the short time between the close of the Workshop and SC/67a and the other commitments of the relevant scientists. In concluding his report, Donovan thanked Punt for his tireless computing work and Weller and the Southwest Fisheries Science Center for once again providing excellent facilities.

Donovan noted that not all aspects of the Workplan could be completed and Punt summarised the progress made on the modelling aspects of the workplan since the Workshop. He noted that the model specifications and associated code had been updated to treat entanglements and ship strikes separately, and to calculate survival rates for PCFG animals separately for animals that joined the population before and after 1999.

As noted above, the Workshop had referred new abundance estimates to the ASI Working Group (see Annex Q). Their conclusions are summarised briefly here and the estimates are included in the final abundance table in Annex Q. SC/A17/GW05 reported on abundance estimates based on mark-recapture modelling of photo-identification data for the period 1996-2015 for the PCFG gray whales. The estimates were endorsed and accepted for use in assessments. SC/A17/GW06 summarises abundance estimates for gray whales migrating southbound off the central California coast between December and February 2014/15 and 2015/16, using the counting and analytical methods described by Durban *et al.* (2015). The paper provided two new estimates of abundance for a time series starting in the mid 1960s. While suggestions were made of potential improvements to the models, the estimates were endorsed and accepted for use in assessments. SC/67a/NH11 provided abundance estimates using mark-recapture modelling of photo-identification data from Sakhalin Island and Kamchatka. The analytical approach has been updated from previous analyses (see Cooke, 2016). The estimates were endorsed and accepted for use in assessments but it was noted that the code will need to be verified formally for use in assessments.

In discussion, it was noted that integrating the abundance estimates provided in SC/67a/NH11 into the modelling framework would require some additional work for the stock structure hypotheses that assume that the southern Kamchatka sub-area is used by more than one feeding group and/or breeding stock. Within this sub-area, the existing SC/67a/NH11 estimates pertain to whales that feed predominantly in the Sakhalin sub-area and those that feed predominantly off southern Kamchatka, but do not explicitly address what proportion of the whales that feed off southern Kamchatka could be part of 'other' groups (e.g. northern feeding group whales in hypothesis 3a or Western breeding stock whales in hypothesis 3b). A small group discussed the issue and, subsequently, reported back that a method to address this issue had been identified and that modeling results incorporating the SC/67a/NH11 abundance estimates will be reported at the next rangewide Workshop.

Results of SC/67a/NH11 also have implications for inferring the extent to which the Sakhalin or the combined Sakhalin and southern Kamchatka feeding groups are reproductively closed. However, the modelling framework is not explicit with respect to mating between groups, and thus further reconsideration of hypotheses in light of this information was not warranted.

In discussion of the approach used to estimate bycatches and ship strikes, it was also noted that the mixing rates used in the model were informed by data from northwest Washington, and that these data do not represent a random sample of the North American west coast. It was suggested that telemetry data can assist in providing some inferences on residence time (although not in a direct quantitative manner) as can photo-identification data although they are limited to sampled areas. Recognising the difficulties of modelling bycatch and the associated uncertainty, the sub-committee agreed that the three scenarios agreed upon during the Workshop represented a reasonable way forward.

The sub-committee thanked the convenors and participants of the Workshop, especially Punt, for their effort and diligence in producing a report in such a short period. It welcomed the progress made and endorsed the report of the Workshop and its recommendations. It noted the endorsement of the abundance estimates and recommended that a 5th Workshop be undertaken with a view to completing the rangewide review at the 2018 Annual Meeting.

The sub-committee recognised that the results of the Workshop are relevant to the updating of the CMP in time for the stakeholder workshop planned to occur before the 2018 Commission meeting that had been endorsed last year. To facilitate this work the sub-committee **recommended** that a small drafting group meeting be held. The sub-committee also recognised the importance of the rangewide work to the ability of the SWG on the AWMP (Annex E) to provide informed advice on subsistence hunts for gray whales.

In recent years as part of the rangewide review, the Committee has recommended and encouraged the sharing of gray whale samples to better understand the stock structure of North Pacific gray whales. Japan kindly indicated its willingness to share samples collected by its scientists if a formal request was submitted (IWC, 2017a, p.24). The Data Availability Group (DAG) received and forwarded a request from the USA to Japan asking for gray whale samples for use in a genetic study extending work that was presented to the Workshop for Sakhalin and US samples. The request is now being reviewed by Japan. This sub-committee noted that such cooperation and collaboration is also facilitated through the Memorandum of Cooperation (MoC) 'concerning conservation measures for the western gray whale population' among the participating range states. The sub-committee **encouraged** the range states of other CMPs to follow this positive example of a MoC, noting the similar step of Chile and Peru noted under Item 2.1.2. In addition, the sub-committee encouraged the Russian Federation to continue to collect photo-identification data (including in Chukotka; see Annex E).

The sub-committee looks forward to receiving papers detailing analyses that incorporate the data from Japan, Russia and the USA.

2.3.2 Regional studies

2.3.2.1 RUSSIA

The sub-committee has had long-standing co-operation with the IUCN Western Gray Whale Advisory Panel (WGWAP) and there is a joint IUCN/IWC CMP for western gray whales. Reeves summarised activities and findings of the WGWAP since SC/66b (see Appendix 3). The Panel's Noise Task Force met twice and focussed primarily on follow-up work related to monitoring and mitigation during Sakhalin Energy's 2015 seismic survey off Sakhalin Island and development of a monitoring and mitigation plan for another large-scale seismic survey in 2018. The full Panel met in Moscow in November. Among the issues addressed at that meeting were: (a) the implications of an apparent long-term decline in amphipod biomass in the Piltun gray whale feeding area; (b) a proposal by Sakhalin Energy to increase speed limits for its crew-change vessels; (c) risks to gray whales of entanglement in salmon nets along the north-eastern Sakhalin coast; and (d) a document prepared for IUCN and submitted to the Russian Ministry of Natural Resources and Ecology entitled 'Principles and Guidelines for the Monitoring and Mitigation of Impacts on Large

Whales from Offshore Industrial Activity in Russian Waters'. The sub-committee thanked Reeves for this update. It noted that a recommendation regarding the updating of the IUCN/CMP is included in the work plan (see Item 2.3.1).

SC/67a/NH03 reviewed findings from 2016 field studies conducted by the Russia Gray Whale Project (formerly the Russia-US Program) on gray whales feeding near Piltun Lagoon in the western North Pacific off Sakhalin Island, Russia. This research program has been ongoing since 1997 and represents the 20+ year time-series that has served as the foundation for the assessments of the population (see discussion of SC/67a/NH11 above). Photo-identification research in 2016 resulted in the identification of 56 individuals, including six calves and seven previously unidentified non-calves. No previously unidentified reproductive females were recorded in 2016, resulting in a minimum of 33 reproductive females observed since 1995. The general distribution of gray whales in 2016 was notably different to that in 2015, with most of the whales encountered south of the mouth of Piltun lagoon. The authors noted that potential impacts from nearby offshore oil and gas developments, including nearly annual seismic surveying, remain a concern for the wellbeing of the population (see Appendix to SC/67a/NH02). Additionally, the coastal salmon trap net fishery, which overlaps spatially and temporally with feeding gray whales during the summer and fall, continues to present considerable risk (SC/67a/HIM17) as is evidenced by the report of an entangled whale in September 2016. This fisheries-related risk is of particular concern because adult females and their calves show strong fidelity to this feeding area at a critical time when the females are recovering from pregnancy and lactation and the calves are being weaned.

There was a general discussion of the information from the Sakhalin and Kamchatka areas including the results of SC/67a/NH11. It was noted that the site fidelity of newly identified non-calves was confirmed to be relatively high. These newly identified individuals are typically assumed to be whales that were missed as calves rather than immigrants. In the model described in SC/67a/NH11, these animals enter the model with a probability distribution for their age depending on the current dynamics of the population. Cooke reported that future analyses will look at the model output to see which group new non-calves are predominately found within. It was suggested that biopsy samples from Kamchatka could provide valuable information to clarify the situation in this region. Additionally, it was suggested that survey work in the Kamchatka region be continued to determine if, for example, some individuals spend significant periods of time there in the summer and autumn feeding season and others just pass through.

The sub-committee commended the ongoing work in the region and recommended that studies in the Kamchatka area continue and if possible expand as they can provide valuable information for analyses regarding stock structure and status. The sub-committee noted the discussion of SC/67a/HIM17, discussed by the HIM sub-committee (see Annex J), that reviewed the available evidence of gray whale entanglements in the western North Pacific and reviewed the literature on gear types used in the Russian Far East that are known or suspected to catch gray whales. The Committee has previously expressed concern over the potential threat of fishing gear off Sakhalin (IWC, 2017a, p.38).

The sub-committee has recommended in the past that the two groups working off Sakhalin (the Russia Gray Whale Project and the Joint Programme of Sakhalin Energy and ENL) work together to develop a single publicly available photo-identification catalogue. This will improve analyses of abundance, movements and biological parameters and lead to a better understanding of the status of the animals there. Donovan provided a short report on efforts to facilitate the development of a single catalogue and related database, perhaps held under the auspices of the IWC. The sub-committee welcomed this news and **strongly encouraged** Donovan to work with the various data holders to facilitate the development of a single reconciled catalogue and database. Furthermore, the sub-committee **reiterated** the importance of the work of the Russian Gray Whale Project and recommended that it continue.

The sub-committee recalled that there had been a major seismic survey effort at Sakhalin in 2015 (IWC, 2017a). It noted that considerable monitoring data had been collected by two of the oil companies involved to enable analyses of potential effects of the surveys on gray whales in the area. The sub-committee was given to understand that such analyses were underway and noted that it would welcome presentation of the results of those analyses at a future meeting.

2.3.2.2 JAPAN

SC/67a/CMP02 reported on the recent status of conservation and research on gray whales in Japan. During the period May 2016-April 2017, no anthropogenic mortality has been reported while two opportunistic sightings of gray whales were made in Tokyo Bay on 22 February and 18-23 April. The Fisheries Agency promptly informed individuals of the occurrence and cautioned responsible local authorities to avoid entanglements of the animal(s) in fishing nets and prevent ship strikes. Fishermen are prohibited from capturing gray whales and set-net fishermen are asked to make their best effort to release any whales found in their nets.

Sightings from Izu archipelago and Shizuoka prefecture from 2015 to 2016 were identified as involving the same individual (Nakamura *et al.*, In press). Additionally, it was noted that Kato (TUMSAT) had been nominated as the coordinator of the Memorandum of Co-operation for Conservation of Western Gray Whales at the 2016 IWC Commission meeting.

In discussion, an additional report (sourced on Facebook) of a gray whale seen and photographed off Aogashima Island, Japan was noted. Whilst the photograph was clearly of a gray whale, the sub-committee noted that confirmation of the location can be more problematic in such cases unless the original source is contacted.

The sub-committee **welcomed** the information and especially that of the sightings off Japan. It **encourages** that sighting information continue to be collected. This can provide helpful information on the age classes using waters near Japan.

2.3.2.3 EAST CHINA SEA

The question of whether a western breeding stock is extant has been a key part of the discussions and hypotheses considered during the rangewide review. At the 2016 Commission meeting, Gagnon (2016) reported on recent acoustic detections made by the US Navy of what have been tentatively classified as gray whales in the East China Sea. These detections have been made on numerous occasions over the last six years (2011-16) using towed hydrophone arrays in mobile, high-precision acoustic monitoring systems (Surveillance Towed Array Sensor System-Low Frequency Active Sonar - SURTASS-LFA). Vocalisations were detected on multiple occasions in multiple years and were consistent in structure across years. Calls consist of a 55 Hz pulse about 1s in duration, which has multiple harmonics (110 and 165Hz strongest) and the calls are typically repeated two or three times by the same individual. These calls have been detected annually in relatively shallow waters between September and March. The whales remain in the same general areas for weeks at a time, but have generally been observed to be moving south in the autumn and north in the spring. These acoustic data have not yet been accompanied by visual observations to confirm species identification.

The sub-committee welcomed this information and expressed its appreciation to the author and the US Navy for bringing it forward. The author has expressed his willingness to collaborate with biologists familiar with gray whale calls with the goal of verifying species identification. If it is determined with high probability that these are gray whale calls, it will be important to develop a dedicated field-research effort to verify species identification with visual observations, photographs and biopsies.

The sub-committee endorsed the recommendation from the rangewide Workshop (SC/67a/Rep04) that every effort be made, in the first instance, to determine with high probability that the calls are from gray whales. If so a dedicated field effort should be launched to observe, photograph and biopsy the animals.

2.3.2.4 MEXICO

SC/67a/CMP11 presented the results of gray whale research conducted in the wintering lagoon of San Ignacio and the Bahía Magdalena complex. Overall, the number of gray whales and their seasonal occupation of the lagoons were slightly lower than seen in previous years, and the authors thought that this was probably due to cooler sea-surface temperatures. Conversely, the number of single animals observed in the Bahía Magdalena complex was notably higher in 2017. A total of 646 individual whales where identified in Laguna San Ignacio and 374 in Bahía Magdalena complex. In recent years, photographic re-captures of gray whales first photographed in Bahía Magdalena and subsequently photographed in Laguna San Ignacio during the same year, suggests that the direction of movement occurs south to north. Females can bear calves up to an age of at least 47 years.

The sub-committee also considered SC/A17/GW07 which had been presented at the intersessional Workshop. It provided an update and overview of results from shore-based counts of northbound eastern North Pacific gray whale calves conducted March-June from the Piedras Blancas Light Station on the central California coast each year from 1994-2016. Estimates of the total number of northbound calves displayed a high degree of inter-annual variability, ranging from 254 calves in 2010 to 1,528 calves in 2004. Calf production has been particularly high during the past 5 years (2012-16) with a total of >6,500 calves estimated during this period, including four of the highest years (>1,000 calves per year) since these calf counts began in 1994. The 2016 estimate of calf production (1,351) is about 5% of the reported total abundance (26,960; SC/A17/GW/06) for the eastern North Pacific population in 2016. A trend in median migration dates was observed, indicating that the midpoint of the migration is now occurring about a week later than it did in the mid-1990s.

The sub-committee **welcomed** the results of this long-term study, as had the Workshop. It **reiterated** the importance of such studies, particularly in light of analyses of abundance and calf production in conjunction with environmental factors. Such analyses can provide general as well as specific insights on the population dynamics of whales in response to environmental factors. The sub-committee looked forward to receiving additional analyses of these data in future years.

2.3.3 Other studies

SC/67a/CMP10 presented a study of steroid hormones in gray whales. Using the ELISA method, progesterone and testosterone were reported from biopsies of 14 western gray whales from Sakhalin Island including 2 immature males, 1 adult male, 2 males of unknown life-stage, 2 immature females, 1 adult female and 6 females of unknown life-stage. Progesterone concentrations ranged from below the limit of detection (8.57pg/mL) to 0.21 ng/g. Progesterone levels in pregnant gray whales have not yet been determined, but the female western gray whale progesterone values detected were below those reported in some non-pregnant mature individuals of other cetacean species, and it is likely that the female western gray whales in this study were not pregnant at the time of sample collection. Progesterone detected in male western gray whales was in the range reported in male humpback whales and bowhead whales. Testosterone concentrations ranged from below the limit of detection (5.67pg/mL) to 1.36ng/g. The values reported here are in the lower end of values reported in pubertal and immature male short-beaked common dolphins. This study also investigated the use of a nanoLC-MS/MS method to determine progesterone, testosterone, hydrocortisone, and cholic acid (as a surrogate internal standard) in blubber samples from 3 stranded eastern gray whales. Progesterone concentrations were detected in two of the three samples and were higher in the adult female than in the adult male. Testosterone concentrations were detected in both male blubber samples with the adult male having a higher testosterone concentration than the juvenile male. Future development of this work will include the addition of biologically relevant hormones, such as estradiol and other glucocorticosteroids.

The sub-committee welcomed these analyses and looks forward to future analyses and further validation of the method, noting that future work should include consideration of how health can be monitored using such data. Additionally, it was recommended that collaboration with field biologists be initiated to combine the laboratory findings with metadata to provide more accurate estimates of animal age and reproductive stage.

2.4 Franciscana

2.4.1 New information

SC/67a/SM04 provided a preliminary report on a project funded by the Government of Italy to assess characteristics of fisheries in Franciscana Management Areas Ia and Ib, two areas thought to have the smallest abundance. They are geographically disjoint from all other areas and thought to be subject to high levels of bycatch. Interviews of 76 fishers were carried out between May to September in 2016 and in March 2017 to evaluate the type of fisheries and fishing gear operating in the area. Of those fishers, 54 claimed to know of franciscana, but only 9 could accurately identify them based on illustrations. Five of these fishers reported having historically captured franciscana in bottom-set and floating gillnets, but the authors were unable to assess the relative proportion of franciscana in reported bycatch because of the difficulty in identifying bycatch to the species level. The authors plan on conducting additional interviews, funded by fisheries monitoring, and providing these results to SC/67b.

In discussion, it was noted that, typically, most fishers are able to identify franciscana in the field and that the improper identification of the species from photographs may have been an artefact of the photographs that were used or that fishers chose to falsely answer the question in the interest of securing access to fishing within these areas.

2.4.2 Progress with the CMP

SC/67/SM12 reported on the beginning of the implementation of the franciscana CMP (IWC/66/CC11) funded by the IWC CMP Voluntary Funds and WWF. A Steering Committee was initiated including representatives from Argentina, Brazil, and Uruguay, IWC Conservation Committee Chair, IWC Scientific Committee Chair, IWC CMP Standing working group Chair and IWC Head of Science, coordinated by Iñíguez and supported by an established panel of experts. The two main objectives of the CMP are to protect franciscana habitat and to minimise anthropogenic threats (e.g. bycatch) to the population. Consequently, the CMP includes seven actions of high priority, ranging from initiating public awareness to increasing capacity for activities such as research and mitigation. Specifically, the need to reduce bycatch was included, and the authors suggested that research be performed to assess the degree to which pingers could reduce bycatch of franciscana in the Buenos Aires gillnet fishery.

In discussion, it was highlighted that Brazil will be providing 1 million dollars for research and conservation work according to the National Action Plan of Franciscana in management areas II and III. Additionally, the authors noted that although initial efforts were initiated in areas in which they currently work, in the future, work will be conducted in additional range states.

The sub-committee **commended** the breadth of work that has been undertaken towards franciscana research and conservation and noted that this CMP is the first for a small-cetacean species and **welcomed** the development of more in the future, as appropriate. It also **commended** efforts being made to coordinate research across international boundaries and **recommended** that this collaboration continue, despite the difficulties involved.

The sub-committee **recommended** that it should conduct an in-depth review of franciscana soon, given that the last IWC review of franciscana was performed in 2004 (IWC, 2005). The review should include new estimates of franciscana mortality, as previously recommended by the Committee. Such estimates are still unavailable for Management Areas Ia and Ib.

Finally, the sub-committee **concurred** with need to investigate the possibility that pingers are suitable to reduce bycatches of franciscana.

3. PROGRESS WITH IDENTIFIED PRIORITIES

3.1 Humpback whales in the northern Indian Ocean including the Arabian Sea

3.1.1 New information

SC/67a/CMP14 summarised reports of humpback whales in the Persian Gulf from 1883 to 2017. In total, five specimens were recorded, but no sightings. The first record, from Bassore Bay, Iraq, is currently on display at the Paris Museum and is the holotype for *Megaptera indica Gervais* 1883. The remaining records included an individual potentially killed from ship strike at the port of Doha, Qatar, an individual struck by a ship's propeller in Kuwait, a juvenile entangled in a gillnet at Qeshm Island, Iran and a juvenile found floating near Akhtar, Iran. Initially, reports were assumed to be of rare stragglers from the Arabian Sea population, however, as additional records were accumulated, the authors hypothesised that perhaps humpback whales are normal visitors to the Persian Gulf, if not resident. The authors recommended that increased efforts be allocated towards systematic surveys in the Persian Gulf region.

The sub-committee **welcomed** this information. It **concurred** with the authors that additional systematic research be conducted within the Persian Gulf area to characterise the residency of whales reported in this area.

SC/67a/CMP05 reviewed published records of baleen whales (including blue whales, Bryde's whales and humpback whales) in Pakistan and an ongoing observer programme implemented in 2012. Prior to 2012, knowledge of whales in Pakistan included a limited number of sighting and stranding records and whaling data (Mikhalev, 1997; 2000; Minton *et al.*, 2015). In 2012, WWF-Pakistan implemented a programme to train the crew of tuna gillnet vessels to document sightings, entanglements and bycatch. Vessels are provided with a digital camera and are encouraged to photograph humpback whales. The programme now includes 75 vessels, and hundreds of bycaught animals have been released alive, including one humpback whale. Three humpback whales were photographed in 2014, and there were two confirmed sightings in 2015 and 12 in 2016.

In discussion, it was noted that the data is part of a larger dataset used to document bycatch by the Indian Ocean Tuna Commission, and that up until now observer reporting within this dataset has been poor for all areas, with Sri Lanka being an exception. Additionally, the cetacean data is stored in the regional archiving system available from the WWF.

The sub-committee **commended** the amount of work that has been conducted, work which has led to the availability of a large amount of data where previously there was none. The sub-committee **recommended** that this work be continued and be replicated, where possible, throughout the region, especially in regions where it is not feasible to conduct cetacean surveys.

SC/67a/CMP03rev1 summarised records of baleen whales from the Indian coast of the Arabian Sea from 2001 to March 2017. Previously, data were available only from the west coast of India (Sutaria *et al.*, 2016). Humpback whales were reported along the west coast, with most sightings occurring between February and May. Additionally, undocumented sightings were reported near the India-Pakistan border. In March 2017, at least one vocalising humpback whale was recorded off the Goa coast, and in prior years, vocalising whales were recorded near the Netrani islands, off the coast of Karnataka, in Kochi harbour in Kerala, and in offshore waters from Malvan-Sindhudurg in Maharashtra (Mahanty *et al.*, 2015). The authors recommended that efforts be made to conduct dedicated baleen whale surveys in Gujarat, Maharashtra, Goa and Karnataka and for the establishment of passive acoustic monitoring along the northwestern coast from Porbandarto the Netrani Islands. Additionally, they recommended an increased collection of samples from stranded whales, the establishment of a centralised repository for tissue samples and the enhancement of collaborative efforts with local regional authorities to facilitate in-depth analyses.

The sub-committee **welcomed** the report and its value to better understand this endangered population. The sub-committee **recommended** that further emphasis be placed on using acoustic methods to document cetaceans in these areas and other areas, particularly areas that are not safe to survey. Additionally, the sub-committee **recommended** that all documented entanglements and ship strikes be entered into the IWC database and that an enhanced effort be made to archive any tissue samples that are or become available in a central repository. No tissue samples are currently available for humpback whales. The sub-committee **thanked** the Government of India, Maharashtra Forest Department and the local office of the United Nations Development Programme for their support of this work.

SC/67a/CMP12 reported on the continuation of Oman-based satellite telemetry studies initiated in 2014. Telemetry data from nine whales showed whales spending 35% of their time in the Gulf of Masirah and 27% in Hallaniyat Bay. During a two-week survey in March 2017 no humpback whales were sighted in the Gulf of Masirah and only two individuals were encountered in Hallaniyat Bay, neither of which were tagged. The authors updated the sub-committee on the increasing threats to areas of critical habitat and high cetacean biodiversity, including increased numbers of gillnet fishing vessels in Hallaniyat Bay. Shipping traffic in the Gulf of Masirah is expected to increase in the next five years due to new investment and the further development of the port of Duqm and associated industrial area. The port in Duqm has supported and is currently supporting a management and mitigation plan, but continued effort is required to ensure research inform such plans. The authors noted that recent stranding records confirm the importance of addressing bycatch in this area.

The sub-committee noted that there is no specific management plan for marine resources within the area, although some vessels did abide by voluntary speed recommendations. The port actively disseminates mitigation information. Additional mitigation plans were discussed, including the use of the 'Whale Alert' system to act as a whale and shipping collision avoidance system for the port and to also aid in the collection of whale sightings in the area.

The sub-committee noted that satellite tagging offers a method to collect cetacean data in areas that can be constrained by inclement weather and piracy. It **recommended** that the work be continued noting its value in understanding the risk of animals to anthropogenic mortality recognising the increasing shipping activity within the two areas that the whales inhabited. Lastly, it was **recommended** that the collaborative efforts with industry shown in Duqm be adopted in other ports and harbours.

SC/67a/CMP15 reported on the use of an Ensemble Ecological Niche Modelling approach to predict humpback whale habitat throughout the Arabian Sea using vessel-sightings data and satellite-telemetry data (using a state-space modelling approach) from Oman. Ensemble models of both datasets predicted areas of suitability along the coast of Oman and Northern Arabian Sea between Iran and India for November to May. Model predictions fit well with historical locations of Soviet whale captures from the 1960s and co-occur with areas of high vessel-traffic density in the Northern Indian Ocean where container-shipping traffic increased threefold between 2004 and 2014 (Willson *et al.*, 2016). Telemetry data provided the most robust source of data, but models could be improved upon by incorporating data from other range states. The authors recommended that this work, together with recent blue whale modelling work (Redfern *et al.*, 2017), could help guide future research activities and mitigation efforts in the region through the use of a multi-species modelling approach.

In discussion, it was suggested that other sources of available data such as acoustic data also be included in the model, where additional data could allow the model to estimate habitat preferences specific to behaviour modes.

The sub-committee **welcomed** the work, and highlighted the immense amount of effort that was put forward to carry out such an analysis. The sub-committee **recommended** that the ensemble niche modelling presented in SC/67a/CMP15 be expanded to include data reported from Pakistan and India and be used to inform future research efforts, particularly where to concentrate efforts for passive acoustic research and to help determine where vessel-based surveys for photo-identification and biopsy work should be prioritised, when logistically possible. Additionally, it was **recommended** that ensemble niche modelling be applied to examine potential threats from shipping using AIS/Vessel traffic data, and fishing using any available data on fishing effort in the region.

3.1.2 Regional co-operation

SC/67a/CMP07rev1 summarised the progress of the Arabian Sea Whale Network (ASWN), an informal collaboration between researchers and conservation bodies working toward better understanding and the conservation of whales in the Arabian Sea. The document summarised the 12 reports prepared for SC/67a by ASWN members and colleagues working in the region, including contributions from Oman, India, Pakistan, Sri Lanka and the Persian Gulf. This represents an increase in the number of reports, the breadth of topics and the number of range states represented from the Arabian Sea presented to this meeting, demonstrating concrete progress toward increased awareness, data collection and capacity building in the region. Most recommendations proposed in 2015 (IWC, 2016) related to improved communication, awareness raising and capacity building have progressed adequately (e.g. ASWN infographics), but the raising of funds for shared regional-level projects has been challenging and limited to funds granted by the IWC and WWF. Progress was also made towards the implementation of regional online data platform, funded under IWC SH3B, where a contract between the IWC and the Emirates Wildlife Society (EWS)-WWF, who will host the project, was signed in February 2017. Co-funding from WWF and the Environment Society of Oman enabled EWS-WWF to sign a contract with Flukebook (a subsidiary of WildMe) allowing photo-identification data from Oman to be included in the online platform starting in June 2017. A fully functioning data platform with expanded capacity to archive and analyse sightings, strandings and genetic data, as well as photo-identification data should be ready to share at SC/67b.

The sub-committee **commended** the work performed by researchers in the Arabian Sea, noting the expansion of research topics and recognising the difficulty of establishing and maintaining such a network, which it recognised as important for the conservation and management of this highly endangered population. The sub-committee **recommend** further development of the online regional data archiving platform to facilitate regional analyses and the comparison of data between study sites and the identification of locations conducive to passive acoustic monitoring to inform directed effort for documenting basin-wide distributions. The sub-committee also **recommended** that the IWC Secretariat communicate the Committee's endorsement to the relevant range states. Lastly, the sub-committee repeated last year's **recommendation** to collect tissue sample where possible to facilitate the genetic identity of these animals.

3.1.3 Progress with international measures such as CMPs

The sub-committee was provided an update from the intersessional working group assigned to consider proposing the Arabian Sea as candidate for a CMP. To date, the working group has been unable to secure endorsement from range state members. Therefore, working group members initiated the regional ASWN as a way to build momentum

Table 1
Summary of the work plan for the sub-committee on Conservation Management Plans (CMP).

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
Southeast Pacific right whales	-	Review progress on scientific aspects of the CMP
South Atlantic right whales	-	Review progress on scientific aspects of the CMP
Gray whales	Workshop; CMP drafting group	Complete rangewide review
Franciscana	-	Prepare for in-depth review
Humpback whales in the northern Indian Ocean	-	-

Table 2
Summary of budget requests for the 2017-18 period. For explanation and details of each project see text.

Title	2018 (£)
Fifth Workshop on the rangewide review of the population structure and status of North Pacific gray whales	2,500
Drafting group to finalise the scientific components of the updated IUCN/IWC CMP for western gray whales	3,000
Total	**5,500**

towards the development of a regional CMP and to directly promote conservation initiatives in the region (SC/67a/CMP07). The IWC Scientific and Conservation Committees recently reiterated the value of an Arabian Sea CMP for this species (see Item 10.3.3 in IWC (2017a). It was suggested that the Convention on Migratory Species (CMS) may offer an alternative means of achieving more regional and inter-governmental collaboration towards whale conservation in the Arabian Sea.

The CMS has introduced a new mechanism with which to designate the status of species or populations as 'Concerted Action' (see CMS Resolution 11.13 in Convention on Migratory Species, 2014). Efforts are underway to draft and complete a proposal to obtain this recognition for Arabian Sea humpback whales during the next CoP of CMS parties in October 2017. It would be valuable if the IWC collaborates on this effort, following the model of the joint IWC-IUCN CMP for western gray whales. Efforts are also underway to obtain support from the relevant range states for this initiative, which, as a joint IWC-CMS initiative, would include all Arabian Sea humpback whale range states.

The sub-committee **reiterated** its serious concern about its status of the endangered Arabian Sea humpback whale population and the anthropogenic threats it faces. It **stressed** the value of regional initiatives and **encouraged** range states to explore the possibility of future collaboration either through a CMP or CMS 'Concerted Action' and encourages IWC co-operation in these initiatives. Finally, the sub-committee **stressed** the need for continued scientific efforts to improve the knowledge of Arabian Sea humpback whales to assist conservation efforts.

4. UPDATE ON PREVIOUSLY SUGGESTED POTENTIAL CMPS

No new information was provided for the following populations: (1) blue whales from the northern Indian Ocean; (2) sperm whales in the Mediterranean; and (3) boto in Amazonia. Donovan reported that efforts are underway to develop a CMP for fin whales in the Mediterranean by ACCOBAMS following the IWC model.

5. WORK PLAN AND BUDGET REQUESTS

5.1 Work plan and intersessional groups

The sub-committee work plan and intersessional groups are found in Table 1 and Annex W.

5.2 Budget requests

The sub-committee **recommended** the following two requests for funding (Table 2).

6. ADOPTION OF REPORT

The Report was adopted at 16:45 on 16 May 2017. The sub-committee thanked Walløe and Urbán-Ramirez for their excellent Chairmanship.

REFERENCES

Convention on Migratory Species. 2014. Concerted and cooperative actions: Adopted by the Conference of the Parties at its 11th meeting (Quito, 4-9 November 2014). UNEP/CMS/Resolution 11.13. 14pp.

Cooke, J.G. 2016. Revised analysis of implications of observed whale movements on the relationship between the Sakhalin gray whale feeding aggregation and putative breeding stocks of the gray whale. Paper SC/A16/GW02 presented to the IWC Workshop on North Pacific Gray Whales, La Jolla, April 2016 (unpublished). 25pp. [Paper available from the Office of this Journal].

DeWoody, J.A., Fernandez, N.B., Brüniche-Olsen, A., Antonides, J.D., Doyle, J.M., San Miguel, P., Westerman, R., Godard-Codding, C. and Bickham, J.W. 2016. Novel single nucleotide polymorphisms from functional genes in the gray whale (*Eschrichtius robustus*) genome provide a powerful genotyping platform. Paper SC/66b/DNA04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 58pp. [Paper available from the Office of this Journal].

Durban, J., Weller, D., Lang, A. and Perryman, W. 2015. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. *J. Cetacean Res. Manage.* 15: 61-68.

Gagnon, C. 2016. Western gray whale activity in the East China Sea from acoustic data: Memorandum for Dr. Brandon Southall. Paper IWC/66/CC29 presented to the Conservation Committee of the International Whaling Commission, October 2016, Portoroz, Slovenia (unpublished). 2pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2005. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 7:307-17.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. Appendix 3. Arabian Sea humpback whale workshop: recommendations for follow-up action. *J. Cetacean Res. Manage. (Suppl.)* 17:280.

International Whaling Commission. 2017a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

International Whaling Commission. 2017b. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage. (Suppl.)* 18:185-202.

Mahanty, M.M., Latha, G. and Thirunavukkarasu, A. 2015. Analysis of humpback whale sounds in shallow waters of the southeastern Arabian Sea: an indication of breeding habitat. *J. Bioscience* 40(2): 407-17.

Mikhalev, Y.A. 1997. Humpback whales, *Megaptera novaeangliae* in the Arabian Sea. *Mar. Ecol. Prog. Ser.* 149: 13-21.

Mikhalev, Y.A. 2000. Whaling in the Arabian Sea by the whaling fleets *Slava* and *Sovetskaya Ukraina*. pp.141-81. *In*: Yablokov, A.V., Zemsky, V.A. and Tormosov, D.D. (eds). *Soviet Whaling Data (1949-1979)*. Centre for Russian Environmental Policy, Moscow. 408pp.

Minton, G., Reeves, R., Collins, T. and Willson, A. 2015. Report on the Arabian Sea Humpback Whale Workshop: Developing a collaborative research and conservation strategy, Dubai, 27-29 January 2015. 50pp. [Available at: *http://www.mmc.gov/wp-content/uploads/Arabian_Sea Humpback_whale_0115.pdf*].
Nakamura, G., Katsumata, H., Kim, Y., Akagi, M., Hirose, A., Aria, K. and Kato, H. In press. Matching of the gray whales off of Sakhalin and the Pacific coast of Japan, with a note on the stranding at Wadaura, Japan in March, 2016. *Open Journal of Animal Science*.
Redfern, J.V., Moore, T.J., Fiedler, P.C., De Vos, A., Brownell Jr, R.L., Forney, K.A., Becker, E.A. and Ballance, L.T. 2017. Predicting cetacean distributions in data-poor marine ecosystems. *Divers. Distrib.* 23: 394-408. [Available at: *http://wileyonlinelibrary.com*].
Sutaria, D., Sule, M., Jog, K., Bopardikar, I., Panicker, D. and Jamalabad, A. 2016. Baleen whale records from the Arabian Sea, India from June 2015 to May 2016. Paper SC/66b/SH34 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].
Suydam, R., George, J.C., Person, B., Ramey, D., Stimmelmayr, R., Sformo, T., Pierce, L. and Sheffield, G. 2016. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2015 and other aspects of bowhead biology and science. Paper SC/66b/BRG03rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 11pp. [Paper available from the Office of this Journal].
Willson, A., Kowalik, J., Godley, B.J., Baldwin, R., Struck, A., Struck, L., Nawaz, R. and Witt, M.J. 2016. Priorities for addressing whale and ship co-occurrence off the coast of Oman and the wider North Indian Ocean. Paper SC/66b/HIM10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 13pp. [Paper available from the Office of this Journal].
Zerbini, A.N., Mendez, M., Rosenbaum, H., Sucunza, F., Andriolo, A., Harris, G., Clapham, P.J., Sironi, M. and Uhart, M. 2015. Tracking southern right whales through the southwest Atlantic: new insights into migratory routes and feeding grounds. Paper SC/66a/BRG22rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 9pp. [Paper available from the Office of this Journal].
Zerbini, A.N., Rosenbaum, H., Mendez, M., Sucunza, F., Andriolo, A., Harris, G., Clapham, P.J., Sironi, M., Uhart, M. and Ajó, A.F. 2016. Tracking southern right whales through the southwest Atlantic: an update on movements, migratory routes and feeding grounds. Paper SC/66b/BRG26 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 16pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Election of Chair and Co-Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of Agenda
   1.5 Review of available documents
2. Stocks for which CMPs are in place
   2.1 SE Pacific southern right whales
   2.2 SW Atlantic southern right whales
   2.3 North Pacific gray whales
   2.4 Franciscana
3. Progress with identified priorities
   3.1 Humpback whales in the northern Indian Ocean including the Arabian Sea
4. Update on previously suggested potential CMPs
   4.1 Blue whales (northern Indian Ocean)
   4.2 Fin whales (Mediterranean)
   4.3 Sperm whales (Mediterranean)
   4.4 Boto in Amazonia
   4.5 Topic-based or area-based CMPs (e.g. bycatch)
5. Work plan and budget requests
6. Other business
7. Adoption of Report

Appendix 2

SOUTHERN RIGHT WHALE OF THE SW ATLANTIC: AN UPDATE ON THE CMP ACTIONS IN ARGENTINA (2016-17)

M. Iñíguez, G. Caille, E. Crespo, V. Reyes Reyes, M. Sironi and A. Zerbini

The Conservation Management Plan for the southern right whale (SRW) Southwest Atlantic population was adopted in 2012 following the recommendations of the IWC and particularly considering the SRW die-off event in Península Valdés (PV) area, Argentina. This plan started to be implemented after the meeting held in 2013 in Buenos Aires (Thomas *et al.*, 2013).

The overall objective of the CMP is to protect southern right whales (SRW) habitat and minimise anthropogenic threats to maximise the likelihood that SRW will recover to healthy levels and recolonise their historical range.

This appendix summarises those actions developed in Argentina and related to the CMP for the period June 2016-April 2017.

ACTIONS

MON-01: Ensure long-term monitoring of abundance, trends and biological parameters

The Marine Mammal Lab of the Centro Nacional Patagónico (LAMAMA-CENPAT) conducted 65 aerial surveys between May 1999 to December 2000 and from June 2005 to November 2016. The results of its work support that the SRW population is still increasing in the nursing area around PV. In spite that the number of whales in the surveyed area is increasing, the rate is steadily decreasing. Density has been also increasing and whales have been expanding their distribution to deeper waters during the last decade, and mothers with calves are using the more protected areas near the coast. These responses are expected as density-dependence response to population increase (SC/67a/CMP01). It was also observed a geographic distribution change from the west to the north coast of San Matías gulf, especially in areas with high-quality habitat. Mother-calf pairs, breeding groups, non-social active groups and solitary individuals were observed in the area, the latter being the predominant group type along the entire coast (SC/67a/CMP06)

Aerial surveys of SRWs off the coast of PV were conducted in September 2015 and 2016 by the Instituto de Conservación de Ballenas (ICB) and Ocean Alliance (OA). The purpose of the surveys was to document the presence and distribution of SRWs along the perimeter of the Península

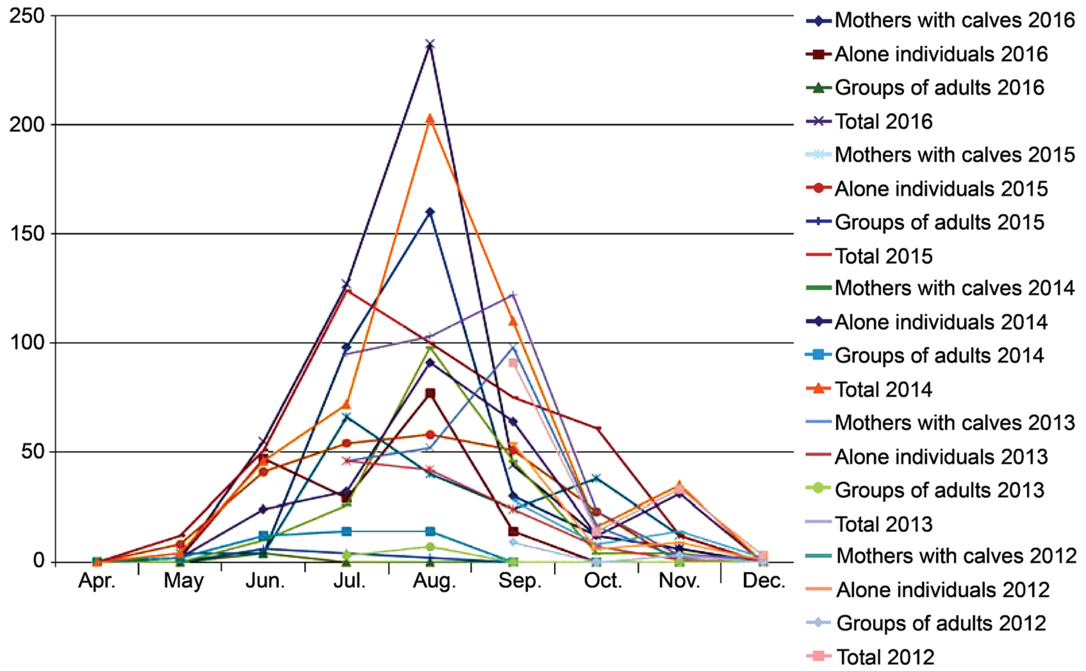

Fig. 1. Number of individuals (total and by category) registered for the 2012, 2013, 2014, 2015 and 2016 seasons.

Table 1

Analyses of photographs in the right whale catalogue of ICB/OA are available for the years 1970-2014. Number of individuals photo-identified: 3,100.

Date	Area	Mothers	Calves	Adults	Juveniles	Total
03/09/15	Golfo Nuevo	145	145	102	46	438
06/09/15	Golfo San José	48	48	8	7	111
06/09/15	Outer Coast	0	0	1	0	1
Total	**P. Valdés**	**193**	**193**	**111**	**53**	**550**
26/09/16	Golfo Nuevo	103	103	33	21	260
28/09/16	Golfo San José	57	57	7	3	124
Total	**P. Valdés**	**160**	**160**	**40**	**24**	**384**

by photo-identifying individuals from the callosity patterns on their heads and recording their locations and the presence of calves.

The following table summarises the basic results of the surveys each year.

Fundación Patagonia Natural (FPN) carried out 9 censuses on SRWs from the right whale observatory 'Punta Flecha', on the coasts of Golfo Nuevo (Chubut Province, Patagonia Argentina) in 2016. The total number of whales counted varied between a maximum of 237 individuals (24 August) and a minimum of 2 individuals (12 May) and 6 individuals (13 November). No whales were recorded in the first census (1 May) and in the last census (22 November). This seasonal data confirm that the months with the greatest number of SRWs, in the waters of the Golfo Nuevo front to the Natural Protected Area 'El Doradillo', cover July to September (3-4 months) and always with a predominance of mothers with calves.

MON-02: enhance existing strandings networks including the capacity for undertaking post-mortems

The Southern Right Whale Health Monitoring Program (SRWHMP) at PV began in 2003 with support from the US National Marine Fisheries Service. The Program is developing as collaboration between local NGOs, research centers, and governmental agencies. At present, the Program operates as a collaboration of the ICB, OA, University of California, Davis, University of Utah, Wildlife Conservation Society (WCS) and FPN, with funds from the member organisations and donations from private foundations and individuals.

Since its beginning in 2003, the Program has recorded 753 dead SRWs found on the shores of PV and surrounding areas, with an annual maximum of 116 dead whales in 2012 (McAloose *et al.*, 2016; Rowntree *et al.*, 2013; Wilson *et al.*, 2016). No other stranding research program in the world has documented such a high number of dead SRWs in one decade or created such complete database on the health of SRWs.

A Contact Network (CN) has been essential to the success of the Program. Members of the CN include: park rangers, fishermen, local people, whale watch companies, dive companies, tourism companies, nature guides, sailors, airplane pilots, artisanal fishermen, researchers, NGOs, and local authorities such as the Argentine Navy and the Argentine Coastguard. In addition to reports from the CN, the Program surveys the beaches in both gulfs in regions where the whales concentrate by land and air. Aerial surveys were opportunistic between 2006 and 2009, but have been systematic (minimum 6 and maximum 8 flights per season) since 2010. Regular aerial surveys encompass the entire perimeter of Golfo Nuevo and Golfo San José, and the external coast of the peninsula is added at least twice during the season.

In 2016, the Program studied and collected samples from a total of 16 stranded whales that died at PV and surrounding areas, including 14 calves (88%), 1 juvenile and 1 adult. The stranded whales included 9 females (56%), 6 males (38%) and 1 whale (6%) of unknown sex. Most whales (13) died in the southern gulf (Golfo Nuevo) followed by 2 whales in the northern gulf (Golfo San José) and 1 in Golfo San Matías, to the north of PV. They conducted post-mortem examinations on the stranded whales and when conditions permitted, biological samples were collected that will be analysed for infectious diseases, biotoxins, contaminants, nutritional

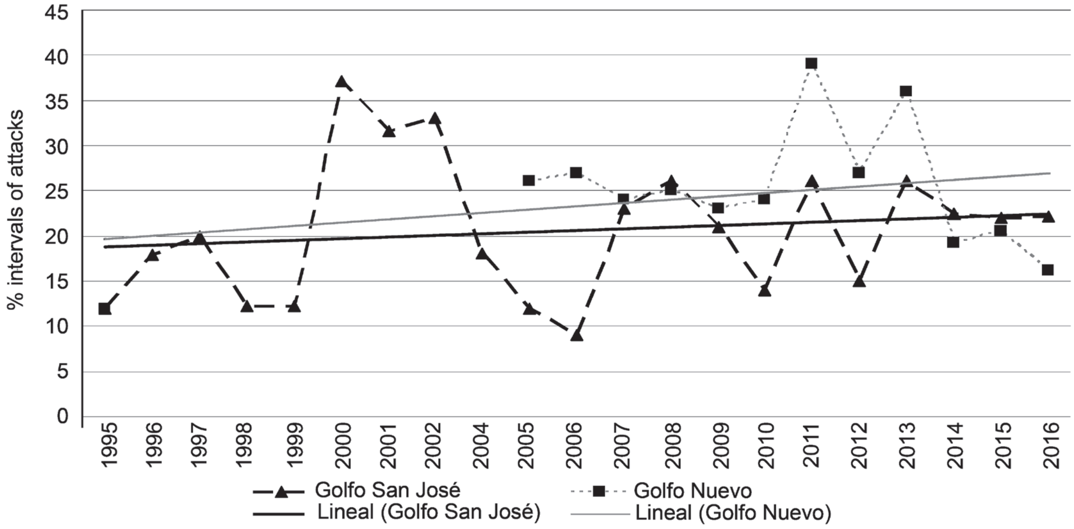

Fig. 2. Kelp gull attack frequency in Golfo San José and Golfo Nuevo, Península Valdés for the period 1995-2016.

status, foraging locations, diet, genetics, and other potential factors contributing to mortality. One live stranding was recorded in 2016: the individual in Golfo San Matías, which died after it, was found.

Among other observations and analyses, the Program's researchers quantified the number and size of kelp gull-inflicted lesions on dead whales through time to assess their potential systemic impacts on the whale's health and welfare. These data will help to develop and test novel diagnostic approaches to identify signs of stress, pain, dehydration and thermoregulatory effects of gull-inflicted wounds on whale calves. It is possible that increasing gull attack frequency and the level of physical and behavioural disturbance of SRW calves has reached a threshold in recent years that has led to the exceedingly high calf mortality levels observed between 2007 and 2014.

Two recent papers were published, Wilson *et al.* (2016) and McAloose *et al*. (2016).

RES-01: determine movements, migration routes and location of feeding ground(s)

Telemetry studies were conducted to assess movements and the location of the feeding grounds of whales wintering near PV. This project is developed by a large group of collaborating organisations including NOAA/Cascadia Research, WCS, Aqualie, FPN, ICB, University of California Davis, and LAMAMA-CONICET. Between 2014 and 2016, 10 location-only and six archival transdermal satellite tags were deployed in individuals of both sexes and different maturity/reproductive stages in Golfo Nuevo, Province of Chubut, and in Golfo San Antonio, Province of Río Negro (Zerbini *et al.*, 2015; 2016). Duration of fully implanted tags varied between 10 and 237 days (average=90 days). Movement data provided new insights into habitat use within the gulfs and potential connections with other habitats along the coast of Argentina during the breeding/calving season. Migratory behaviour showed substantial individual and yearly variation. Tagged whales visited the outer Patagonian shelf east of PV and north of the Falkland Islands/ Islas Malvinas, the Scotia Sea near South Georgia Islands/Islas Georgias del Sur and the South Sandwich Islands/Islas Sandwich del Sur, and the South Atlantic basin between 38 and 58°S. In some cases, individuals visited these three regions within the same season. State-space models were used to estimate behavioural states and suggested areas of potential foraging importance in the Patagonian shelf (PS), the subtropical convergence and the continental shelf break around South Georgia Islands/Islas Georgias del Sur. An investigation of movement patterns relative to environmental data indicated that SRWs might be using oceanographic features (e.g. eddies) at the Subtropical Convergence for foraging. Dive profiles suggest potential differences in juvenile and adult whale habitat use and provide unprecedented information on diving behaviour of these animals. Future studies are planned to continue elucidating the movement patterns of PV SRWs with the ultimate goals of understanding their large-scale habitat use in the South Atlantic Ocean.

Line-transect visual observations were made by dedicated observers of Fundación Cethus on the Argentinean Shelf (including the PS) and shelf break during four surveys from two Argentinean Coast Guard's vessels used as platforms of opportunity: one in January, two in February, and one in December 2016. A total of 34 groups of SRWs were observed in the PS, totalising 58 individuals, and 4 groups in the shelf break, totalising 5 individuals, up to a depth of 970m. The highest encounter rate (ER) was estimated for the PS between 42° and 46°S in January. The estimated mean ER for the shelf was substantially lower than that from January in the northern area of the PS. Dedicated efforts of research within the PS should be made covering a wider area than already surveyed opportunistically including during different months of the year.

Since 2016 a systematic survey in Miramar, province of Buenos Aires, from April to November has been conducted by Fundación Cethus to establish the seasonality and habitat use of the species in the area. The peak of sightings occurred in August, with 194 whales, then declining towards November abruptly.

An aerial survey between Mar del Plata and Necochea to census and photo-identification SRWs was carried out. Thirteen whales in eight groups were sighted and many of them were photographed to create a SRW catalogue for the area.

MIT-02: develop and implement a strategy to minimise kelp gull harassment

Kelp gull (*Larus dominicanus*) attacks are a unique, increasing, and acute element of the life cycle of young SRW calves at PV. The physical injury of extensive gull lesions has been hypothesised to compromise the integrity and impermeability of a calf's surface layers and lead to dehydration, loss of thermoregulatory capacity, and an increased energy outlay to wound healing and metabolic stasis. Documented behavioural consequences of gull attacks include increased high energy reactive or flight behaviour and reduced time resting and probably nursing.

Researchers from the ICB and the OA have recorded the frequency of the attacks at different sites of PV annually since 1995 as a way to gauge the success of efforts to curb gull attacks. This is the longest database in the world on this parasitic behaviour (Maron *et al.*, 2015; Rowntree *et al.*, 1998; Sironi *et al.*, 2009).

ICB/OA monitored the attack frequency in September of 2015 and 2016. The following figure shows the annual frequency of gull attacks in Golfo Nuevo and Golfo San José since 1995.

A proposed hypothesis to guide the evaluation of the possible contribution of gull attacks to the ongoing calf mortality at PV states that 'high levels of harassment by kelp gulls that peck on a calf's exposed skin and then feed on the underlying blubber, cause significant physical injuries, energetically expensive avoidance behaviour, and reductions in suckling time. This syndrome may result in, *inter alia,* decreased food intake, increased energy expenditure, exhaustion, catabolism, dehydration, and thermoregulatory stress, with cumulative and cascading effects that can lead to calf death' (Thomas *et al.*, 2013). Gulls aim the vast majority of their attacks at newborn calves, which raises concerns about the impact that this parasitic behaviour has on the health and welfare of this highly sensitive age class.

Monitoring and controlling the gull harassment problem has become a joint initiative with NGOs and national research centers (CENPAT-CONICET) and government officials of Chubut Province.

Drone-derived measures of respiratory microbiome and girths: non-invasive indicators of right whale health

Understanding the relationship between health and environmental stressors is important for large whale conservation. However, robust measurements of health are challenging to acquire, but methodology to non-invasively assess the health of large whales is being developed. In 2015 we began a study to assess the health of SRWs at PV utilising drones to: (1) collect blow samples of the respiratory microbiome (the assemblage of microorganisms residing in the respiratory tract), which is the most common source of cetacean disease; and (2) acquire high resolution vertical images to assess body condition from girth (fat) levels and gull lesion markings. Using the drone APH-22 (Aerial Imaging Systems) with a high resolution still camera we took 1,220 vertical overhead images of 57 whales. The photographs will be used to take accurate measurement of length and width profiles for morphometric analyses, photo-identification and visual assessment of skin lesions. Using another drone (*Yuneec Typhoon/Tornado*) with sterile Petri dishes we collected 22 blow samples that were preserved in liquid nitrogen. Results of photographs and blow samples are still pending.

The study is a collaborative effort between ICB and the SRWHMP from Argentina and OA, Woods Hole Oceanographic Institution, NOAA SW Fisheries Science Center, and University of California, Davis from the USA.

PACB-01: develop a strategy to increase public awareness

On 20 and 21 April 2016 a responsible whale watching workshop was held promoting land-based whale watching in Miramar, province of Buenos Aires, as part of a joint project between Fundación Cethus and the Municipality of General Alvarado.

REFERENCES

Maron, C.F., Beltramino, L., Di Martino, M., Chirife, A., Seger, J., Uhart, M., Sironi, M. and Rowntree, V.J. 2015. Increased wounding of southern right whale (*Eubalaena australis*) calves by kelp gulls (*Larus dominicanus*) at Península Valdés, Argentina. *PLoS ONE* 10(10): 20pp.

McAloose, D., Rago, V.M., Di Martino, M., Chirife, A., Olson, S.H., Beltramino, L., Pozzi, L.M., Musmeci, L., La Sala, L., Mohamed, N., Sala, J.E., Bandieri, L., Andrejuk, J., Tomaszewicz, A., Seimon, T., Sironi, M., L.E., S., Rowntree, V. and Uhart, M.M. 2016. Post-mortem findings in southern right whales *Eubalaena australis* at Península Valdés, Argentina, 2003-2012. *Dis. Aquat. Organ.* 119: 17-36.

Rowntree, V., Uhart, M., Sironi, M., Chirife, A., Di Martino, M., La Sala, L., Musmeci, L., Mohamed, N., Andrejuk, J., McAloose, D., Sala, J.E., Carribero, A., Rally, H., Franco, M., Adler, F.R., Brownell, R., Jr., Seger, J. and Rowles, T. 2013. Unexplained recurring high mortality of southern right whale *Eubalaena australis* calves at Península Valdés, Argentina. *Mar. Ecol. Prog. Ser.* 493: 275-89.

Rowntree, V.J., McGuiness, P., Marshall, K., Payne, R., Sironi, M. and Seger, J. 1998. Increased harassment of right whales (*Eubalaena australis*) by kelp gulls (*Larus dominicanus*) at Península Valdés, Argentina. *Mar. Mamm. Sci.* 14(1): 99-115.

Sironi, M., Rowntree, V.J., Snowdon, C.T., Valenzuela, L. and Marón, C. 2009. Kelp gulls (*Larus dominicanus*) feeding on southern right whales (*Eubalaena australis*) at Península Valdés, Argentina: updated estimates and conservation implications. Paper SC/61/BRG19 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 12pp. [Paper available from the Office of this Journal].

Thomas, P.O., Uhart, M., McAloose, D., Sironi, M., Rowntree, V.J., Brownell, R.L., Jr. , Gulland, F.M.D., Moore, M.J., Marón, C. and Wilson, C. 2013. Workshop on the southern right whale die-off at Península Valdés, Argentina. Paper SC/65a/BRG15 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 5pp. [Paper available from the Office of this Journal].

Wilson, C., Sastre, A.V., Hoffmeyer, M., Rowntree, V.J., Fire, S.E., Santinelli, N.H., Ovejero, S.D., D'Agostino, V., Marón, C.F., Doucette, G.J., Broadwater, M.H., Wang, Z., Montoya, N., Seger, J., Adler, F.R., Sironi, M. and Uhart, M. 2016. Southern right whale (*Eubalaena australis*) calf mortality at Península Valdés, Argentina: Are harmful algal blooms to blame? *Mar. Mamm. Sci.* 32(2): 423-51.

Zerbini, A.N., Mendez, M., Rosenbaum, H., Sucunza, F., Andriolo, A., Harris, G., Clapham, P.J., Sironi, M. and Uhart, M. 2015. Tracking southern right whales through the southwest Atlantic: new insights into migratory routes and feeding grounds. Paper SC/66a/BRG22rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 9pp. [Paper available from the Office of this Journal].

Zerbini, A.N., Rosenbaum, H., Mendez, M., Sucunza, F., Andriolo, A., Harris, G., Clapham, P.J., Sironi, M., Uhart, M. and Ajó, A.F. 2016. Tracking southern right whales through the southwest Atlantic: an update on movements, migratory routes and feeding grounds. Paper SC/66b/BRG26 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 16pp. [Paper available from the Office of this Journal].

Appendix 3

PROGRESS REPORT ON IUCN WESTERN GRAY WHALE ADVISORY PANEL (WGWAP) WORK FROM JUNE 2016 TO MAY 2017

R. Reeves, D. Weller, J. Cooke and G. Donovan

The Western Gray Whale Advisory Panel (WGWAP)[1], which is convened by the International Union for Conservation of Nature (IUCN), continued to provide advice to various parties, but particularly to Sakhalin Energy Investment Company (SEIC), concerning the gray whales that feed each summer off Sakhalin Island, Russia. Since SC/66b, there has been no major change in the Panel's composition and remit although a reduced budget has required scaling back the Panel's range of activities. Reeves and Donovan continue as Co-chairs and Cooke and Weller as members. IUCN and Sakhalin Energy have agreed to extend the WGWAP project for a third five-year tranche from 1 January 2017.

Three formal meetings took place between June 2016 and May 2017:

(1) 11th meeting of the Noise Task Force (NTF-11), November 2016 in Moscow, Russia;
(2) 17th meeting of the Panel (WGWAP-17), November 2016 in Moscow, Russia; and
(3) 12th meeting of the Noise Task Force (NTF-12), March 2017 in Gland, Switzerland.

Final reports of Panel and Noise Task Force (NTF) meetings are available on the WGWAP website. In addition, all recommendations made by the WGWAP and its predecessor IUCN western gray whale panels can be viewed on a searchable database[2].

The objectives of the 2016 and 2017 NTF meetings were: (1) review progress on analyses of data collected during the 2015 seismic survey; (2) receive updates on the proposed 2018 seismic survey and proceed with development of a Monitoring and Mitigation Plan (MMP); and (3) review non-seismic issues as time allowed. A major element of the NTF's work was a simulation analysis by Cooke of the implications of Sakhalin Energy's 2015 MMP to determine: (a) to what extent the mitigation measures contributed to reducing sonic exposure of gray whales; and (b) the effects on predicted exposure of the decisions that were made to relax certain measures that had been implemented in the company's 2010 seismic survey. The Panel recommended that Cooke carry out a similar analysis for the planned 2018 seismic survey once more details on timing, mode (streamer *vs* ocean bottom node) and other aspects are available.

The ongoing collaboration between the IWC and the WGWAP in 2016/17 led to further progress with model testing of gray whale stock identity hypotheses, updating and revision of scientific components of the IUCN/IWC Western Gray Whale Conservation Management Plan, and preparations for a western gray whale stakeholder workshop in early 2018.

Important new information was received at WGWAP-17 on gray whale observations in the western Pacific outside the Sakhalin feeding areas. There were reports of two dead gray whales in Japan in the spring of 2016 and a mother-calf pair of gray whales was photographed in Gizhiginskaya Bay (north-eastern Okhotsk Sea) in late June 2016. The Panel also received the report on acoustic data from the US Navy suggesting that small groups of gray whales are present annually in the East China Sea, moving southwards in the autumn and northwards in the spring that had been presented to the IWC Conservation Committee (Gagnon, 2016). Efforts are underway for independent confirmation of species identity by acoustic experts.

In its WGWAP-17 report, the Panel again emphasised the importance of regular updates to the population assessment and expressed appreciation for the work of the Russian Gray Whale Project (formerly the Russia-US Program), which has provided the long time-series of data used in Cooke's regular assessments. An updated assessment by Cooke is presented at this meeting (SC/67a/NH11).

The Panel expressed concern about an apparent long-term decline in amphipod biomass in the Piltun feeding area because of the implications for gray whale feeding. It recommended that the joint research programme of the two oil and gas companies (SEIC and Exxon Neftegas Limited) explore the nature and causes of this apparent decline in greater detail and provide a report on findings at the next Panel meeting.

In response to a proposal by Sakhalin Energy to increase the speed limit for its crew change vessels from 21 to 35 knots in areas outside the main feeding grounds, the Panel advised that from a conservation perspective, such an increase would be acceptable for a provisional period of 2 years, pending more refined estimation of the risk of ship strikes. The Panel recommended that within the provisional 2-year period, consideration be given to installing dashcams on each vessel that would monitor the sea surface area in front of the bows and that accelerometers be installed with continuous recording, or selective recording of large accelerations. The Company gave assurance that it would carry out the recommended monitoring to enable a risk analysis and also attempt to make the recommend installations on its vessels.

A collaboration between IUCN and the Project 'Mainstreaming Biodiversity into Russia's Energy Sector Practice and Policy' of the United Nations Development Programme (UNDP)/Global Environmental Facility (GEF)/ Ministry of Natural Resources and Ecology of the Russian Federation (MNR) resulted in a final document issued by UNDP titled 'Principles and Guidelines for the Monitoring and Mitigation of Impacts on Large Whales from Offshore Industrial Activity in Russian Waters'[3] for consideration by Russian authorities. This work was presented to Russian authorities immediately ahead of the November 2017 WGWAP meeting in Moscow.

Finally, the issue of gray whale entanglement in fishing gear continued to be a significant concern, as evidenced by a gray whale entangled in fishing gear (net and rope) sighted off Sakhalin in September 2016. An Associate Scientist (Vladimir Burkanov) was enlisted in 2016 to assist the Panel in preparation of a document for the attention of Russian fishery authorities and for submission to the Scientific Committee (see SC/67a/HIM17).

REFERENCE

Gagnon, C. 2016. Western gray whale activity in the East China Sea from acoustic data: Memorandum for Dr. Brandon Southall. Paper IWC/66/CC29 presented to the Conservation Committee of the International Whaling Commission, October 2016, Portoroz, Slovenia (unpublished). 2pp. [Paper available from the Office of this Journal].

[1] *http://www.iucn.org/western-gray-whale-advisory-panel.*
[2] *http://www.iucn.org/western-gray-whale-advisorypanel/recommendations.*
[3] *https://www.iucn.org/sites/dev/files/wgwap_17-28_final_undp_guidelines_clean_2016_en.pdf.*

Annex P

Matters Related to Special Permit Discussions

Annex P1

RELATIVE EFFICIENCY OF BIOPSY VERSUS LETHAL SAMPLING: A RESPONSE TO SC/67A/SCSP11

Phil Clapham

In SC/67a/SCSP11, Yasunaga *et al.* report the results of experiments to compare the relative success of lethal sampling and biopsy sampling of Bryde's, sei and minke whales in the North Pacific. The paper concludes that biopsy sampling 'is not feasible' for minke whales.

There are several problems with this conclusion. First, the sample size involved in the biopsy experiment was very small (only 14 trials, with 2 samples obtained). Second, it appears likely that those responsible for the biopsy sampling lacked experience (this appears to be acknowledged in the final paragraph of the paper), and were very unlikely to improve their aim in only 14 trials. In this context, I would note that I have observed several individuals routinely, and with high success, take biopsy samples from animals smaller than minke whales (including baleen whale calves 5m in length). If this experiment is repeated, it should involve numerous attempts, and should employ an individual with proven high success in sampling minke whales or animals of similar size.

Third, during the presentation of the paper it was noted that the experiments were conducted in sea conditions typical of those occurring during lethal sampling; this included higher sea states than typically exist during biopsy sampling. This would certainly favour lethal sampling since a harpoon has sufficient force to penetrate a whale even if water is covering the body at the time of the hit. However, this misses the main point of sampling, which is not to compare methods but rather to obtain a sufficient sample size to address the biological questions being asked. If, for example, calculations indicate a required sample size of 50 to address a particular question, that does not require that those samples be gathered in sub-optimal sea conditions, only that they be obtained over a reasonable period of time. It should be noted that tens of thousands of biopsy samples have been obtained from baleen whales, including from numerous relatively small animals; Japan appears to be alone in rejecting the utility of this widely used non-lethal method.

Finally, I would suggest that the use of a Generalised Linear Model to assess the relative efficiency of the two methods represents an inappropriately complex statistical approach in light of the very small sample size involved with the biopsy sampling. In short, it is 'statistical overkill' that cannot validate the conclusions of a poorly designed experiment with inadequate trials.

Annex P2

RELATIVE EFFICIENCY OF BIOPSY VERSUS LETHAL SAMPLING: A RESPONSE TO ANNEX P1

Genta Yasunaga and Tsutomu Tamura

First of all, it is important to note that the purpose of this experiment was to conduct a comparative study between lethal and non-lethal methods. The experiment was thus designed to verify a hypothesis that lethal methods could be replaced by non-lethal methods. Unfortunately, the Annex P1 seems to be based on the author's misunderstanding of the purpose of this study, which was that it explores the utility of non-lethal methods.

The aim of document SC/67a/SCSP11 was to refine the preliminary analyses presented to the NEWREP-NP review workshop on the efficiency of biopsy sampling in relation to lethal sampling (Yasunaga *et al.*, 2017), which was conducted using the evaluation framework developed by Mogoe *et al.* (2016). The statistical analyses reported in SC/67a/SCSP11 were in specific response to recommendations from the Expert Panel for NEWREP-NP.

In Annex P1, Clapham disagrees with the main conclusion of SC/67a/SCSP11 that biopsy sampling is not feasible for coastal common minke whale, arguing as follows:

'The sample size involved in the biopsy experiment was very small in common minke whales'

While the sample size of biopsy experiment is considered by Clapham to be 'very small', the basic statistical analyses based on GLM already indicated a significant difference given this sample size. The statement of 'very small' is therefore of little relevance. The proponents have shown that the results of the analyses suggested by the Expert Panel for NEWREP-NP basically confirm the original conclusion submitted to the workshop that biopsy sampling is not feasible in practical terms (too inefficient) for coastal minke whale (Yasunaga *et al.*, 2017; SC/67a/SCSP11).

'It appears likely that those responsible for the biopsy sampling lacked experience'

The reference to 'experience' in SC/67a/SCSP11 was in comparison to the experience of the shooters in offshore waters. However the proponents consider that all shooters (coastal and offshore) have sufficient experience and ability with the Larsen system because essential experience/ requirements for biopsy sampling (e.g. finding, scoping and shooting whales) are almost the same as those for lethal sampling. Our carefully considered view is that dramatic improvement cannot be expected for the success rate of biopsy sampling for common minke whales, even if shooters had more experience and training time in biopsy sampling, because their skill and long experience as whalers are already sufficient.

'I have observed several individuals routinely, and with high success, take biopsy samples from animals smaller than minke whales (including baleen whale calves 5m in length)'

The proponents consider that the fundamental issue here is not animal size itself, but rather a matter of behaviour (in this case of common minke whales in western North Pacific). Typically, the behaviour of these whales is quick and unpredictable movements. The Expert Panel of NEWREP-NP has agreed '… it is more difficult to biopsy sample common minke whales than the other species' (SC/67a/Rep01). No evidence is provided in Annex P1 that invalidates the conclusion of the Panel.

'This misses the main point of sampling, which is not to compare methods but rather to obtain a sufficient sample size to address the biological questions being asked'

It should be made clear that the purpose of this research was to COMPARE non-lethal methods to lethal method rather than just exploring the utility of biopsy sampling. Therefore, the experiments needed to be conducted in sea conditions typical of those occurring during lethal sampling. We have already estimated the expected number of biopsy samples of common minke whales obtainable using the Larsen system in each coastal survey component. The expected sample size of biopsy samples of minke whales in the Sanriku and Kushiro surveys are 3.8 and 6.2 whales/research period respectively. These results make very clear that a reasonable number of biopsy samples of common minke whales cannot be obtained by biopsy sampling in the Sanriku and Kushiro surveys (Yasunaga *et al.*, 2017).

'It is "statistical overkill" to compare two methods using GLM analyses'

The author of Annex P1 comments that 'the use of a Generalized Linear Model to assess the relative efficiency of the two methods represents an inappropriately complex statistical approach in light of the very small sample size involved with the biopsy sampling.' First, the proponents note that the Expert Panel of NEWREP-NP requested statistical analyses of the type presented in SC/67a/SCSP11. Specifically, the Expert Panel of NEWREP-NP recommended that 'analyses that provide a proper comparison of biopsy sampling and catching (including time to process samples under various variables such as experience of sampler, vessel, equipment, effort under similar conditions)' (SC/67a/Rep01). The analyses in SC/67a/SCSP11 were conducted to check that the preliminary comparative analysis presented to the review workshop was not misleading, and this aim was achieved by the additional analyses presented in SC/67a/SCSP11.

The author of Annex P1 states that 'Japan appears to be alone in rejecting the utility of this widely used non-lethal method'. However, the proponents have not rejected the utility of biopsy sampling *per se*. Rather, the proponents have demonstrated that the efficiency of biopsy sampling is significantly and substantially inferior to the lethal method, to the extent that biopsy sampling for common minke whale is practically unfeasible for reasons of inefficiency. Japan has extensively collected and used a large number of biopsy samples for other large whale species such as humpback, right and blue whales. In fact Japan has collected the largest number of biopsy samples of humpback and southern right whales in the Antarctic Ocean. Furthermore, Japan will conduct some further experiments for common minke whales in order to improve the technical aspects of the biopsy sampling equipment under NEWREP-NP, following the advice of foreign experts.

REFERENCES

Mogoe, T., Tamura, T., Yoshida, H., Kishiro, T., Yasunaga, G., Bando, T., Kitamura, T., Kanda, N., Nakano, K., Katsumata, H., Handa, Y. and Kato, H. 2016. Field and analytical protocols for the comparison of using lethal and non-lethal techniques under the JARPNII with preliminary application to biopsy and faecal sampling. Paper SC/66b/SP08 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Yasunaga, G., Mogoe, T., Tamura, T., Yoshida, H., Bando, T. and Kato, H. 2017. Results of the feasibility study on non-lethal techniques to address the key research objective of JARPNII, based on data and samples obtained in the period 2014-2016. Paper SC/J17/JR03 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 39pp. [Paper available from the Office of this Journal].

Annex P3

COMMENTS ON JAPAN'S SPECIAL PERMIT WHALING PROGRAMS

G.J. Pierce, R. Almeida, E. Arguedas, C.S. Baker, E. Bell, R.L. Brownell Jr., E. Burkhardt, D. Cholewiak, P. Clapham, J. Cooke, M. Cosentino, W. de la Mare, M. Double, P. Fruet, P. Gallego, A.M. Gonzalez, N. Hielscher, M. Iniguez, Y. Ivashchenko, K. Jeliæ, G Lauriano, R. Leaper, K. Long, D. Lundquist, S.D. Mallette, J. McKinlay, S. Panigada, S. Reeves, V. Ridoux, F. Ritter, J. Rodriguez, H. Rosenbaum, M.B. Santos, M. Scheidat, M. Sequeira, M. Simmonds, M. Stachowitsch, A. Strbenac, E. Vermeulen, P. Wade and A. Zerbini

At an IWC Workshop in January/February 2017, the independent Expert Panel reviewing Japan's Proposed Research Plan for New Scientific Whale Research Programme in the western North Pacific (NEWREP-NP) concluded, with consensus, that:

> 'in its current version: (1) the Proposal does not adequately justify the need for lethal sampling and the proposed sample sizes, particularly with respect to quantifying the likely extent of management and conservation improvement in the context of the IWC; and (2) has basic design shortcomings. The Panel recommends that the lethal sampling components of the programme should not occur until the additional work identified in its report is undertaken and reviewed.' (SC/67a/Rep01, p.44)

Specifically, the Panel concluded that the proponents had not provided sufficient justification for either the proposed sampling design or the sample size, nor had they demonstrated that additional age data obtained from lethal sampling would significantly improve conservation and management. In addition, the Panel expressed concern regarding the potential effect of the catches on minke whales, notably with regard to J stock (for which there are already known conservation concerns relating to high levels of bycatch). The papers presented by Japan to IWC SC/67a (SC/67a/SCSP01, SC/67a/SCSP09-SCSP10, SC/67a/SCSP12) did not address these substantive issues identified by the Expert Panel. A detailed description of the problems identified by the Panel can be found in SC/67a/Rep01 and is not repeated here.

This is the second IWC Expert Panel to conclude that Japan has not demonstrated the need for lethal sampling. In February 2015, another independent Expert Panel reviewing the proposal for the Antarctic Special Permit program, NEWREP-A, concluded that:

> 'with the information presented in the proposal, the Panel was not able to determine whether lethal sampling is necessary to achieve the two major objectives; therefore, the current proposal does not demonstrate the need for lethal sampling to achieve those objectives... the Panel agrees that if there is a short (e.g. 2-3 year) gap in the existing series to enable the recommended analyses to be completed related to fully quantifying and prioritising sub-objectives and determining appropriate techniques (lethal or nonlethal), this will not have serious consequences for monitoring change. The Panel therefore agrees that [its] recommendations... should be completed and the results evaluated before there is a final conclusion on lethal techniques and sample sizes.' (IWC, 2016)

Thus, the conclusion that lethal sampling is currently unjustified, and should be halted at least until more research has been conducted, now applies to both of Japan's active whaling programs; the additional work performed since publication of the two panels' reports has not yielded results that change the situation (for example, with respect to age data, the Committee agreed in 2015 that whether the further work was 'likely to lead to substantial improvements in conservation and management is yet to be demonstrated').

Despite this, and the availability of non-lethal alternatives to achieve proposal objectives, Japan has disregarded the major conclusions of both independent Expert Panels as well as the view of many members of the Scientific Committee, and is continuing to conduct lethal sampling in the North Pacific and Antarctic.

REFERENCE

International Whaling Commission. 2016. Report of the Expert Panel to Review the Proposal by Japan for NEWREP-A, 7-10 February 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 17:507-54.

Annex P4

RESPONSE TO: COMMENTS ON JAPAN'S SPECIAL PERMIT WHALING PROGRAMS GIVEN IN ANNEX P3

Government of Japan

Pierce *et al.* (Annex P3) claim that lethal sampling in Japan's research programs (NEWREP-NP and NEWREP-A) is unjustified and should be halted.

This claim is however without foundation and thus invalid.

With respect to NEWREP-NP, they reference four documents submitted by the proponents (SC/67a/SCSP01, SC/67a/SCSP09-10 and SC/67a/SCSP12) and argue that the proponents 'did not address these substantive issues identified by the Expert Panel'. This conclusion is however incorrect, as Pierce *et al.* clearly fail to consider the most important document that addresses the major concerns of the Expert Panel, namely SC/67a/SCSP13, as well as the results of deliberations on that document in the sub-committee on the RMP.

For example, the Expert Panel recommended further analyses to assess the potential effects of catches. The proponents presented results of the additional analyses (SC/67a/SCSP13, pp.45-56), and the sub-committee on the RMP, which reviewed the progress in detail, commended the considerable work conducted by the proponents, and further agreed that the analyses of SP13 'address[ed] the major concerns raised by the Expert Panel' (see Annex D).

While the Expert Panel also expressed its concerns about the justification of sample sizes for the lethal components, the proponents conducted further analyses and presented the amended sample sizes of minke and sei whales (SC/67a/SCSP13, pp.2-38 for common minke whale; pp.39-44 for sei whale), together with provision of additional clarification and scientific justification for their overall approach. As recorded in the report of the sub-committee on the RMP, while the existence of 'widely different opinions' was noted (see Annex D), the justification of sample sizes of NEWREP-NP was duly recognized and supported by a number of members of the Scientific Committee.

Pierce *et al*. thus ignore the additional analyses and justifications provided by the proponents in responding to the recommendations by the Expert Panel as well as the conclusion of the sub-committee on the RMP. Furthermore they query the need for the collection of age data while ignoring the fact that this is regarded as of high priority by many other RFMOs (among other marine resource management groups) for improved resource management (see SC/67a/SCSP13, pp.6-7); their position implies that these many organisations are incorrect in this regard, but they offer no scientific analyses to justify this implication of their stance.

Furthermore, it should be noted that the proponents responded, in good faith, to all other recommendations by the Expert Panel providing scientific justifications, in addition to the major concerns mentioned above (see SC/67a/SCSP01 and SC/67a/SCSP10). The proponents' responses were supported by a number of members of the Scientific Committee.

It is unfortunate that Pierce *et al*. demonstrate their unwillingness to understand and appreciate the considerable efforts made by the proponents in sincerely responding to the comments by the Expert Panel Workshop, as well as the discussion thereon that ensued at SC/67a.

With respect to NEWREP-A, Pierce *et al*. also refer to the report of the Expert Panel for NEWREP-A held in 2015, and argue that 'lethal sampling is currently unjustified'. However, it should be noted that the proponents have already reported to last year's Scientific Committee that they had sufficiently completed responses to the recommendations to be addressed prior to the start of the program, and their view was shared by other scientists who 'commented that the proponents had responded satisfactorily to most of the recommendations of the Expert Panel, noting that some of the suggested further analyses have already been completed, while others are in progress or will be addressed within a reasonable timeframe' (IWC, 2017). The proponents reported further progress on their additional analyses in response to the recommendations made by last year's Scientific Committee (SC/67a/SCSP12) to this year's Scientific Committee and will continue to do so. Unfortunately, however, Pierce *et al*. hardly indicate any willingness to consider this and accept that progress has been made by the proponents.

In conclusion, the proponents have demonstrated the justification for lethal sampling sufficiently for both NEWREP-NP and NEWREP-A. The statement by Pierce *et al*. that 'Japan has disregarded the major conclusions of both independent Expert Panels as well as the view of many members of the Scientific Committee' shows only their absence of consideration of all the pertinent information.

REFERENCE

International Whaling Commission. 2017. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

Annex P5

SUMMARY TABLES OF PROGRESS ON RECOMMENDATIONS FOR NEWREP-A AND JARPN II

NEWREP-A: Summary table of progress with recommendations

Key for 'Purpose': A: To evaluate contribution of a particular objective or sub-objective of the programme to meet conservation and management needs. B: To evaluate feasibility of particular techniques (whether lethal or non-lethal). C: Relevant to a full evaluation of whether any new lethal sampling is required D: Relevant to issues related to sample size (irrespective of method used to obtain data). E: Relevant to improve existing components of the proposed programme. Note that under 'Suggested timeframe' this was a rough estimate by the Panel and will depend on the amount of time and effort available. A considerable number of the recommendations require analytical work (this includes simulation modelling). Achieving all of these within the timeframe estimated for each individual item will require considerable resources. Those that relate to purposes A, B, C and D are higher priority for completion.

Item	Summary	Purpose	Panel's suggested timeframe	Needs new samples/data? Effort type	Proponents comments on progress (see SC/67a/SCSP12)	*Committee comments on progress in 2016* **Committee comments in 2017**
2.1.2 (1)	Evaluate the level of improvement that might be expected either in the SCAA or in RMP performance by improved precision in biological para-meters using simulation studies including updated *Implementation Simulation Trials*.	A, C, D	Within 6 months	No, analytical	**Completed to a reasonable level** (see details in Government of Japan, 2016b). The RMP/*IST*-like simulations conducted show that in nearly all cases, the modifications of the RMP's *CLA* to include information from catch-at- age data lead to either or both of catch being increased and low levels of lowest depletion being improved (where necessary) compared to the *CLA*. This also applies given periods of especially low or especially high recruitment to the minke whale populations under consideration.	*2016: The proponents have decided to evaluate how the availability of age data can improve management performance rather than assessing the extent to which estimates of management quantities (such as MSYR) can be improved given additional data from NEWREP-A. The RMP/IST-like simulations are conceptually the appropriate way to conduct this evaluation. However, the MCLA needs to be tuned to ensure better comparability with the CLA to allow appropriate comparisons to be made (see Item 5.1.1) and the scenarios need to linked more clearly to information from SCAA (i.e.be conditioned on the data). This could be achieved, for example, by assuming that the past changes in carrying capacity and/or growth could occur in the future. An Advisory Group has been established to provide advice with respect to mathematical specifications (see Annex T4). The Committee recognized a range of opinions as to the extent to which this recommendation has been addressed.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid. See also Recc. 26 and Item 19.2.1.**
3.1.3 (2)	Analyses to distinguish between two stocks with mixing versus isolation by distance.	A, D	Within 3 months	No, analytical	**Already in progress.** Preliminary analyses have been conducted between the ICR and the Tokyo University of Marine Science and Technology (a document with results will be prepared for the 2017 SC meeting). As expected by the proponents, preliminary results showed that the effect size of the stocks in the Antarctic is too low to allow for the methods proposed by the review workshop to distinguish between the two hypotheses. The proponents consider that the hypothesis of at least two stocks with mixing in the research area is the hypothesis better supported by the genetic and non-genetic data.	*2016: The Committee notes that the work will be presented at the 2017 meeting.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
3.1.3 (3)	Simulation study to examine how additional sampling could be expected to improve precision and/or reduce bias in estimates of mixing rates.	A, D	Within 3 months	No, analytical	**To be completed in the next 1-2 years.** The original timeframe for this recommend-ation was for report at the 2016 IWC SC. However, the proponents consider that the work associated with this recommendation has lower priority among the remaining recommendations as this topic is not related to the main objectives of NEWREP-A. The proponents plan to conduct the relevant analyses to be reported to the 2018 SC meeting.	*2016: No progress reported although the Committee notes that the work will be presented at the 2018 meeting.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
3.1.3.1 (4)	Comprehensive biopsy sampling feasibility study.	B, C, D, E	1-2 field seasons	Yes, field effort	**Already in progress.** Explanation of the design of the biopsy sampling feasibility studies has been included in the research plans for the dedicated sighting surveys presented annually to, and endorsed by the IWC SC (Government of Japan, 2015d; Hakamada *et al.*, 2016). The design has considered all elements in the recommendation. Results of the feasibility study conducted in Area IV in 2015/16 were presented by Isoda *et al.* (2016), and those obtained in the study conducted in Area V in 2016/17 are presented in SC/67a/ASI07. A Generalized Linear Model (GLM) used to compare the efficiency between biopsy and lethal sampling, indicated that the success of biopsy sampling was significantly lower than the lethal sampling (SC/67a/ASI07). Final results will be presented to the 2018 SC annual meeting.	*2016: Hakamada et al. (2016) summarised the research plan for the 2016/17 survey, including the biopsy feasibility study. Isoda et al. (2016) reported preliminary results on biopsy sampling obtained during the 2015/16 NEWREP-A survey.* **2017: SC/67a/ASI07 reported results on biopsy sampling obtained during the 2016/17 NEWREP-A survey.**
3.1.5 (5)	Comprehensive telemetry feasibility study.	B, E	2-3 field seasons	Yes, field effort	**Already in progress.** Explanation of the design of the telemetry feasibility studies has been included in the research plans for the dedicated sighting surveys presented annually to, and endorsed by the SC (Government of Japan, 2015d; Hakamada *et al.*, 2016). The design has considered all elements in the recommendation. Results of the feasibility study conducted in Area IV in 2015/16 were presented by Isoda *et al.* (2016), and those obtained in the study conducted in Area V in 2016/17 are presented in SC/67a/ASI07. The focus on the first feasibility studies was on the attachment system, which was improved in the second study. Details of the attachment system, effort, number of successful trial and tracking of the whales are shown in Isoda *et al.* (2016) and SC/67a/ASI07. Final results will be presented to the 2018 SC annual meeting.	*2016: Hakamada et al. (2016) summarised the research plan for the 2016/17 survey, including the telemetry feasibility study. Isoda et al. (2016) reported preliminary results on tagging obtained during the 2015/16 NEWREP-A survey.* **2017: SC/67a/ASI07 presented results on telemetry obtained during the 2016/17 NEWREP-A survey**

Item	Summary	Purpose	Panel's suggested timeframe	Needs new samples/data? Effort type	Proponents comments on progress (see SC/67a/SCSP12)	*Committee comments on progress in 2016* **Committee comments in 2017**
3.2.2 (6)	Estimate $g(0)$for all species.	E	Through-out	Yes, field effort then analytical	**Already in progress.** Survey design and protocols with both the IO and closing modes were implemented during the dedicated sighting surveys in Area IV in 2014/15 (Matsuoka *et al.*, 2015), in Area IV in 2015/16 (Isoda *et al.*, 2016), and in Area V in 2016/17 (SC/67a/ ASI07). The analysis of data collected will allow the estimation of $g(0)$ for large whales.	*2016: Hakamada et al. (2016) summarised the research plan for the 2016/17 survey, which includes the estimation of g(0) for large whale species (using the IWC- SOWER approach). The proposed field plan was approved by the Committee.* **2017: SC/67a/ASI04 summarised the research plan for the 2017/18 survey. The Committee endorsed the cetacean abundance estimation component of this proposal and Matsuoka was appointed to provide IWC oversight.**
3.2.2 (7)	(1) Review survey design and methods taking into account: (a) analysis of IWC IDCR/SOWER cruises; (b) spatial modelling developments; (c) experience of previous multi-disciplinary surveys; (d) JARPA II review recommendations; (e) the possibility of focused surveys on specific issues in some years; (f) whales within the ice; and (g) updated power analyses of the effects of survey interval and estimation of trend. (2) Work closely with the IWC Scientific Committee before finalising survey approaches. (3) Ensure that future survey plans submitted to the Scientific Committee follow fully the guidelines for such survey plans, including incorporating proposed tracklines.	E	Within 6 months then through-out	Yes, analytical then field effort then analytical	**Already in progress.** Research plans including the elements in the recommendations above have been presented annually to the IWC SC. See Government of Japan (2015c) for the survey in 2016/17; Hakamada *et al.* (2016) for the survey in 2016/17, and the research plans have been endorsed by the Committee. The plan for the survey in 2017/18 is presented to the IWC SC in SC/67a/ASI04.	*2016: The Committee approved the proposal in Hakamada et al. (2016).* **2017: See previous recommendation.**
3.3.3 (8)	Examine feasibility of using DNA methylation ageing technique with Antarctic minke whales using good quality earplugs, testing against geo-graphical areas and different time periods and using several laboratories.	B, C, D	Within 1 year	No, laboratory then analytical	**Already in progress.** After technical consultation with one of the authors of Polanowski *et al.* (2014) it was confirmed that genes and position of age-related DNA methylation sites in the Antarctic minke whale were almost homologous to those in the humpback whales. The procedure for identification of age-related DNA methylation site (CpG) and measurement of methylation level followed previous study on humpback whale by Polanowski *et al*. (2014). DNA methylation rate of seven CpGs on three different loci were scored successfully. Furthermore regression analyses of each CpG against age (determined by earplug reading) were conducted. The regression coefficients of each CpG were lower than in the case of the humpback whale study. The next step will involve multiple linear regressions analyses for combined CpG. Final results of the feasibility study will be presented to the 2018 IWC SC annual meeting. Depending on the results and evaluation, further analyses could be conducted considering other whale species and a larger number of loci.	*2016: The Committee was informed that this work has started in collaboration with other research institutions. Results will be presented in 2018.* **2017: See comments in SC/67a/SCSP12.**
3.4.3.1 (9)	Examine use of hormones in blubber to detect sexual maturity.	B, C, D	Within 2 years	No, laboratory	**Already in progress.** The idea here is to estimate reproductive status in females using the concentration of progesterone in blubber, with appropriate accuracy. To this end, a total of 230 female blubber samples (157 pregnant, 17 non-pregnant and mature, and 56 immature) of Antarctic minke whales from Area IV and V sampled in the 2015/16 NEWREP-A survey will be analyzed by ELISA assay, using Crocodile mini-workstation (Titertek-Berthold). The hormone extractions from blubber samples and ELISA assay follow mainly the procedure by Nagata *et al.* (1996) and Perez *et al.* (2011), respectively. The analytical validation and procedure are consulted with the Faculty of Agriculture, Tokyo University of Agriculture and Technology. Measurement of progesterone in the above indicated blubber samples are ongoing. These data will be compared with reproductive information (from anatomical studies on ovaries) to evaluate the feasibility of this progesterone technique to determine reproductive status. As blubber can be obtained by biopsy samples, this technique can potentially be used by non-lethal means. Final results will be presented to the 2018 SC annual meeting.	*2016: The Committee was informed that this work has started in collaboration with other research institutions. Results will be presented in 2018.* **Some information is available (see SC/67a/SCSP12).**
3.4.3.1 (10)	Evaluate the effect on SCAA of assuming 'resting' females are immature females.	A, C, D	Within 6 months	No, analytical	**To be completed in the next 1-2 years.** The proponents will complete this evaluation when conducting additional *IST*- like simulation studies to further validate the improved performance of RMP in the context of recommendation 1*.	*2016: No methods or results presented at this meeting but see discussion under Recommendation 1.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**

Item	Summary	Purpose	Panel's suggested timeframe	Needs new samples/data? Effort type	Proponents comments on progress (see SC/67a/SCSP12)	*Committee comments on progress in 2016* **Committee comments in 2017**
3.4.3.2 (11)	Update SCAA with respect to density-dependence following Punt *et al.* (2014), and stock mixing based on existing data.	A, C, D	Within 3 months	No, analytical	**Completed.** See Government of Japan (2015b). The density- dependence had already been incorporated (the panel comment reflected a misunderstanding). Sensitivity to an extreme alternative boundary was tested and found to make little difference to combined abundance trends. Hence this recommendation is considered to have been addressed, though mixing issues may be considered further when the proponents conduct additional *IST*-like simulation studies to further validate the improved performance of RMP in the context of recommendation 1*.	*2016: The SCAA has been updated using the density-dependence function suggested by the Panel – task complete. However, the SCAA has yet to be updated to include the data on stock mixing and to estimate mixing rates (rather than changing the assumed fixed boundary in the SCAA). Punt advised that this recommendation was not intended by the Panel to be related to RMP/IST testing, but rather to the structure of the SCAA.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
3.4.3.2 (12)	Identify more fully the data to be used to inform the time-varying natural mortality in the SCAA and analyse existing data to determine the feasibility and accuracy of obtaining such estimates.	A, C, D	Within 6 months	No, analytical	**To be completed in the next 1-2 years.** The proponents will complete this identification when conducting additional *IST*- like simulation studies to further validate the improved performance of RMP in the context of recommendation 1*.	*2016: No results nor methods presented but see discussion under Recommendation 1. The Siler model in De La Mare (2016) is one way to account for time-varying natural mortality.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
3.4.3.2 (13)	Develop metrics to evaluate the benefits of including time varying ASM data in the SCAA.	A, C, D	Within 3 months	No, analytical	**Already in progress.** The proponents have shown the impact of time varying ASM on the results of the SCAA (IWC, 2016b). The integration of time varying ASM into ISTs will take place when the proponents conduct additional *IST*-like simulation studies to further validate the improved performance of RMP in the context of recommendation 1*.	*2016: The approach outlined by the proponents should be able to address the recommendation – it would involve imposing time-trends in ASM and evaluating the impacts on performance measures when catch limits are set using the CLA (after NEWREP-A is completed). The analyses to address this recommendation could be used to select an effect size which could then have formed the basis for a power analysis to determine sample size.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
3.6.2.1 (14)	Consider the adoption of this multibeam sonar in krill surveys.	E	Within 6 months	No, logistical	**To be addressed.** Careful consideration will be given before the first dedicated krill survey (CCAMLR-type survey) tentatively scheduled for the 2018/19 austral summer season.	*2016: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **2017: No new information was presented (see SC/67a/SCSP12).**
3.6.2.3 (15)	Trial the ship and echosounder system(s) in Japan well before going to the Antarctic to determine the likely effective acoustic sampling range and potential for detecting krill for multiple frequencies over the required survey depth. Conduct for both annual and broad-scale survey vessels.	B, E	Within 1 year for annual surveys	Yes, logistical, field effort, analytical	**Completed.** Calibration of the echosounder system (EK80) was conducted in Japan before the start of 2016/17 NEWREP-A. Details of this work are provided in SC/67a/EM09.	*2016: This work was completed before the start of the first whale sighting-based krill survey and results were presented in Wada et al. (2016). The Ecosystem Modelling working group encouraged further work on the survey in consultation with CCAMLR specialists.* **2017: Results of the krill and oceanographic survey under the NEWREP-A in the Antarctic in 2016/17 were presented in SC/67a/EM09.**
3.6.2.5 (16)	In the years (two out of 12) when both NEWREP-A and CCAMLR-type surveys are conducted, try to survey the same transects by both vessels in near synchrony.	E	Within prog-ramme	No, logistical	**To be addressed.** Tentatively the first dedicated krill survey (CCAMLR-type survey) will be conducted in the 2018/19 austral summer season. Research plans will be presented to CCAMLR's EMM workshops in 2017 and 2018. This recommendation will be considered in the research plan. The research plan will be adjusted in the light of these recommendations from these meetings.	*2016: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **2017: No new information was presented (see SC/67a/SCSP12).**
3.6.2.6 (17)	Conduct full analysis of statistical power to detect changes in krill abundance from proposed techniques.	A, E	Within 6 months	No, analytical	**To be addressed.** This has been deferred until planned discussions with CCAMLR experts have taken place.	*2016: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **2017: No new analysis was presented (see SC/67a/SCSP12).**
3.6.2.7 (18)	Develop more detailed plans to consider whether comparisons between stomach contents and proposed krill survey data are feasible and if so, how they can be done.	A, B, C	Within 3 months	No, logistical	**To be addressed.** This has been deferred until the planned discussions with CCAMLR experts have taken place.	*The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **2017: No new analysis was presented (see SC/67a/SCSP12).**
3.7.2 (19)	Ensure that sufficient time is allocated for adequate net sampling, based an analysis of previous net sampling data (e.g. BROKE/BROKE West data).	E	Within prog-ramme	No, logistical, analytical	**To be addressed.** Tentatively the first dedicated krill survey (CCAMLR-type survey) will be conducted in the 2018/19 austral summer season. Research plans will be presented to CCAMLR's EMM workshops in 2017 and 2018. This recommendation will be considered in the research plan. The research plan will be adjusted in the light of the recommendations from these meetings.	*The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **No new analysis was presented (see SC/67a/SCSP12).**
3.8.2 (20)	Give careful consideration to scale and design of oceanographic sampling, taking into account BROKE/BROKE West data.	E	Within prog-ramme	No, logistical, analytical	**To be addressed.** Tentatively the first dedicated krill survey (CCAMLR-type survey) will be conducted in the 2018/19 austral summer season. Research plans will be presented to CCAMLR's EMM workshops in 2017 and 2018. This recommendation will be considered in the research plan. The research plan will be adjusted in the light of the recommendations from these meetings.	*2016: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists.* **2017: No new analysis was presented (see SC/67a/SCSP12).**
3.9.3.1 (21)	Compare overlap in diet amongst fin and Antarctic minke whales using stable isotopes in skin, with concurrent analyses of krill samples to obtain stable isotope baselines.	E	Through-out prog-	Yes, field effort, analytical	**In progress.** The study involves two steps: the first is the stable isotope analyses of the prey species (krill) samples to ensure the correct determination of stable isotope baselines; and the second is stable isotope analyses of skin samples of Antarctic minke whales and of biopsy samples of fin and humpback whales. At this juncture, the stable	*2016: The Committee was informed that this work was started in collaboration with other research institutions. Final results will be presented to the mid- term review.* **2017: No new analyses (see SC/67a/SCSP12).**

Item	Summary	Purpose	Panel's suggested timeframe	Needs new samples/data? Effort type	Proponents comments on progress (see SC/67a/SCSP12)	*Committee comments on progress in 2016* **Committee comments in 2017**
			ramme		isotope analyses of four Antarctic krill samples and of 16 Antarctic minke whale skin samples have been conducted. The isotope value of δ13C and δ15N at the base of four krill samples were -26.90±0.45‰ and 3.68+0.36‰, respectively. The isotope value of δ13C and δ15N at the base of 16 skin samples of Antarctic minke whales were -25.04±0.43‰ and 7.26+0.61‰, respectively. Further analyses will be conducted on additional samples to obtain a correct determination of stable isotope baselines. This study is being carry out in collaboration with the Laboratory of Marine Ecosystem Change Analysis, Field Science Center for Northern Biosphere, Hokkaido University. Final results will be presented to the mid-term review meeting.	
3.9.3.1 (22)	Develop a more powerful approach to esti-mating energy intake (requirements) using a bioenergetics model; evaluate non-lethal methods for obtaining a time series of tuning data for such models.	A, B, D	Within 6 months	No, analytical	**To be addressed.** Need clarification from the IWC SC.	*2016: The Committee was informed that this work will be completed in 1-2 years.* **2017: No new information (see SC/67a/SCSP12).**
3.9.3.1 (23)	Investigate stable isotopes along edge of baleen plates to see if this provides insights into duration of time on feeding grounds.	B	Within 6 months	No (if existing samples), laboratory	**In progress.** Stable carbon and nitrogen isotope ratios will be determined along edge of the baleen plates of 10-20 Antarctic minke whale baleen plates. Each baleen plate will be examined at around 20 places following Mitani *et al.* (2006). The analysis of baleen plates from ten Antarctic minke whales sampled by the NEWREP-A in the Ross sea in 2016 were already conducted to understand annual cycle of nitrogen and carbon, and to estimate prey species among five potential prey species: Antarctic krill, ice krill, silver fish, Australian krill and Australian pelagic fish. The annual cycle of nitrogen in baleen plates was 7.7±2.0cm (mean±SD, range: 6.0-10.0cm), while no constant cycle was observed in carbon. The stable isotopic values at the base of baleens in carbon and nitrogen were -25.01±0.49‰ and 7.03+0.33‰, respectively. Assuming that the trophic enrichment factor in this species is the same as that in fin whales (2.77‰), the Antarctic krill was the most likely prey as the difference in nitrogen between the baleen and prey was the minimum (3.48‰) among five potential prey species. No seasonal variation in carbon suggested that they were fasting after feeding in the Antarctic, while there were two individuals which had a nitrogen cycle of more than 12cm in baleen plates. The extended period of nitrogen cycle suggested that they remained at the Antarctic to save their energy and to accumulate the energy for their growth to prepare for the next year by skipping migration to the breeding grounds. This study is being carried out in collaboration with the Field Science Center for Northern Biosphere, Hokkaido University. Final results will be presented to the 2018 IWC SC meeting.	*2016: The Committee was informed that this work has been started in collaboration with other research institutions. Final results will be presented at the 2018 Annual Meeting.* **2017: Some new information was presented in SC/67a/SCSP12**
3.9.3.3 (24)	Use 'non-lethal' techniques on all animals; develop 'condition indices'; work to develop non-lethal techniques for total consumption.	E	Within prog-ramme	To be deter-mined after relevant anal-yses related to purposes A-D are completed	**To be addressed.** This needs careful consideration. Clarification from the IWC SC is required.	*2016: No new information.* **2017: No new information (see SC/67a/SCSP12). (See comments from the proponents).**
3.11.2 (25)	Provide an improved outline of the pro-posed ecosystem and multispecies model structures and provide a data gap analysis.	E	Within 3 months	No, analytical	An update of the Mori- Butterworth Antarctic ecosystem model, taking JARPA and JARPAII data into account was presented in SC/67a/EM14.	*2016: The Committee notes that the work will be presented at the 2017 meeting.* **2017: Some results were presented in SC/67a/EM14. The Proponent will present results in 2018 (see SC/67A/SCSP12).**
4.2.1 (26)	Provide a thorough power analysis of sample sizes required to detect change in ASM and follow the other recommendations in this Item.	D	Within 3 months	No, analytical	**Completed to a reasonable level.** See details in Government of Japan (2016b; 2015a). The proponents conducted re- analyses and the results indicate that the point estimate of the cohort random effect is zero. The results therefore do not lead to any strong reason to change the sample size. Consequently the proponents have concluded that the reasonableness of the proposed sample size (333) has now been adequately demonstrated.	*2016: The analyses now reasonably account for three of the six aspects that constitute a realistic model (i.e. ageing-reading error, overdispersion in catch composition, recruitment variation).* ***Overall, the approach being taken to address the recommendation is appropriate but some further refinements are required.*** • *Government of Japan (2016b) restricts the data used to fit the models to ages 4- 13 and 1980-87 and 1992-99. All of the data should be used to estimate the amount of extra- age, -cohort and -year variation rather than restricting the analysis to a subset of years and ages. Doing this also avoids the need to simulate the process of excluding some cohorts and ages when analysing future (simulated) age data.* • *The estimates in Government of Japan (2016b) of the variance of cohort random effects and extra-binomial variation (i.e. overdispersion) are zero, which makes these asymptotic estimates potentially questionable. Use a method (such as likelihood profile or the R package blme) to better quantify the*

Item	Summary	Purpose	Panel's suggested timeframe	Needs new samples/data? Effort type	Proponents comments on progress (see SC/67a/SCSP12)	*Committee comments on progress in 2016* **Committee comments in 2017**
						uncertainty of these variances and develop probability distributions for them. An example of a likelihood for the overdispersion parameter was provided, confirming that the asymptotic estimate of variance is too small. The simulations to evaluate power should then sample from these distributions. • *The current analyses do not attempt to specifically quantify the effects of year-to-year sampling variation, which reflects the impact of, for example, the locations of sampling (for examples, in some years in regions where mature animals predominate) although overdispersion arising from this sort of heterogeneity was considered to some extent in Government of Japan (2016b) in beta-binomial model.* • *Though challenging, simultaneous estimation of random effects of year and cohort can be explored using the type of model used to estimate cohort random variation in Government of Japan (2016b).* **2017: No new analysis was presented (see SC/67a/SCSP12) and Item 19.2.1. The 2016 comments remain valid.**
5.2 (27)	Provide additional analyses on effect of catches upon the stocks for comparison with those presented.	E	Within 3 months	No, analytical	The proponents had provided results based on one application of the *CLA* and by using the program Fitter. The NEWREP-A review workshop agreed that the conclusion that catches of the order of 333 every 2nd year form these analyses will not harm the stocks is very likely robust to the analytical method applied (IWC, 2016a). Therefore the proponents see no real need to implement this recommendation.	*2016: The Committee notes the rationale for the additional work provided in the Panel report and agrees with that position.* **2017: No new information (see SC/67a/SCSP12). The 2016 comments remain valid.**
7.2 (28)	Improve mechanisms for co-operative research.	E	Within 3 months	No, logistical	**Already in progress.** The proponents have already posted a formal protocol for outside scientists to submit proposals for both field and analytical work. Expanded information on the mechanisms for co-operative research was presented in the revised research plan proposal for NEWREP-NP (GOJ, 2017), which is also valid for NEWREP-A (see section 6 and Annexes 20 and 22 of the NEWREP-NP revised research proposal).	*2016: The Committee noted the protocol placed upon the ICR website.* **2017: See comments in SC/67a/SCSP12.**
8.2 (29)	Provide information on programme management, personnel and logistic resources.	E	Through-out prog-ramme	No, logistical	**Already in progress.** Expanded information and explanation of the logistics and project management was presented in the revised research proposal for NEWREP-NP (Government of Japan, 2017), which is also valid for NEWREP-A. In particular refer to section 5 and Annex 21 of the research proposal.	*2016: Government of Japan (2016a), Appendix 1 contains a progress report on management, personnel and logistic resources.* **2017: See comments in SC/67a/SCSP12.**

*As described in the sub-section 4.4 of Government of Japan (2016a), the proponents believe that the response required for recommendation 1 has been provided. Building upon this, the proponents are aware that, for justifying the adoption by the Committee of a modified *CLA* with age data (MCLA) for Antarctic minke whales in preference to the existing *CLA*, further work would need to be specified by and then undertaken through the Committee. This would involve both refinement of the MCLA developed here and its testing under a more extensive set of trials/OMs, and such further work would desirably be pursued in the future. However, in line with the Committee's customary practice, a pre-requisite for this further work, is for the Committee to provide a pre-specified set of agreed trials (the proponents, if contributing to such further work, should not be expected to invest considerable time in developing and running further trials, only to be informed later by the Committee that they would have wanted different trials run). Accordingly, the proponents look forward to the Committee agreeing on the specifications of an extension to the trials undertaken here (or at least, more immediately, on a process to develop those specifications in the Committee), so that work can continue in the Scientific Committee with the aim of ultimately adopting a MCLA making use of age data which would be suitable for implementation for setting catch limits for Antarctic minke whales.

REFERENCES

De La Mare, W.K. 2016. Simulation studies on the properties of estimates from statistical catch at age models. Paper SC/66b/IA08rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 42pp. [Paper available from the Office of this Journal].

Government of Japan. 2015a. Information on Japan's plan for krill surveys in East Antarctic. Paper WG-EMM-15/43 presented to the CCAMLR-WG-EMM.

Government of Japan. 2015b. Proponents' additional responses to the Report of the Expert Panel to review the proposal for NEWREP-A. Paper SC/66a/SP08 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 38pp. [Paper available from the Office of this Journal].

Government of Japan. 2015c. Proponents' preliminary response to the Report of the Expert Panel to review the proposal for NEWREP-A. Paper SC/66a/SP01 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 34pp. [Paper available from the Office of this Journal].

Government of Japan. 2015d. Proposed research plan for new scientific whale research program in the Antarctic Ocean (NEWREP-A). Paper SC/F15/Document presented to the Newrep-A Special Permit Expert Panel Review Workshop, February 7-10 2015, Tokyo, Japan (unpublished). 101pp. [Paper available from the Office of this Journal].

Government of Japan. 2016a. Progress report of the work conducted by the proponents in response to IWC Scientific Committee's recommendations on NEWREP-A. Paper SC/66b/SP09 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Government of Japan. 2016b. Results of the analytical work on NEWREP-A recommendations on sample size and relevance of age information for the RMP. Paper SC/66b/SP10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 24pp. [Paper available from the Office of this Journal].

Government of Japan. 2017. Proposed research plan for new scientific research program in the western North Pacific (NEWREP-NP). Paper SC/J17/JR01 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 164pp. [Paper available from the Office of this Journal].

Hakamada, T., Matsuoka, K. and Pastene, L.A. 2016. Research plan for the NEWREP-A dedicated sighting survey in the Antarctic in 2016/17. Paper SC/66b/IA04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 13pp. [Paper available from the Office of this Journal].

Isoda, T., Kawabe, S., Ohkoshi, C., Mogoe, T. and Matsuoka, K. 2016. Results of the NEWREP-A dedicated sighting survey in Area IV during the 2015/16 austral summer season. Paper SC/66b/IA05 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 26pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2016a. Report of the Expert Panel to Review the Proposal by Japan for NEWREP-A, 7-10 February 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 17:507-54.

International Whaling Commission. 2016b. Report of the Scientific Committee. Annex Q. Matters related to Item 17. Special Permits. *J. Cetacean Res. Manage. (Suppl.)* 17:415-22.

Matsuoka, K., Tsunekawa, M., Yamaguchi, F., Honma, H., Ohkoshi, C. and Abe, N. 2015. Cruise report of the 2014/15 Japanese dedicated whale sighting survey in the Antarctic in Area IV. Paper SC/66a/IA07 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 22pp. [Paper available from the Office of this Journal].

Mitani, Y., Bando, T., Takai, N. and Sakamoto, W. 2006. Patterns of stable carbon and nitrogen isotopes in the baleen of common minke whale *Balaenoptera acutorostrata* from the western North Pacific. *Fish. Sci.* 72: 69-76.

Nagata, S., Kondou, M., Kaneko, H., Araki, K., Nambo, Y., Oikawa, M., Watanabe, G. and Taya, K. 1996. A simple defatting method using a partition method of acetonitrile and n-hexane for radioimmunoassay of low blood levels of estradiol-17β. *J. Reprod. Develop.* 42: 43-49.

Perez, S., Garcia-Lopez, A., Stephanis, R.D., Gimenez., J. and Garcia-Tiscar, S. 2011. Use of blubber levels of progesterone to determine pregnancy in free-ranging live cetaceans. *Mar. Biol.* 150: 1011-24.

Polanowski, A.M., Robbins, J., Chandler, D. and Jarman, S.N. 2014. Epigenetic estimation of age in humpback whales. *Mol. Ecol. Res.* 14(5): 976-87.

Punt, A., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93-116.

Wada, A., Isoda, T., Okoshi, C. and Tamura, T. 2016. Result of the 2015/16 NEWREP-A sighting survey vessel-based krill survey in the Antarctic Area IV. Paper SC/66b/EM03 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].

JARPN II: 2017 Scientific Committee discussion and the current status of progress.

	Topic (and agenda number from the 2016 Panel review)	2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents (SC/67a/SCSP09)	**Progress at SC/67a (2017)**
Sampling design and areas (Item 3.4.2.1)				
(1)	A new paper that in addition to the information on sightings, it should document, for each year and season: (a) the predetermined tracklines for sampling and the rationale for those lines; and (b) the actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the rationale for any new lines developed. (c) It should also address the issue of whether the actual sampling that occurred can be said to be representative of: (a) the animals in the surveyed area; and (b) those in the biological population(s) and discuss the extent to which this may affect those objectives/ parameters/analyses for which this is or may be important.	By SC/2016 - The proponents responded in Bando *et al.* (2016). The Committee discussed this at some length (see Item 18.2.3.1). Suggestions were made to improve the manuscript and to better evaluate the appropriateness of the pooling of data. This requires analyses that disaggregate the data collected according to the two different sampling strategies. This may allow pooling of data but the precision of estimated quantities, and hence required sample sizes, should also be examined. Issues related to the sample representativeness and the effect of this are partially addressed. **2017 Panel comment: Relevant to discussion under Item 4.2.**	**Already in progress.** The proponents responded to the above recommendations in Tamura *et al.* (2016a) and Bando *et al.* (2016). Several analyses are ongoing.	**No new information presented (see SC/67a/SCSP09).**
(2)	Papers using data from the inshore component must fully address the implications of the logistical rather than scientific sampling design.	By SC/2016 - Partially addressed in Bando *et al.* (2016) but further analyses required to make allowance for non-random sampling. **2017 Panel comment: Relevant to discussion under Item 4.2.**	**Already in progress.** The proponents responded to the above recommendations in Tamura *et al.* (2016a) and Bando *et al.* (2016). Several analyses ongoing.	**No new information presented (see SC/67a/SCSP09).**
Sample size (Item 3.4.2.2)				
(3)	A new paper should be developed that: (a) provides a clearer rationale for the changes in sample sizes initiated in 2014 and any implications for meeting the original objectives of the programme; and (b) provides the field and analytical protocols for the comparison of using lethal and non- lethal techniques for each key parameter taking into account the advice provided in 2009.	By SC/2016 - (3a) The proponents provided some information in Tamura *et al.* (2016a). The Committee noted that this largely referred to information already available to the Panel and Committee and noted that further information, especially with respect to the implications for meeting the original objectives would be helpful. By SC/2016 - (3b) The proponents presented the field and analytical protocols in Mogoe *et al.* (2016). Committee advice on presentation of results and analyses in a final report is given under Item 18.2.3.2 of SC/66b (IWC, 2017). **2017 Panel comment: Relevant to discussion under Item 3.**	**Already in progress.** Update of analyses on efficiency of biopsy sampling presented in SC/67a/SCSP11.	**See information presented in SC/67a/SCSP11.**
Stock structure (Item 4.4.3)				
(4)	All inferences regarding 'randomness' of observations (e.g. satellite tracks, mitochondrial DNA haplotypes and unassigned common minke whales) should be substantiated by a statistical assessment of the presumed randomness.	By SC/2016 (or 2017 at latest) - Tamura *et al.* (2016a) indicates this will be addressed and proposes two approaches.	**Already in progress.** *Progress was shown in Appendix 1 of Tamura et al. (2017) and SC/67a/ SDDNA05.*	**Partially addressed. Regarding J and O stock, the random effect of microsatellite locus selection on stock assignment was investigated (see SC67a/ SDDNA05). Further, the occurrence of Parent-Offspring pairs within and among stocks was statistically compared to random expectations (SC67a/SDDNA01).**
(5)	The presence of multiple stocks within sample partitions should be assessed (employing, e.g. STRUCTURE and DAPC).	By SC/2016 (or 2017 at latest) - In progress (see discussion in SC/67a/Rep01. **See Item 3.3.1 for 2017 Panel's full comments.**	**Already in progress.** *STRUCTURE analyses for Bryde's and sei whales were conducted and presented in Appendix 2.1 of Tamura et al. (2017). DAPC analysis is in progress (Appendix 2.2 of Tamura et al. (2017). The final results of DAPC for Bryde's whale were submitted to the Bryde's whale Implement-ation Review Workshop held in March 2017.*	**Addressed for Bryde's whale.**
(6)	More explicit information on quality checks be provided in each study as well as study-specific estimates or genotyping and DNA sequencing error rates.	By SC/2016 (or 2017 at latest) - Goto *et al.* (2016) fully addresses this (see SC/67a/Rep07). **The 2017 Panel agreed that this recommendation has been completed.**	**Completed.** *See Appendix 3 of Tamura et al. (2017).*	**Completed.**
(7)	To facilitate more definitive discrimination between single and multiple stock hypotheses, undertake work to determine the demographic dispersal rates among areas at which whales in different areas can be managed as a single stock. Identifying 'critical' dispersal rates by specific case and the corresponding levels of genetic divergence, should enable such discrimination. The approach of Van der Zee and Punt (2014) is commended. This will allow the development of a working definition of a 'stock'.	2-3 years after the 2016 Annual Meeting - The proponents noted that work had begun to address (7), (9) and (10). They propose use of kinship analyses to address (8). Progress is discussed further in SC/67a/Rep01. **2017 Panel: No progress presented at the meeting.**	**To be completed in the future.** *This recommend-ation will be addressed after a discussion on direction of the analysis at the IWC SC.*	**To be completed by 2019.**
(8)	Analytical approaches should be applied that do not assume mutation-drift-migration equilibrium (Hey, 2010).		**Will not be addressed.** *This may not be feasible for the cases of O stock common minke, Bryde's and sei whales where the effect sizes are low. Instead, kinship information will be used as a way to estimate migration rates, as this is an approach that does not depend on the assumption of genetic equilibrium.*	**To be completed by 2019.** See comments from the proponents.
(9)	Serious consideration should be given to using genome-wide SNP geno-typing approaches, such as RAD sequencing and GBS (Elshire *et al.*, 2011; Miller *et al.*, 2007). This will increase the data per sample thereby improving the accuracy and precision of genetic parameter estimates and facilitate additional analyses (Hey and Machado, 2003; Robinson *et al.*, 2014).		**Already in progress.** *Novel SNPs for minke whale species were developed under the collaborative research with Norway (Malde et al., 2017), which will be used for the subsequent genetic analyses.*	**To be completed by 2019.**

	Topic (and agenda number from the 2016 Panel review)	2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents (SC/67a/SCSP09)	**Progress at SC/67a (2017)**
(10)	A focused satellite tagging programme should be developed to greatly increase sample size to assess individual migration in the context of stock structure hypotheses more thoroughly.		**Already in progress**. *The proponents agree to make efforts to increase the number of satellite tagging experiments. In the case of the Bryde's and sei whales, this information should be examined in conjunction with the available information on mark- recapture from the period of commercial whaling. Effort to collect tagging data will be increased in the NEWREP-NP.*	**To be completed by 2019.**
Feeding ecology and ecosystem studies – Oceanography (Item 5.4.3.1)				
(11)	Chl-a concentration should be examined as a potential proxy for the food environment for whales.	2 years after the 2016 Panel review - Used in some analyses already and discussed in Tamura *et al.* (2016a).	**Completed.** Used in some analyses already and discussed in Tamura *et al.* (2016a).	**Completed**
(12)	Oceanographic monitoring is required to compare with prey species distribution and abundance in the new 'decadal regime'.	Several years - The proponents agreed – this is long-term monitoring.	**To be addressed**. *Long-term monitoring.*	**To be completed in future**
Feeding ecology and ecosystem studies – Distribution (Item 5.4.3.2)				
(13)	With respect to papers Murase *et al.* (2016), Murase *et al.* (2014), Matsuoka *et al.* (2016), Sasaki *et al.* (2013) and Tamura *et al.* (2016b), develop revised versions that: (a) include statistical summaries on model fit (R2 and % deviance explained) and model comparison and spatial covariate selection (e.g. AIC, GCV scores); (b) avoid extrapolation of the regression models outside to data-poor areas or areas lacking coverage (especially when combining food consumption with sightings data); and (c) include variance plots of the fitted prediction surfaces in order to address precision and data sparseness.	By SC/2016 - (13a) The proponents provided statistical summaries relating to model fits in papers Murase *et al.* (2016), Murase *et al.* (2014), Sasaki *et al.* (2013) and Tamura *et al.* (2016b), but not in Matsuoka *et al.* (2016). (13b, 13c) No information received. **2017 Panel: no progress presented at the meeting. See new details on plans in Annex D**.	**To be addressed.** *Improvement of analyses of Matsuoka et al. (2016) (spatial abundance estimation) and Tamura et al. (2016b) (spatial prey consumption estimation) is ongoing. Because they are companion papers, the improvement is conducted in parallel. Some of the results were presented to 2016 PICES annual meeting (Sasaki et al., 2016) to invite comments from regional experts. The improved version will be presented to 2017 PICES annual meeting for further consideration. Fully improved version would be submitted to IWC/SC after 2018. Revision of published papers (Murase et al., 2014; Sasaki et al., 2013) will not be conducted because they only used part of JARPN II data and full consideration can be achieved by improving Matsuoka et al. (2016) and Tamura et al. (2016b).*	No information presented.
(14)	Considerable effort be put into the methodological improvement of the spatial modelling in the various analysis related with the objectives on distribution of large whales and oceanography. A particular focus must be on the combination of survey data from the different years to make them more comparable in terms of distribution (and abundance) over time; use of data from other sources (e.g. the IWC-POWER programme). This work is not only valuable in itself but is essential for a better parameterisation of ecosystem models.	2-3 years after the 2016 Annual Meeting - The proponents agreed and will undertake in light of guidelines to be developed by the Scientific Committee in 2017 (see Annex D). Will also include additional data. **2017 Panel: no new analyses presented at the meeting although the proponents suggested that a new paper will be presented at the 2018 Scientific Committee meeting.**	**To be addressed.** *See also comments to Recommend-ation 13.*	**To be completed by 2019.**
(15)	Additional effort be placed on fulfilling the 2009 recommendation with respect to the photo- identification data to contribute to the understanding of large scale movements and whale distribution within and outside the JARPN II survey area for several species.	2-3 years after the 2016 Annual Meeting - The proponents agreed that consideration will be given to sharing photo-ID data. **2017 Panel: no progress presented at the meeting.**	**To be addressed.** *The database validations work started for several species.*	**To be completed by 2019.**
Feeding ecology and ecosystem studies – Distribution (Item 5.4.3.2)				
(16)	Explore methods to account for sampling differences between areas and years to obtain measures of short- and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models).	2-3 years after the 2016 Annual Meeting - The proponents agreed and expect to achieve this within the timeframe. **2017 Panel: no progress presented at the meeting.**	**To be addressed.** *The proponents will explore the method using models such as mixed effect model.*	**To be completed by 2019.**
(17)	Compare results from the design-based estimates of abundance with those of model-based estimates to potentially address problems of unequal sampling coverage between surveys and to potentially account for additional sources or causes of variability.	2-3 years after the 2016 Annual Meeting - The proponents agreed and expect to achieve this within the timeframe and in line with the IWC guidelines discussed under (14) above.	**To be addressed** Work are ongoing.	**To be completed by 2019.**
Feeding ecology and ecosystem studies - Field and laboratory studies				
(18)	The sampling distribution for the parameters should be used in the assessment of the uncertainty associated with the estimation of consumption.	By SC2016 (or 2017 at latest) - Proponents agreed and will complete by 2017. **2017 Panel: see Item 3.3.2 for full comments.**	**Already in progress.** *Progress summarised in Appendix 4 of Tamura et al. (2017).*	**No information presented.**
(19)	Clarification should be provided on how density and diet consumption have been extrapolated outside the areas and months covered during the surveys and diet studies.	By SC2016 (or 2017 at latest) - Response provided in Bando *et al.* (2016) and discussed.	**Already in progress** Analyses are ongoing.	**No information presented.**
(20)	All sources of uncertainty should be quantified and an evaluation of which parameters contribute the most to uncertainty be conducted and taken into account in the analyses and modelling.	2-3 years after the 2016 Annual Meeting - The proponents agree. **2017 Panel: no progress presented at the meeting.**	**Already in progress** *Analyses are ongoing.*	**To be completed by 2019.**
(21)	The studies on allometric relationships should be developed further to refine the range of suitable allometric-energy intake/consumption relationships.	2-3 years after the 2016 Annual Meeting - The proponents will complete the work within the timeframe. **2017 Panel: no progress presented at the meeting.**	**Already in progress** *Analyses are ongoing.*	**To be completed by 2019.**

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents (SC/67a/SCSP09)	Progress at SC/67a (2017)
(22)	The analyses of diet composition should consider the effect of seasonal changes in energy density of the various prey species.	2-3 years after the 2016 Annual Meeting - Proponents agreed and will complete by 2017. **2017 Panel: see Item 3.3.2 for 2017 Panel's full comments.**	**Already in progress.** *The proponents considered the effect of seasonal changes in energy density of the various prey species. Table 3 of Tamura et al. (2016b) indicated seasonal changes in energy density of the various prey species. Table 4 of Tamura et al. (2016b) indicated prey composition (W%) of each whale sampled. Table 5 of Tamura et al. (2016b) indicated the energy contents consumed by whales calculated based on their prey composition in research area based on Tables 3 and 4. See Appendix 5 in Tamura et al. (2017).*	**To be completed by 2019.**
(23)	Stable isotope analysis of whale tissues and their prey should be introduced not only into the assessment of diet, but also to statistically evaluate overlap in distribution and trophic niche between baleen whale species.	2-3 years after the 2016 Annual Meeting - With respect to (23) a study has begun with Hokkaido University. **2017 Panel: see Item 3.3.2 for 2017 Panel's full comments.**	**Already in progress.** *Preliminary result is shown in Appendix 6 of Tamura et al. (2017).* From this feasibility study, it was revealed that stable isotope ratio of both whale skin and prey species shows seasonal and yearly variation and it is necessary to analyze samples covering the whole feeding season and area. Although only skin was analyzed in this study, other tissues such as muscle or liver would be useful to consider turnover time. Further analysis will be carried out to evaluate the possibility of contribution by stable isotope analysis to feeding ecology study of whale species in the western North Pacific. The final report will be presented at the 2018 IWC/SC meeting.	**To be completed by 2019**
Feeding ecology and ecosystem studies – Ecosystem modelling (Item 7.4.3)				
(24)	Generic recommendations identified by the 2009 Panel remain.	2-3 years after the 2016 Annual Meeting	**Already in progress**	**To be completed by 2019**
(25)	Generic recommendations identified by the 2009 Panel remain.	2-3 years after the 2016 Annual Meeting - The proponents agree.	**Already in progress**	**To be completed by 2019**
(26)	Establish clear objectives on the ultimate use of the models to make further progress (e.g. better understanding ecosystem linkages, delivering advice for fishery management) – ecosystem models are not suitable for tactical management.	2-3 years after the 2016 Annual Meeting - The proponents agree. **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *Objective will be considered by a domestic group comprising scientists and managers in parallel with improvement of basic structures of models.*	**To be completed by 2019**
(27)	Use models in concert e.g. use food web modelling to establish key predation linkages for extended single-species or multispecies models. In such a way the suite of available modelling tools can be used to integrate available knowledge.	2-3 years after the 2016 Annual Meeting - The proponents agree. **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *The proponents have been under-taking some basic analysis especially on the effect of presence of ghost population etc. Construction of food web model at local scale (e.g. off Sanriku) will also be considered.*	**To be completed by 2019**
(28)	Use stable isotopes to provide information on long term feeding patterns and inform models about trophic relationships between whales and their prey (see also Item 6.4).	2-3 years after the 2016 Annual Meeting - The proponents agree in broad terms but note the use in modelling may be limited. **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *See also comments to Recommendation 23.*	**To be completed by 2019**
(29)	With respect to the EwE modelling: (a) evaluate data quality for each input parameter (the 'pedigree', e.g. Gaichas *et al.* (2015) to characterise uncertainty in model inputs; (b) further evaluate PREBAL and other diagnostics; (c) present more clearly and evaluate further the estimated vulnerabilities and other fit diagnostics (including sensitivity analysis using ranges of consumption estimates).	2 years after the 2016 Panel review - The proponents agree and will undertake analyses within the time frame but note some limitations with EE in the western North Pacific situation. **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *Improved version of the model was presented to 'ICES/PICES: Drivers of dynamics of small pelagic fish resources' in March 2017 to invite comments from experts of small pelagic fish (Watari et al., 2017). Further improvement will be considered based on the comments if any. Fully improved version would be submitted to IWC/SC after 2018.*	**To be completed by 2019**
(30)	With respect to extended single-species modelling: (a) ensure that the majority of predation mortality is captured; (b) carry out additional diagnostics: (1) examine the fits to: (i) fishery-independent survey data; (ii) proportion information; and (iii) trends in fishing mortality; (2) use posterior predictive checks to evaluate Bayesian model. (c) provide thorough justification for the current spatial boundaries of the model and the use of fishery CPUE as an index of abundance. (d) focus the model fitting on the fishery- independent survey if CPUE not considered likely to index abundance; (e) examine sensitivity to alternative plausible functional forms of the feeding relationship; and (f) explore the causes of the implausible posteriors, e.g. Kitakado *et al.* (2016) by changing the weights assigned to the data sources and fitting the model.	2-3 years after the 2016 Annual Meeting - The proponents broadly agree with all components of this recommendation, but identify some difficulties with lack of data for item (e). **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *Some works have been undertaken such as standardisation of CPUE series and use of them in the model fitting. In addition to Bayesian methods, estimation with ML method has been revisited. All but (e) will be finalised in 2018.*	**To be completed by 2019**
Monitoring environmental pollutants in cetaceans and marine ecosystem (Item 8.4.3)				
(31)	To improve the statistical analyses based on clear and well-formulated hypotheses.	By SC/2016 (or 2017 at latest) - Addressed in Yasunaga *et al.* (2016b) and Yasunaga *et al.* (2016a), although additional consultation with statisticians would be beneficial.	**Completed.** Addressed for Hg Yasunaga *et al.* (2016b) and PCB Yasunaga *et al.* (2016a).	
(32)	Recalculate OC concentrations as values on a lipid weight basis, and Hg concentrations on a dry weight basis.	By SC/2016 (or 2017 at latest) - The proponents elucidate some difficulties to address this recommendation due to e.g. loss of samples by tsunami ensued the 2011.	**Cannot be addressed.** Difficulties to address this recommend-ation due to e.g. loss of samples by tsunami in 2011.	**See comments from the Proponents**

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents (SC/67a/SCSP09)	**Progress at SC/67a (2017)**
(33)	Explore trends in pollutant concentrations using generalized additive models (GAMs) or other non-linear approaches, in addition to the linear models.	By SC/2016 (or 2017 at latest) - Addressed in Yasunaga *et al.* (2016b) and Yasunaga *et al.* (2016a).	**Completed.** Addressed for Hg Yasunaga *et al.* (2016b) and PCB Yasunaga *et al.* (2016a).	
(34)	Evaluate the pollutant concentrations found in comparison with data from previous studies conducted in comparable species and available in the literature.	By SC/2016 (or 2017 at latest) - More discussion on comparisons with previously published studies were included in Yasunaga *et al.* (2016b) and Yasunaga *et al.* (2016a).	**Completed.** Addressed for Hg Yasunaga *et al.* (2016b) and PCB Yasunaga *et al.* (2016a).	
(35)	Since body length is a poor proxy for age, particularly in sexually mature whales, incorporate age data into the multivariate analysis of pollutant concentrations as soon as they become available.	2-3 years after the 2016 Annual Meeting - The proponents agree and will undertake work. **2017 Panel: no progress presented at the meeting. However, in light of the proponents' comments, the Panel stresses that this recommendation can be implemented without collecting additional samples and the results can be presented within the suggested timeline.**	**Already in progress.** Analyses are ongoing.	**To be completed by 2019**
(36)	To include stable isotope values in the analyses to investigate the bioaccumulation process of pollutants through the food chain.	2-3 years after the 2016 Annual Meeting - The proponents agree and will undertake work. See comments in Tamura *et al.* (2017).	**Already in progress.** *See progress on Recommendation 23. Proponents will integrate this result for investigating the bioaccumulation process of pollutants.*	**To be completed by 2019**
(37)	To assess more widely the risk that these chemical pollutants present to the populations' abundance or distribution.	2-3 years after the 2016 Annual Meeting -The proponents agree but for long-term. They note no health risk from OCs or Hg thus far. **2017 Panel: no progress presented at the meeting. However, in light of the proponents' comments, the Panel stresses that this recommendation can be implemented without collecting additional samples and the results can be presented within the suggested timeline.**	**Already in progress.** *This item will be addressed under Ancillary Objective I (iii) of the research plan for NEWREP-NP.*	**To be completed by 2019**
Ageing (Item 9.1.2)				
(38)	To investigate into whether there is any relationship between age or sex and readability that may affect the representativeness of the earplugs that can be read.	2 years after the 2016 Panel review - The proponents agree and work is underway. **2017 Panel: progress in this area was presented at the meeting (see Annex D). See Item 3.3.3 and 4.4.3.2 for 2017 Panel's full comments.**	**Already in progress.** *Some progress on ageing was provided at the NEWREP-NP Review Workshop (Government of Japan, 2017) and Implementation Review Workshop for western North Pacific Bryde's whales (Bando and Kato, 2017); SC/67a/Rep01; SC/67a/Rep07).*	**To be completed by 2019**
(39)	To age as many of the existing samples as possible and to incorporate age where appropriate in updated analyses (e.g. see the recommendations on pollutant studies).	2 years after the 2016 Panel review - Work is underway. **2017 Panel: no progress presented at the meeting.**	**Already in progress.** *Some progress on ageing was provided at the NEWREP-NP Review Workshop (Government of Japan, 2017) and Implementation Review Workshop for western North Pacific Bryde's whales (Bando and Kato, 2017; SC/67a/Rep01; SC/67a/Rep07).*	**To be completed by 2019**
Recommendations to the Scientific Committee on process (Item 11)				
(40)	The Panel recommends that the Scientific Committee considers: (a) including a guideline either relating to the minimum time after completion of a programme that a final review can take place or establishing a small review group to determine whether the materials available are for a review Workshop; (b) adopt guidelines for an integrated final report by the proponents. (c) to consider a mechanism for proponents to provide a short biennial update on progress with recommendations. (d) develop a mechanism to allow for the completion of expert panel reviews if a Panel states that its review is incomplete until further information/analyses is provided.	Some of these matters are under consideration by the Scientific Committee - see Item 26.3 in IWC (2017). **The Panel reiterates recommendations 40a, 40c and 40d. See Item 3.3.5 and 5.1 for 2017 Panel's full comments.**	Proponent's representatives are fully involved in the intersessional work carried out by the Intersessional Correspondence Group on 'Annex P'.	**Still in progress**

REFERENCES

Bando, T. and Kato, H. 2017. Report on progress in earplug-based age determination and estimation of biological parameters of Bryde's whales collected during 2000 to 2014 JARPNII surveys. Paper SC/M17/RMP03 presented to the RMP Bryde's Whale Workshop, March 2017, Tokyo, Japan (unpublished). 10pp. [Paper available from the Office of this Journal].

Bando, T., Yoshida, H., Kishiro, T., Yasunaga, G., Mogoe, T., Konishi, K., Tamura, T., Fujise, Y. and Kato, H. 2016. Further information on sampling design of JARPNII. Paper SC/66b/SP04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 23pp. [Paper available from the Office of this Journal].

Elshire, R.J., Glaubitz, J.C., Sun, Q., Poland , J.A., Kawamoto, K., Buckler, E.S. and Mitchell, S.E. 2011. A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. *PLoS ONE* 6.

Gaichas, S., Aydin, K. and Francis, R.C. 2015. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. *Prog. Oceanog.* 138: 1-17.

Goto, M., Yoshida, H. and Pastene, L.A. 2016. A note with an estimate of microsatellite genotyping error rate for common minke whales. Paper SC/66b/DNA01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 4pp. [Paper available from the Office of this Journal].

Government of Japan. 2017. Proposed research plan for new scientific research program in the western North Pacific (NEWREP-NP). Paper SC/J17/JR01 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 164pp. [Paper available from the Office of this Journal].

Hey, J. 2010. Isolation with migration models for more than two populations. *Mol. Biol. Evol.* 27: 905-20.

Hey, J. and Machado, C.A. 2003. The study of structured populations - new hope for a difficult and divided science. *Nature Reviews Genetics* 4: 535-43.

International Whaling Commission. 2017. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

Cont.

REFERENCES cont.

Kitakado, T., Murase, H. and Tamura, T. 2016. Predation impacts on sandlance population by consumption of common minke whales off Sanriku region. Paper SC/F16/JR29 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 11pp. [Paper available from the Office of this Journal].

Malde, K., Seliussen, B.B., Quintela, M., Dahle, G., Besnier, F., Skaug, H.J., Oien, N., Solvang, H.K., Haug, T., Skern-Mauritzen, R., Kanda, N., Pastene, L.A., Jonassen, I. and Glover, K.A. 2017. Whole genome resequencing reveals diagnostic markers for investigating global migration and hybridization between minke whale species. *BMC Genomics* 18: 76pp.

Matsuoka, K., Hakamada, T. and Miyashita, T. 2016. Distribution of blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and north Pacific right (*Eubalaen japonica*) whales in the western North Pacific based on JARPN and JARPNII surveys (1994 to 2014). Paper SC/F16/JR09 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 13pp. [Paper available from the Office of this Journal].

Miller, M.R., Dunham, J.P., Amores, A., Cresko, W.A. and Johnson, E.A. 2007. Rapid and cost-effective polymorphism identification and genetyping usinf restriction site associated DNA (RAD) markers. *Genome Res.* 17: 240-48.

Mogoe, T., Tamura, T., Yoshida, H., Kishiro, T., Yasunaga, G., Bando, T., Kitamura, T., Kanda, N., Nakano, K., Katsumata, H., Handa, Y. and Kato, H. 2016. Field and analytical protocols for the comparison of using lethal and non-lethal techniques under the JARPNII with preliminary application to biopsy and faecal sampling. Paper SC/66b/SP08 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Murase, H., Hakamada, T., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Tojo, N. and Kitakado, T. 2014. Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-subtropical transition area of the western North Pacific in relation to oceanic fronts. *Deep-Sea Res. II* 107: 22-28.

Murase, H., Hakamada, T., Sasaki, H., Matsuoka, K. and Kitakado, T. 2016. Seasonal spatial distributions of common minke, sei and Bryde's whales in the JARPNII survey area from 2002 to 2013. Paper SC/F16/JR07 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].

Robinson, J.D., Bunnefield, L., Hearn, J., Stone, G.N. and Hickerson, M.J. 2014. ABC inference of multi-population divergence with admixture from unphased population genomic data. *Mol. Ecol.* 23: 4458-71.

Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S.I. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. *Fish. Oceanog.* 22(6): 496-508.

Sasaki, H., Tamura, T., Hakamada, T., Matsuoka, K., Murase, H. and Kitakado, T. 2016. Spatial estimation of prey consumption by common minke, Bryde's and sei whales in the western North Pacific: A preliminary attempt. Abstract presented to the 2016 PICES Annual Meeting, OMNI Hotel, San Diego, USA, 3 November 2016.

Tamura, T., Kishiro, T., Bando, T., Yasunaga, G., Murase, H., Maeda, H., Kitakado, T. and Pastene, L.A. 2016a. Response to the 'Report of the Expert Panel of the final review on the Western North Pacific Japanese Special Permit Program (JARPNII)'. Paper SC/66b/SP01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 18pp. [Paper available from the Office of this Journal].

Tamura, T., Kitakado, T. and Pastene, L.A. 2017. Progress report of the work responding recommnendations from the JARPNII final review Workshop. Paper SC/J17/JR02rev1 presented to the Special Permit Expert Panel Review Workshop on NEWREP-NP, January 2016, Tokyo, Japan (unpublished). 51pp. [Paper available from the Office of this Journal].

Tamura, T., Murase, H., Sasaki, H. and Kitakado, T. 2016b. Preliminary attempt of spatial estimation of prey consumption by sei whales in the JARPNII survey area using data obtained from 2002 to 2013. Paper SC/F16/JR16 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 22pp. [Paper available from the Office of this Journal].

Van der Zee, J.P. and Punt, A.E. 2014. Evaluting critical dispersal rates for whale management under the IWCs Revised Management Procedure: an application for North Atlantic common minke whales. *J. Cetacean Res. Manage* 14: 125-32.

Watari, S., Murase, H., Yonezaki, S., Okazaki, M., Kiyofuji, H., Tamura, T., Hakamada, T. and Kitakado, T. 2017. Ecosystem modeling in the western North Pacific with a focus on small pelagic fish. Abstract presented to the International Symposium on Drivers of Dynamics of Small Pelagic Fish Resources. Victoria Conference Centre, Victoria, Canada, 6-11 March, 2017.

Yasunaga, G., Hakamada, T. and Fujise, Y. 2016a. Update of the analyses on temporal trend of PCB levels in common minke whales from the western North Pacific for the period 2002-2014. Paper SC/66b/E07 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].

Yasunaga, G., Hakamada, T. and Fujise, Y. 2016b. Update of the analyses on temporal trend of total Hg levels in three baleen whale species based on JARPN and JARPNII data for the period 1994-2014. Paper SC/66b/E08 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 19pp. [Paper available from the Office of this Journal].

Appendix 1

PAST OR EXPECTED EXPERT (‘ANNEX P’) WORKSHOPS TO REVIEW NEW, ONGOING OR COMPLETED SPECIAL PERMIT PROGRAMMES

Table 1

Past or expected Expert (‘Annex P’) Workshops to review new, ongoing or completed special permit programmes.

Subject	Status	Proposed dates	References
JARPN II (ongoing programme)	Completed in 2009	N/A	IWC (2010a; 2010b)
Icelandic (final review)	Completed in 2012	N/A	IWC (2014a)
JARPA II (ongoing programme)	Completed in 2014	N/A	IWC (2015)
JARPN II (ongoing programme)	Completed in 2016	N/A	IWC (2014b)
NEWREP-A	Completed in 2015	N/A	IWC (2016)
NEWREP-NP	Completed in 2017	N/A	SC/67a/Rep01.
NEWREP.-A mid-term review	Expected in 2021		
NEWREP.-NP mid-term review	Expected in 2023		

References

International Whaling Commission. 2010a. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.

International Whaling Commission. 2010b. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1-98.

International Whaling Commission. 2014a. Report of the Expert Workshop to Review the Icelandic Special Permit Research Programme, 18-22 February 2013, Reykjavik, Iceland. *J. Cetacean Res. Manage. (Suppl.)* 15:455-88.

International Whaling Commission. 2014b. Research Proposal for Special Permits: Proposal to hold an IWC Workshop for the Periodic Review of JARPN II. Paper SC/65b/SPRP01 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 2pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2015. Report of the Expert Workshop to Review the Japanese JARPA II Special Permit Research Programme, 24-28 February 2014, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 16:369-409.

International Whaling Commission. 2016. Report of the Expert Panel to Review the Proposal by Japan for NEWREP-A, 7-10 February 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 17:507-54.

Annex Q

Ad hoc Working Group on Abundance Estimates, Status and International Cruises

Members: Zerbini, Butterworth (co-Convenors), Allison, Baba, Baker, Bell, Bickham, Bravington, Brockington, Brownell, Burkhardt, Castro, Cipriano, Clapham, Collins, Cooke, Cubaynes, De la Mare, de Moor, Diallo, Doherty, Donovan, Double, Enmynkau, Filatova, Fortuna, Fretwell, Frey, Fruet, Funahashi, Galletti Vernazzani, Genov, Givens, Gunnlaugsson, Hakamada, Herr, Hielscher, Hubbell, Iñíguez, Isoda, Ivashchenko, Jackson, Kim, Kitakado, Konan, Konishi, Lang, Lauriano, Lundquist, Mallette, Matsuoka, McKinlay, Miyashita, Mizroch, Morishita, Morita, Moronuki, Murase, New, Øien, Olson, Palka, Panigada, Park, Pastene, Punt, Redfern, Reeves, Rendell, Robbins, Rodriguez-Fonseca, Rose, Rosenbaum, Simmonds, Slooten, Slugina, Tamura, Víkingsson, Wade, Walløe, Walters, Yasunaga, Yoshida, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Zerbini welcomed participants.

1.2 Election of Chair
Zerbini was elected as Chair.

1.3 Appointment of Rapporteurs
Herr, McKinlay and Olson acted as rapporteurs.

1.4 Adoption of the agenda
The adopted agenda is given in Appendix 1.

1.5 Documents available
SC/67a/ASI01-10; SC/67a/AWMP08-09; SC/67a/CMP01, SC/67a/CMP06; SC/67a/NH05; SC/67a/NH07; SC/67a/NH09-11; SC/67a/RMP03-04; SC/67a/SM18, SC/67a/SM21; Hansen *et al.* (2016); Calambokidis *et al.* (2017); Durban *et al.* (2017); Baker *et al.* (2017); Dares *et al.* (2017); Bravington *et al.* (2016); Vacquié-Garcia *et al.* (2017); Sutaria and Marsh (2011); Weller *et al.* (2016); Pike *et al.* (2009); Pike *et al.* (2002); Pike *et al.* (2010); Hammond *et al.* (2016); Hamner *et al.* (In press); Paudel *et al.* (2015); Pike *et al.* (Unpublished); Minton *et al.* (2013); Rone *et al.* (2016); Durban *et al.* (2015); Paxton *et al.* (2007); Matsuoka and Hakamada (2014).

2. TERMS OF REFERENCE AND APPROACH

Following previous discussions within the IWC Scientific Committee (IWC, 2017, p.94), the Working Group on Abundance Estimates, Status and International Cruises was established to formally review and agree on the status of the abundance estimates submitted to the Scientific Committee across all of the Committee's sub-committees and working groups. The Working Group will also be responsible for assisting the Committee and the Secretariat in developing a biennial document to inform the Commission on the abundance and status of whale stocks. Finally, this Group will also consider survey design and data analysis related to abundance estimates of IWC-related projects. The **agreed** Terms of Reference of this new Working Group are provided in Appendix 2.

Allison provided a background on the current Tables of Accepted Abundance Estimates and explained that the aims of these tables are: (i) to collate information in a consistent way on abundance estimates accepted by the Scientific Committee for various purposes; and (ii) to provide a simplified table of abundance estimates suitable as a broad overview for the Commission and the public. She detailed the changes made to the format of the tables since their inception in 2014 (IWC, 2014) and suggested that a grand, single table be developed. A single table would be easier to maintain and less prone to error when updating, as data would not need to be entered or changed in multiple places. Details of the items included in the table and the codes used are given in Appendix 3. The Working Group **agreed** that, when reviewing estimates of abundance (see Item 3), it would allocate these estimates to one of the following categories:

- **Category 1:** acceptable for use in in-depth assessments or for providing management advice;
- **Category 2:** underestimate - suitable for 'conservative' management but not reflective of total abundance;
- **Category 3:** while not acceptable for use in (1) or (2), adequate to provide a general indication of abundance; and
- **Category P:** provisional estimates.

The Working Group noted that the Table of Accepted Abundance Estimates (hereafter referred to as the 'IWC Abundance Table') contains estimates not yet agreed by the Scientific Committee. It was **agreed** that a process to conduct the reviews of these estimates will be developed by an intersessional email group (see Item 8).

3. EVALUATIONS OF ABUNDANCE ESTIMATES AND UPDATES OF THE IWC ABUNDANCE TABLE

3.1 Evaluation of new abundance estimates
3.1.1 Large whales

The Working Group noted that the AWMP workshop (SC/67a/Rep06) had extensively discussed abundance estimates of common minke, humpback and fin whales in West and East Greenland and recommended that the estimates presented in Table 1 (reproduced from SC/67a/Rep06) were appropriate for use in the *Strike Limit Algorithm* (*SLA*) development and implementation. In reviewing these estimates, the Working Group **agreed** that they were of high quality and the best available for the three whale species in West and East Greenland. The Working Group **endorsed** these estimates for inclusion in the IWC Abundance Table under Category 1.

3.1.1.1 NORTH ATLANTIC MINKE WHALES
SC/67a/NH05 presented an aerial survey using cue counting methods to estimate minke whale abundance, which had been conducted in coastal Icelandic waters in July 2016. This was the most recent estimate from a series of surveys conducted in 1987, 1995, 2001, 2007 and 2009 using nearly

Table 1

Summary of new agreed abundance estimates (see text) for common minke, fin and humpback whales in West and East Greenland. Detection depth was assumed to be up to 2m apart from for fin whales for which estimates were not corrected for availability bias. Availability bias takes time in view into account. For the MRDS for humpback whales, a combined mean group size was used. Key: LT=line transect; SC=strip census; ESW=effective search width; *N*=number of sightings; E+W indicates that sightings from East and West Greenland were pooled to estimate the detection function.

			Perception bias					
Method	ESW (m)	*N*	Model	Value	Availability bias	Abundance	CV	95% CL
Common minke whale – East 2015								
LT	450	23 E+W	MRDS 2015	0.97 (0.04)	0.20 (0.26)	2,681	0.45	1,153; 6,235
Common minke whale – West 2015								
SC	300	12	Chapman	0.94 (0.06)	0.18 (0.32)	5,241	0.49	2,114; 12,992
Common minke whale – West 2007								
SC	240	18	Chapman	0.98 (0.02)	0.18 (0.32)	9,853	0.43	4,433; 21,900
Fin whale – West 2015								
LT	700	75 E+W	MRDS 2015	0.99 (0.001)	-	465	0.35	233; 929
Humpback whale – East 2015								
LT	1,200	76 E+W	MRDS 2015	0.98 (0.02)	0.42 (0.14)	4,288	0.38	2,097; 8,770
Humpback whale – West 2015								
LT	1,200	76 E+W	MRDS 2015	0.98 (0.02)	0.42 (0.14)	1,008	0.38	493; 2,062

identical survey design and methodology. These surveys were generally associated with the wider ship-based North Atlantic Sighting Surveys (NASS) carried out in surrounding waters. The aerial NASS survey in 2015 was unsuccessful due to adverse weather conditions. The 2016 survey used a Twin-Otter aircraft for the first time and employed a full double platform configuration on both sides of the aircraft. However, the bubble windows on the Twin-Otter were smaller and less convenient than those from the Partenavia aircraft used in earlier work. A newly developed electronic device, the Geometer, was used to record declination angles and times of cetacean groups detected directly to a database. Prolonged periods of poor weather resulted in a realised coverage of only 53% of the planned effort, with no effort in the northernmost block. Minke whale sighting rates were similar to those in 2007 and 2009, but lower than in surveys prior to that. Duplicate sightings were identified using an algorithm based on similarity in observer measurements of declination angle, sighting time, group size and species identity. Cue counting methods, using a cueing rate of 53 surfacings per hour (as in earlier estimates), and corrected for visible cues missed by observers, estimated the abundance at 13,497 (CV=0.50, 95% CI=3,312-55,007). An alternative approach, using line transect methodology with corrections for visible groups missed by observers and for animals not in view during passage of the aircraft based on tagging in Greenland, resulted in an estimate of 11,428 (CV=0.48, 95% CI=3,727-35,046). This estimate is likely negatively biased due to the inclusion and identical handling of the submerged animals, and did not appreciably reduce the CV. The results, although not totally comparable to earlier estimates due to the total lack of effort in one block, confirm that minke whale density has declined substantially in the area since 2001. The authors suggested that this decline may be the result of a re-distribution of the population due to ecological changes observed in the area.

In discussion, several problems associated with the 2016 survey were identified, including incomplete survey coverage leading to non-random sampling in some areas, and the potential for estimation bias. Most issues seemed related to poor weather conditions that occurred during the survey, with incomplete sampling towards the edge of the survey area and insufficient coverage in several strata being of particular concern. The use of model-based abundance estimation approaches to correct for poor coverage was discussed; however, it was generally recognised that such patterns of 'missingness' would likely render the data unsuitable because they would require a model to extrapolate beyond the range of existing data, rather than the more acceptable approach of interpolating between areas with sufficient surveys. Documented annual changes in the distribution of minke whales in the survey area might also make spatial modelling approaches difficult. In addition, the reliability of applying the same 'cue' counting rate used in previous surveys would be questionable if environmental changes result in changes in behaviour or group sizes.

It was suggested that if estimates were to be adopted for use in future *Catch Limit Algorithm* (*CLA*) *Implementation Review* trials, then incomplete coverage need not necessarily be an issue because those effects could be explored in simulations. However, it was noted that it was unlikely that future *CLA Implementation* trials would commence before 2022, providing ample time for more reliable estimates to be computed from new surveys. It was also noted that Generalized Linear Model (GLM) approaches could be used to account for missing coverage if survey data were post-stratified, potentially also resulting in estimates of minimum abundance for use in future *CLA*s. However, the use of such methods was likely to provide estimates with large variances. In conclusion, it was **agreed** that the estimates were of insufficient quality to allow their adoption for use in the *CLA*. The Working Group **recommended** that the authors consider post-stratification, possibly using GLM methods to take account of information from past surveys, in an attempt to obtain a minimum estimate of abundance.

SC/67a/RMP03 presented preliminary abundance estimates of common minke whales in the Northeast Atlantic area based on the progress made during the first three years of the mosaic survey cycle over 2014-19. The areas covered so far are the Svalbard area, the Norwegian Sea and the Jan Mayen area. The analyses have been conducted using the same methodology as for the most recent completed survey cycle over 2008-13. The resulting estimates indicate that large distributional shifts of minke whale abundance are occurring in this region. The drop in abundance in the Jan Mayen area, which was observed in the 2008-13 survey cycle to fall to 40% of the abundances recorded in the two earlier survey cycles, seems to have reversed recently. In 2016, the abundance in the CM Management Area (Jan Mayen) was more than twice the estimates from the 1996-

2001 and 2002-07 cycles, and five times that of 2010. The minke whale abundance attributed to the Norwegian Sea has seen a decrease during the recent survey cycles. In the Svalbard area (*ES*) the minke whale abundance in 2014 had decreased to 45% of the abundance level observed in 2008.

In discussion, the Working Group noted that the last complete survey-cycle for abundance estimation had been provided in 2008, and that the current work was an update of progress on work since that time. As such, no new abundance estimates were presented for consideration. However, results from the present work highlighted large shifts in the distribution of minke whales in the North Atlantic, suggesting that six-year survey cycles may eventually prove problematic for obtaining precise abundance estimates, if changes in distribution occur at smaller time-scales. While the need to finalise the current survey cycle was recognised, the Working Group considered there may be merit in investigating whether different patterns in the allocation of effort through time might better account for distributional shifts when estimating abundance. For instance, if the whole area is currently surveyed in six-year cycles, it is possible that that doubling survey coverage with half the intensity every three years (or similar) might better account for range shifts.

In conclusion, the Working Group acknowledged the progress report and **recommended** that the authors consider a simulation study to assess what benefit might be derived from a temporal reallocation of effort to account for potential changes in species distributions.

3.1.1.2 NORTH ATLANTIC HUMPBACK WHALES

Víkingsson provided a short overview of abundance estimates of humpback whales in the Central North Atlantic derived from the North Atlantic Sightings Surveys (NASS) during 1987-2007 (Paxton *et al.*, 2009; Pike *et al.*, Unpublished; Pike *et al.*, 2002; 2009; 2010). These estimates are relevant for a forthcoming assessment of North Atlantic humpback whales as well as for ecosystem modelling. The estimates were derived from conventional line-transect methods, and in addition spatial modelling was applied to the 1995 and 2001 survey data. None of the estimates were corrected for availability bias and only the 2007 estimate was corrected for perception bias. The estimates indicate a rapid increase in the abundance of humpback whales in Icelandic waters during this period, with the first estimate (1987) at less than 2,000 whales, while the more recent uncorrected estimates (1995-2007) were in the range of 11,000-14,000 animals. The clumped distribution of humpback whales is reflected by the high CVs for most estimates. The authors considered the most recent analysis to provide best estimates from each survey.

There was insufficient time to review all the estimates during the meeting. An intersessional correspondence group was established under Palka to perform this review. A report from this group will be presented at the Scientific Committee meeting next year (see Item 8).

Estimates of abundance of humpback whales from aerial surveys in east and west Greenland in 2015 were provided in Hansen *et al.* (2016), presented in Table 1. The Working Group **endorsed** estimates of 4,288 (CV=0.38, 95% CI=2097-8770) for East Greenland in 2015 and 1,008 (CV=0.38, 95% CI=493-2,062) for West Greenland in 2015 for inclusion in the IWC Abundance Table under Category 1.

3.1.1.3 NORTH ATLANTIC FIN WHALES

Estimates of fin whale abundance in east and west Greenland in 2015 were presented in Hansen *et al.* (2016), summarised in Table 1. The Working Group **endorsed** the estimate of 465 (CV=0.35, 95% CI=233-929) for West Greenland in 2015 for inclusion in the IWC Abundance Table under Category 1.

3.1.1.4 NORTH ATLANTIC (SVALBARD) BOWHEAD WHALES

Vacquié-Garcia *et al.* (2017) provided the first partial survey estimates for the Svalbard/Spitsbergen stock of bowhead whales and narwhals in an ice-covered area north of Svalbard. The Svalbard archipelago is an Arctic hot spot which has experienced large changes in ice-related statistics like the coverage and extent of ice, its thickness and its multi-year character. Water and air temperatures have also increased, and modelling indicates the possibility of an ice-free Arctic at the end of this century. The main objective of this study was to try to provide baseline abundance estimates for three ice-associated cetacean species: the bowhead whale (critically endangered according to IUCN Red List), the narwhal and the white whale (near threatened). This was addressed by conducting helicopter and ship line transect surveys in the Marginal Ice Zone (MIZ), that is the transition zone between open ocean and sea ice, north of the Svalbard archipelago in August 2015. The helicopter ran parallel transects perpendicular to the ice edge and approximately 100 n.miles (185km) into the sea ice, while the ships ran zig-zag transects along the ice-edge in open water. The total primary survey search effort was 599km for the ship and 7,830km for the helicopter. No cetaceans were recorded on the ship transects, while 15 bowhead sightings (of 27 individuals) and 11 narwhal sightings (of 58 individuals) were made during the helicopter survey. No white whales or other cetaceans were observed. Bowheads occurred mostly near the ice-edge in medium ice concentrations and narwhals at higher latitudes with heavier ice concentrations. This resulted in abundance estimates uncorrected for availability bias of 69 for bowhead whales and 268 for narwhals. After correction for availability bias using external correction factors derived from similar Greenlandic surveys, abundance for bowhead whales was estimated at 343 (CV=0.49, 95% CI=136-862) animals. The local marine mammal sightings database gives some additional information on other species in adjacent open waters during the survey period in August 2015. In the open waters north of Svalbard towards the MIZ, a considerable number of baleen whales was recorded, especially fin and blue whales, indicating that the retreat of ice may also extend the possible feeding areas of the seasonally migrating baleen whales.

While the Working Group recognised several limitations with the survey and resulting abundance estimates for bowhead whales (e.g. partial coverage, high CVs), it also understood the importance of the survey work given that it relates to a population once thought to be extinct. Consequently, the Working Group **endorsed** the abundance estimate of 343 (CV=0.49, 95% CI=136-862) bowhead whales for the Svalbard/Spitsbergen stock in 2015 for inclusion in the IWC Abundance Table as Category 3.

3.1.1.5 BERING-CHUKCHI-BEAUFORT SEAS BOWHEAD WHALE

SC/67a/AWMP08 reported on a unique opportunity to estimate the abundance of Bering-Chukchi-Beaufort Seas (B-C-B) bowhead whales that arose in late August 2016. During a set of five line-transect survey flights for marine mammals that were conducted by the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, the survey crew found unprecedented numbers of bowhead whales in the western Beaufort Sea. Although not explicitly designed to estimate absolute population abundance, the ASAMM survey protocols and design, data collected and encounter rates enabled abundance estimation of bowhead whales within the survey region that encompassed the continental shelf (0-200m) during a short four-day sampling period with 2,198km of on-transect effort. The plane diverted from the transects to circle sighted groups and determine group size. Total abundance was estimated with a Horvitz-Thompson type estimator using the results from a single-observer multiple covariates distance sampling analysis. It was not possible to estimate $g(0)$, so a published value was used. The best estimate of abundance, which included data from circling and allowed for a variable strip width was 15,575 whales (CV=0.5). However, data from past surveys, satellite tags, opportunistic encounters and traditional knowledge all indicate that the bowhead whales in the survey region during these four days likely constitute only a portion of the overall B-C-B bowhead whale population.

The Working Group noted several limitations with the abundance estimates presented, including negative bias, an assumed $g(0)$ that resulted in a relatively large correction factor (>5) for trackline detection bias adjustment, and no estimate of uncertainty for this adjustment. Comments were made that if the current estimate was to be used for *SLA* trials the CV of the abundance estimate itself could be considered too high, since it was outside the plausible range of uncertainties previously tested. The authors acknowledged these limitations, particularly the lack of an estimate of uncertainty for $g(0)$, but indicated their view that overall CVs of this magnitude were not unprecedented for use in *SLA* calculations (e.g. minke whale abundance estimate CVs of around 0.5 have been used). It was further suggested that it might be possible to conduct sensitivity tests using a range of CV values for $g(0)$. In considering this proposition, the Working Group noted that detectability varies with school size and that several very large school sizes were detected during the survey. Since the assumed $g(0)$ value was derived from the literature, it would be important for its applicability to be carefully considered in the light of the distribution of school sizes observed in the original and in the present study. It was noted that an exact understanding of the design and methodological issues was hindered by the use of non-standard terminology for line transect sighting surveys, though these nomenclature issues did not ultimately limit an understanding of the final estimates. Some members of the Working Group considered that the lack of a CV for $g(0)$ was unlikely to be the most important limitation, citing negative biases as potentially more important due to a possible interaction between $g(0)$, availability and the method for estimating group size for which the circling nature of closing mode gives whales more time to come to the surface.

The Working Group referred the estimates provided in SC/67a/AWMP08 to the Standing Working Group (SWG) on Aboriginal Whaling Management Procedures (AWMP) for consideration as to whether they could be used as estimates of minimum abundance for use in *SLA*s (Annex E, item 5.3.1). The Working Group noted that as a result of additional work kindly undertaken by the authors and reported to the SWG on AWMP, the authors had decided to withdraw the estimate as the CV of the revised estimate was too high to be useful for management purposes.

SC/67a/AWMP09 presented new photo-identification data that were collected from a 2011 aerial survey of B-C-B Seas bowhead whales. These images were scored for photo quality and whale identifiability, and then matched to existing images from 1985, 1986, 2003, 2004, and 2005. Other inter-year comparisons between this set of years were also conducted to generate a complete matching matrix for the 6 years. These data were used to estimate bowhead survival rate and population abundance using Huggins models embedded in a Robust Design capture-recapture analysis. BIC was used to select covariates, and to rank, compare and average models. The estimated survival rate was 0.996 with an approximate lower confidence bound 0.976, which is consistent with previous estimates and with research showing that bowhead lifetimes can be very long. The estimated 2011 abundance was 18,797 (CV=0.214, 95% CI=12,403-28,486). Although much less precise than the 2011 ice-based abundance estimate (16,820 with CV=0.052, 95% CI=15,176-18,643) of Givens *et al.* (2016), this 2011 photo-identification estimate adds to the evidence that the stock is abundant, having increased from previous years, and unlikely to be harmed by limited subsistence hunting.

In considering these estimates, the Working Group sought clarification about how the markings on whales were used to re-identify individuals in subsequent years. The author provided an explanation of how multiple photographs of the same individual, and multiple zones on individuals, are used to re-identify whales across years. Importantly, the degree of 'markedness' and photo quality are treated in an integrated fashion; if marks on one zone are visible in one photo, but marks in another zone are visible in another photo, then it is the integration of this information that is important in determining a positive match to a known individual. It was noted by the author that if an individual is highly marked but the photo quality is poor, this may still prove adequate for identification since a high degree of marking can be sufficient for future recognition. The Working Group discussed the estimation method, which was a Robust Design model with a Jolly-Seber primary model and Huggins secondary model based on three primary periods. It was noted that only a single secondary occasion was available in the third primary period, necessitating the creation of a 'dummy' period. The Working Group queried how the dummy period could be accommodated in the Robust Design, and was advised that while data were obviously missing for that period, so too are the parameters in the estimation; the algebra shows how that part drops out of the likelihood. The Working Group noted that SC/67a/AWMP09 gives two alternate abundance estimates and, pending further work, it was not immediately clear which estimate should be adopted. The author indicated that further work to estimate p^*, the proportion of the bowhead whale population that is marked, is currently underway and a final abundance estimate would be presented in the future.

In light of this discussion, and recognising that new abundance estimates are not required for the current meeting, the Working Group supported the methodological approaches presented and **recommended** that further work be undertaken by the authors to finalise the estimate for consideration at a future meeting.

3.1.1.6 OKHOTSK SEA BOWHEAD WHALE

SC/67a/NH10 applied an open-population mark-recapture model to genetic samples from bowhead whales in the western Okhotsk Sea. The best-fitting model based on the AIC criterion resulted in an estimate of abundance that was declining, dropping to 218 (CV=0.22) individuals in 2016. However, an open population model with constant population size of 258 (CV=0.20) was not definitely rejected ($p \approx 0.03$, one sided). A more detailed summary and a discussion of this document is presented in Annex G, item 9.3.8.

The Working Group considered this to be an important population estimate given the low population size and paucity of information about the region. In discussion, it was noted that the estimate of survival seemed low for bowhead whales. The paper noted that hunting by killer whales was frequently observed, and the author speculated that earlier ice melting might increase the exposure to killer whale predation. The possibility of emigration would not explain the combination of apparent high mortality and population decline, which were estimated independently of one another. The recruitment rate was not well estimated (0.07 with an SE of 0.05) and even zero recruitment was consistent with the data. The author indicated that in future work it be might be possible to incorporate qualitative information on whale sizes, potentially informing the recruitment-mortality-emigration question by allowing some assessment of the distribution and relative contribution of smaller whales (sub-adults) to the estimates. The Working Group concluded that while the evidence for the decline was not conclusive, there was clearly a high priority for resuming the monitoring this stock. In addition, the Working Group **endorsed** the abundance estimate of 218 individuals (CV=0.22) in 2016 as appropriate to be included in the IWC Abundance Table as Category 3.

3.1.1.7 NORTH PACIFIC GRAY WHALES

SC/67a/NH11 presented an updated population assessment of gray whales off Sakhalin and Kamchatka, using a population model that allows for multiple feeding and breeding areas. The model is fit to photo-identification data collected off Sakhalin during 1995-2015 (Burdin and Sychencko, 2015), tracking of whales from Sakhalin to the eastern North Pacific (Mate *et al.*, 2015), photo-identification matches of gray whales between the Sakhalin and Mexico catalogues (Urbán R. *et al.*, 2013) and reported photo-id results from Kamchatka collected during 2014 (Yakovlev *et al.*, 2013). The results show that the Sakhalin and Kamchatka feeding populations have been increasing at 2-5% per year over the 10 to 20 years prior to 2015. The number of non-calf whales in 2016 is estimated to be 320-410, of which 130-170 are predominantly Sakhalin-feeding whales and 180-220 are whales that feed at least occasionally off Sakhalin. If some of the whales breed in the western North Pacific, the size of that subset of the population is estimated to be at most 50 animals.

Being essentially a modelled mark-recapture estimate, the method provides a time series of abundance estimates with covariances, and is dependent on stock structure assumptions because it estimates a population rather than a snapshot of the whales in a given area at a given moment. It was proposed that for the purpose of the IWC Abundance Table, it would be reasonable, given a stock structure hypothesis, to select one abundance estimate from near the start of the series and one from near the end, because the covariance between the two ends is negligible.

SC/67a/NH11 outlined various aspects of the latest application of the analysis method. However, it does not describe the method employed fully. The Working Group **recommended** that Cooke provide a consolidated paper that fully specifies the method to the next year meeting of the Scientific Committee, including full details of the likelihood function and how posterior samples are generated. This will involve combining aspects of SC/67a/NH11, Cooke *et al.* (2016) and SC/A16/GW02. The analysis is based on software developed by Cooke rather than conventional methods for analysing photo-identification data such as the program MARK.

The Working Group **endorsed** the estimates of abundance for 1995 and 2015 for the two cases: (i) a Sakhalin feeding population (whose members do not necessarily feed exclusively of Sakhalin); and (ii) a combined Sakhalin and Kamchatka feeding population (see Table 2) for inclusion in the IWC Abundance Table under Category 3, noting that these estimates arise from a population model that integrates several sources of data, including photo-id matches between the Sakhalin and Mexico catalogues as well as photo-id data from Kamchatka and Sakhalin Island and satellite-based tracking data.

Table 2

Estimates of abundance for gray whales (1+ population) in Sakhalin and Sakhalin and Kamchatka from SC/67a/NH11.

	Sakhalin		Sakhalin and Kamchatka	
Year	Estimate	SE	Estimate	SE
1995	74	5	129	10
2015	191	8	282	14

Table 3

Abundance estimates for the PCFG (Pacific Coast Feeding Group of western gray whales) based on mark-recapture analysis from SC/A17/GW5.

Year	Estimate [PCFG]	CV
1995		
1996		
1997		
1998	126	0.087
1999	145	0.101
2000	146	0.098
2001	178	0.076
2002	197	0.069
2003	207	0.084
2004	216	0.077
2005	215	0.125
2006	197	0.108
2007	192	0.136
2008	210	0.089
2009	208	0.101
2010	200	0.095
2011	205	0.078
2012	217	0.052
2013	235	0.059
2014	238	0.080
2015	243	0.078

Calambokidis *et al.* (2017) provided updated abundance estimates of gray whales for the Pacific Coastal Feeding Group (PCFG) range as defined by the IWC. Photo-identification data collected from 1996 through 2015 were used in open population models to estimate survival and a time series of abundance estimates. The most recent estimate for 2015 was 243 whales (SE=18.9). Abundance had been relatively stable since the early 2000s but increased in the 2013-15 period.

The Working Group noted that this document provided an update from existing estimates previously reviewed and accepted by the Scientific Committee. It was **agreed** that the updated time series of abundance estimates for PCFG gray whales (Table 3) be accepted for use in the assessments of North Pacific gray whales and for inclusion in the IWC Abundance Table under Category 1.

Durban *et al.* (2017) provided results from two years of new counts and abundance estimates for gray whales migrating southbound off the central California coast between December and February 2014/15 and 2015/16. These counts were made from a shore-based watch station at Granite Canyon, California, and represent a continuation of the NOAA gray whale abundance time-series that began in

1967 (Laake *et al.*, 2012). Counting methods and analytical techniques for the 2014/15 and 2015/16 estimates followed those previously reviewed by the Scientific Committee and described in Durban *et al.* (2015) for four previous abundance estimates between 2006/07 and 2011/12. The 2014/15 estimate was 28,790 (95% HDPI=23,620-39,210) and the 2015/16 estimate was 26,960 (95% HDPI=24,420-29,830). There was consistency between the model predictions and observed counts for both years. However, daily and total abundance in 2014/15 were subject to considerable uncertainty, as shown by the large error bars associated with each of the daily estimates (illustrated in Fig. 1 of Durban *et al.* (2017)) and the relatively large coefficient of variation (CV=posterior standard deviation/posterior median; CV_{2015}=0.13). This is likely explained in part by the results of model fitting, as significant departures from the Normal migration model (probability of Normal model <0.25) were estimated in 18/90 days in 2014/15 compared to only 9/90 days in 2015/16. These departures, and the uncertainty associated with estimating an independent migration curve, constrained the estimation of a precise migration curve. In contrast the CV_{2016}=0.05 was consistent with previous estimates using this counting approach and model (CV=0.04-0.06 for four previous estimates since 2006/07), and this estimate was therefore more useful for interpretation in the context of the abundance time series. Differences in the CVs from the two years demonstrated the value of completing two counts and abundance estimates in back-to-back years, which provided a measure of redundancy.

Being updates to previous estimates using previously agreed methods, the Working Group **agreed** that the gray whale abundance estimates from shore-based counts off California in 2014/15 (*N*=28,790, 95% HDPI=23,620-39,210) and 2015/16 (*N*=26,960, 95% HDPI=24,420-29,830) are suitable for use in *SLA* and as part of the conditioning process for range-wide modelling, and are classified as Category 2 in the IWC Abundance Table. However, potential methodological issues were raised in discussion, including apparent oscillatory behaviour between the spline and standard model, and a tendency for the spline model to be consistently estimated to lie below the Normal model in 2014/15. The Working Group **encouraged** the authors to investigate these issues and report their findings to the Scientific Committee in the future.

3.1.1.8 NORTH PACIFIC SEI WHALES

No paper was presented under this agenda item.

3.1.1.9 NORTH PACIFIC BRYDE'S WHALES

SC/67a/RMP04 provided western North Pacific Bryde's whale abundance estimates by sub-areas and additional variance estimates for use in *Implementation Trials* for this species. This paper had been submitted in response to a recommendation from the first intersessional Bryde's whale Workshop (SC/67a/Rep07) that a new document be provided to the Scientific Committee meeting in May 2017. This document had been recommended to include more details on the survey collection modes and data used, analytical methods (e.g. how were the CVs calculated, model averaging, use of alternative covariates) and results reported. It had also been recommended that the paper include the additional analyses that need to be undertaken before the estimates can be agreed such as: (a) including sightings that were identified as 'Bryde's like' and 'unidentified large baleen whales'; and (b) attempting to estimate *g*(0). Abundances by sub-area were estimated incorporating the new boundaries agreed at the workshop. Abundance estimates are based on 2013-15 IWC-POWER surveys and 2008, 2012 and 2014 JARPNII surveys. In this paper, details on the survey collection modes and data used, analytical methods and reported results are presented in accordance with the review Workshop's recommendations. Plots for pre-determined tracklines, the survey order in each survey year, primary and secondary sightings of the Bryde's whales, and tracklines actually surveyed are provided. Abundance estimates and their variance were estimated using Horvitz-Thompson like estimators. Detection functions are fitted using school size, Beaufort scale and year as candidate covariates. Covariates were selected by AIC for POWER and JARPNII data, respectively. Akaike weights were used to obtain weighted averages of abundance estimates, with higher weights assigned to those estimates with lower AIC scores. Sensitivity analysis was performed to assess the effects of including undetermined large baleen whales and Bryde's-like whales in estimates. Additional CVs were estimated using abundance estimates by sub-area in three periods (1988-96, 1998-2002 and 2008-15) using four models. These four models (with/without adjustment by areal coverage and with/without exponential growth) are used to estimate additional CVs and their standard deviations. Abundance estimates are 8,219 (CV=0.179) for the IWC-POWER data and 18,080 (CV=0.272) for JARPNII, both using the best estimated detection function. These estimates were used to estimate abundance by sub-areas. Weighted averages using Akaike weights and abundance estimates including species codes other than Bryde's whales were not substantially different from the abundance using the best model for IWC-POWER and JARPNII. The abundance estimates were 15,422 (CV=0.289), 6,716 (CV=0.216) and 4,161 (CV=0.264) in sub-areas 1W, 1E and 2 respectively, based on the recent surveys. The total abundance estimate was 26,299 (CV=0.185, 95% CI=18,374-37,643). Additional variance was estimated as 0.335 with SD=0.161 for the best model.

The Working Group thanked the authors for following up on the workshop recommendations, and **agreed** to accept the total abundance estimate of 26,299 (CV=0.185; 95% CI=18374-37643) and the additional variance estimate of 0.335 (SD 0.161) for inclusion in the IWC Abundance Table under Category 1, noting that the estimate assumes that *g*(0)=1. The Working Group **reiterated** the recommendation from SC/67a/Rep07 that an investigation be undertaken to ascertain if *g*(0) can be estimated, and that results of this investigation be reported to the Working Group next year.

3.1.1.10 SOUTHERN HEMISPHERE RIGHT WHALES

SC/67a/CMP01 estimated the relative abundance of southern right whales by conducting an aerial survey of individuals in a 620km coastal strip in the Península Valdés (PV) area, Argentina. Perfect detectability of animals was assumed due to the shallow depth of the survey area (<20m) and the fact that flights were conducted during Beaufort Sea State 0-3 conditions only. The purpose of the survey was to estimate temporal trends in relative abundance for the study region. Surveys were carried out using high-wing single-engine aircrafts, with a total effort of 65 flights from 1999 to 2016. Mother-calf pairs, solitary individuals and breeding groups were counted. Data were analysed using a generalised linear model with log-link and assumed negative-binomial distribution. Predictor variables included year and a quadratic term in month, with the latter was tested against an alternate within-season term, reflecting a quadratic effect in Julian day. Response variables were total number of whales; number of calves; number of solitary individuals and number of mating groups. AIC was used for all model selections. The selected model for total number of whales estimated a rate of increase of 0.60% p.a. and 2.30% p.a., for calves while solitary individuals and mating groups had negative rates of increase. The annual rate of increase declined from 2007 to 2016, both for total number of whales and calves. The declining trend in the rate of increase, the increase in mortality rate, and the relocation of adults to deeper waters to the Northern Golfo San Matias is thought to provide evidence of a density dependence process and an indication that whales are is reaching carrying capacity for the PV region.

In discussion, the authors were asked why standard distance sampling methods were not employed for these surveys. In response, the authors explained that detection functions had been estimated in the past, but surveys are only conducted in good flying conditions and over shallow depths, so that the survey was essentially a time- and area-specific census. It appeared there may have been some expansion of the population into deeper waters, and that this may have been increasing over time. The author suggested that carrying capacity may have been reached in the PV area, and this apparent expansion might account for the estimated decreasing rates of population increase. It was not possible to know if rates of increase were decreasing at a local scale, or simply due to an expansion of their usual range. The Working Group **recommended** that surveys to monitor relative abundance continue within the PV study area.

3.1.2 Small cetaceans

3.1.2.1 SMALL CETACEANS IN RIVERS, ESTUARIES AND RESTRICTED COASTAL HABITATS IN ASIA

There was insufficient time to discuss papers relevant to this agenda item. The Working Group **agreed** that documents relevant to the work of the Scientific Committee or those containing estimates that could be incorporated in the IWC abundance table would be reviewed intersessionally by an email correspondence group under Palka (see Item 8, below).

3.1.2.2 OTHER SMALL CETACEANS

Baker *et al.* (2017) presented results from the continued genetic monitoring of the Māui dolphin subspecies in 2015-16, following methods published previously which had been applied to surveys conducted in 2010-11 and from 2001-07. A total of 25 small-boat surveys dedicated to the collection of biopsy samples had been conducted in the known current range of Māui dolphins during a three-week period in the austral summers of 2015 and 2016. Māui dolphins are highly aggregated in distribution, with an extreme occurring in 2015, and are very attracted to boats, making them good candidates for biopsy sampling. A total of 92 biopsy samples were collected from individual dolphins older than one year of age. DNA profiles were completed for each sample, including genotyping of up to 25 microsatellite loci, genetic sex identification and mitochondrial DNA (mtDNA) control region sequencing. Based on matching of the microsatellite genotyping, 17 individuals were sampled in both 2015 and 2016, providing a minimum census of 51 individuals (19 males, 32 females) alive at some point during the two-year study, of which two were identified genetically as Hector's dolphins. For the Māui dolphins, a two-sample, closed-population model was used to estimate an abundance of 63 individuals of age 1+ (CV=11%) for the 2015-16 surveys. This estimate is comparable to, but slightly larger than the previous estimate of N=55 (CV=15%) based on the genotype surveys in 2010-11. In addition to the conventional genotype capture-recapture analysis, the study took advantage of the microsatellite genotypes to estimate the effective population size using linkage disequilibrium (Do *et al.*, 2014; Waples and Do, 2008). Using the combined sample of 49 Māui dolphins from 2015-16, the linkage disequilibrium method estimated an effective population size of N_e=34 (95%, CI=24-51). Retrospective matching of DNA profiles for all samples collected from 2001 to 2016 resulted in a total count of 115 individual Māui dolphins, 102 of which were sampled live, 13 sampled beached (dead) and one sampled alive and dead two years later. Three individuals (two females; one male) were sampled in both 2001 and 2016, confirming a minimum survival of 15 years.

The Working Group asked for clarification on how the estimates of effective size (N_e) should be interpreted. It was noted that the method used effectively calculates the number of parents contributing to the current population (N_b). This estimate can be converted into a 'true' N_e estimate if life history parameters of the species are known (Waples *et al.*, 2014). The estimate of effective size was based on the linkage disequilibrium method (Waples and Do, 2008). A benefit of using this approach is that, unlike genetic mark-recapture, samples from two distinct time periods are not required. The Working Group commented that the last two estimates of census size (i.e. from the genetic mark-recapture approach) are similar, and both are markedly more precise than the earlier estimate of abundance (2001-07) reported in Baker *et al.* (2013). The author clarified that the 2001-07 estimate was based on an open population model, while the last two estimates were based on a closed population model given that they encompassed two sequential years. There were also differences in survey effort between the first period and the last two periods. It was noted that the survival rates estimated using the genetic mark-recapture data are low, which is consistent with a declining population. Additional surveys would be needed, however, to obtain a robust estimate of the trend in abundance from the mark-recapture genetic data.

In discussion, the Working Group **agreed** that while other estimates of abundance estimates using similar methods were mentioned on the paper, only the one computed for 2015-16 (N=63, CV=0.11), for which the methods were explicitly presented in the report, were **endorsed** for inclusion in the IWC Abundance Table under Category 1. Suggestions were made that earlier estimates obtained using similar techniques should also be approved. However, the Working Group **agreed** that for consistency of the review process, the methods used to compute estimates must be available when abundance estimates are reviewed and **encouraged** submission of these estimates for discussion at the Scientific Committee.

Hamner *et al.* (In press) described a similar estimate of abundance (N) using genotype capture-recapture and effective population size (N_e) using Linkage Disequilibrium methods for a local population of Hector's dolphins, the sister subspecies of the Māui dolphins. This population was chosen, in part, because of the availability of estimates of abundance using different methodologies, e.g. vessel and aerial line transect (Dawson *et al.*, 2004; Mackenzie and Clement, 2014). Cloudy Bay was surveyed by small vessels during August 2011 and again in 2012, with the primary objective of collecting genetic samples and photographs for individual identification. A total of 263 samples had been collected for genetic identification and 856 photographs for individual identification. The assumption of geographic closure in Cloudy Bay was supported by the lack of genetic differentiation between the two survey years and the absence of any genetically detectable migrants. Using a two-sample closed population recapture analysis based on genotype identifications, the authors estimated the abundance of individuals age 1^+ (N_{1+}) to be 269 (CV=0.12). This was similar to, but more precise than, N=230 (CV=0.30) from the more traditional analysis using contemporaneously collected photo-identifications. The N_e of the parental generation was 191 (95% CI=23-362), and the resulting N_e/N_{1+} of 0.71 was in reasonable agreement with species of similar life history characteristics (Waples *et al.*, 2014).

Baker noted that the capture-recapture estimates of abundance from both sources of identity (i.e., genotype and photo-identification) were larger than the previous vessel-based line transects (Dawson *et al.*, 2004) but considerably smaller than recent aerial line-transect surveys (Mackenzie and Clement, 2014) in the same region.

In discussion, a query was raised whether assumptions of random biopsy sampling and population closure were met. The author responded that there was no evidence of bias in individuals sampled and the field teams took care to avoid replicate sampling within a season. The lack of genetic differentiation between the two survey years was consistent with a closed population, supporting that assumption. In conclusion, the estimate of 269 individuals (CV=0.12) for the period 2011-12 was **endorsed** for inclusion in the IWC Abundance Table under Category 1.

Hammond *et al.* (2016) provided design-based estimates of cetacean abundance in European waters in summer 2016 from the SCANS-III survey. The independent project, ObSERVE, conducted surveys in Irish waters during the period 2015-17, providing coverage for the waters to the south and west of Ireland in the SCANS-III study area. These estimates will be reviewed next year.

3.2 Update of the IWC Abundance Table

An updated table including the abundance estimates discussed above and **agreed** for inclusion in the IWC Abundance Table during the meeting is presented in Appendix 4.

4. CONSIDERATION OF APPROACHES TO SPECIFY THE STATUS OF STOCKS

The Scientific Committee has been asked to provide the Commission with a summary of advice on the status of stocks on a broad level (e.g. ocean basin or region). RMP and AWMP *Implementation Simulation Trials* are designed to provide robust management advice but not 'status' in the traditional sense expected by the Commission (i.e. what is the present 'stock' level compared to the unexploited level and what are the likely future trends). Rather they provide considerable output for a wide range of plausible scenarios that would need to be integrated and summarised to provide measures of status. The results of a set of *Implementation Simulation Trials* should be summarised by the following three statistics to provide information on status:

- current depletion (number of animals aged 1+ and older relative to 1+ carrying capacity);
- current 1+ abundance; and
- 1+ abundance in 2050 if all future RMP and AWMP catches (but not projected bycatches) are assumed to be zero.

Results should be provided for two values for the MSY rate (1% in terms of harvesting of the total (1+) component of the population and 4% in terms of harvesting of the mature component) unless the base-case trials are based on a higher value for the lowest plausible value for MSY rate or if MSY rate has been estimated and there is an agreed value. In addition, results should be summarised across simulations and trials (medians over simulations and averages across base-case trials).

Each base-case trial may have a different number of breeding stocks. Results should be reported by area, specifically for the Ocean Basin (i.e. 'Region') and by 'Medium Area' rather than by the sub-areas on which the population models underlying the trials are based to avoid having a very large number of summary statistics. However, there needs to be flexibility in reporting. For example, the Committee may also wish to present results for individual biological stocks about which it believes the Commission needs to be informed and hence that the default of reporting results by area only provides a misleading impression. The choice of the stocks for which results are be reported needs to be decided during *Implementations* and *Implementation Reviews*. The sub-committee **recommends** that the Guidelines for Conducting *Implementations* and *Implementation Reviews* be updated to reflect this, and that the control programs used for *Implementation Simulation Trials* be modified to report the three measures of status listed above. In addition, the results for all stocks should be calculated and made available to the Commission, but not included in the primary presentation.

5. RESEARCH PROGRAMS – DESIGN AND PLANNING OF ABUNDANCE SURVEYS

5.1 IWC-POWER cruises

Donovan introduced the report of the planning meeting for the IWC-POWER cruise for 2017 (SC/67a/Rep02), held in Tokyo from 15-17 September 2016. Donovan thanked Japan for hosting the meeting and the warm welcome. The planning meeting finalised details for the forthcoming IWC-POWER cruise to be held from 3 July-25 September 2017, including transit from and to Japan using the research vessel *Yushin-Maru No. 2*, kindly provided by Japan. It was confirmed, after the planning meeting, that the ship had received international clearance. Sailing with international status will provide considerable benefits with regard to permits and port entries for refuelling, and acoustic components like deployment of sonobuoys. This will be the eighth cruise under the successful international IWC-POWER programme. Together, the cruises to be conducted in 2017, 2018 and 2019 will cover the Bering Sea (Fig. 1). These plans have been endorsed by the Scientific Committee at SC/66b in 2016. The 2017 cruise will cover the easternmost stratum in the Bering Sea (Fig. 1), i.e. the US coast. This will give more time for obtaining the relevant permits for covering Russian waters in the westernmost stratum of the survey area. The 2017 cruise objectives (and also those of the 2018 and 2019 cruises) will be broadly the same as in previous years, with the important addition of an acoustic component, as endorsed by the Scientific Committee, where this component will be conducted in cooperation with the US. The cruise will focus on the collection of line transect data to estimate abundance as well as collection of acoustic, biopsy and photo-identification data. This will make a valuable contribution to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific.

A number of tasks to be completed prior to the cruise were identified including application for permits, final choice of researchers (Koji Matsuoka of Japan has been nominated as Cruise Leader), updating of Guidelines for Researchers, obtaining necessary equipment including biopsy darts and improved equipment for angle and distance experiments, as well as technical details and logistics concerning the

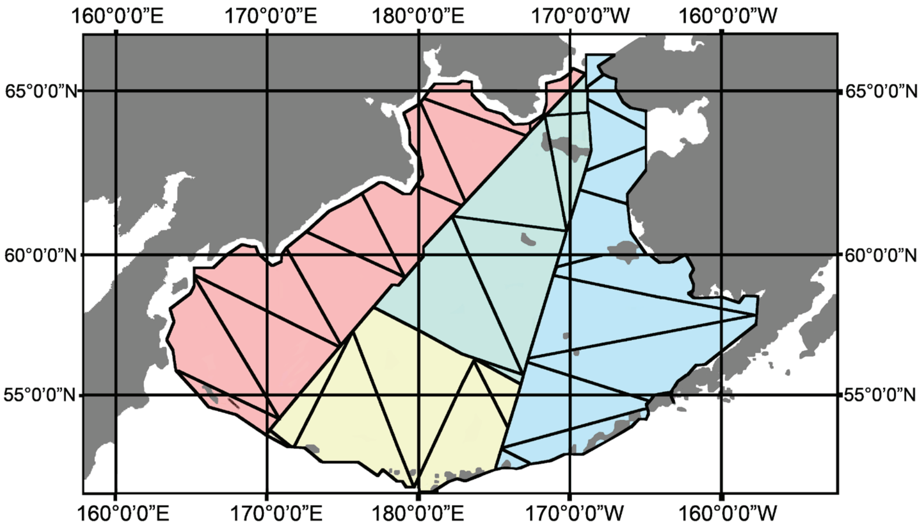

Fig. 1. Survey strata and proposed tracklines for POWER-cruises planned for the period 2017-19. The central block is divided into two strata for logistical reasons (trackline design). In 2017, the eastern (blue) block will be covered.

implementation of the acoustic component. Appropriate deadlines and responsible persons were identified. It was noted that a two-year budget had already been agreed upon, including the budget for the survey in 2018.

On behalf of the Working Group Donovan thanked the Government of Japan for the long-term provision of the vessel, and the Government of the USA for providing acoustic equipment. Russian colleagues were thanked for attending the planning meeting.

The Working Group **endorsed** the 2017 POWER cruise and recommended a detailed planning meeting for the 2018 cruise. Furthermore, the Working Group recommended that the USA and Russia facilitate the proposed research by providing respective permits for their national waters. The Working Group looked forward to receiving a report from the survey and **encouraged** this to be brought to the next Scientific Committee meeting.

It was noted that in the intersessional period funds for the development of the IWC integrated relational data base DESS, which links the various types of data that are collected and archived within the IWC (sighting, effort, and weather line transect related data; photographs; biopsies; processed genetic data; and processed passive acoustic data) had been made available. The next step to undertake is the development of a tender for the development of this database. The Working Group **encouraged** that this work be undertaken.

SC/67a/ASI09 reported the results of the 7th annual IWC-POWER cruise, conducted between 2 July to 30 August 2016 in the central North Pacific (with the dedicated research area located between 20°N-30°N and 135°W-160°W). The survey was conducted aboard the Japanese R/V *Yushin-Maru No.3*. Researchers from Japan, the US and the Republic of Korea participated in the survey, which was implemented using methods based on the guidelines of the Scientific Committee. Sighting coverage was 97.2% of the planned track-line. A total of 2,237.5 n.miles was surveyed under the Passing with abeam closing (NSP) and the Independent Observer passing (IO) modes. Additionally, 626.2 and 580.1 n.miles were surveyed during transit to and from the research area respectively. The following sightings were made: blue whale (1 school/1 individual), sei whale (1/1), Bryde's whale (28/32), sperm whale (32/125), Cuvier's beaked whale (2/5), Mesoplodon spp. (2/3), Ziphiidae (7/11), short finned pilot whale (2/31), pygmy killer whale (1/16), Risso's dolphin (2/19), bottlenose dolphin (1/37), common dolphin (8/217), striped dolphin (5/378) and spotted dolphin (1/133). Bryde's and sperm whales were the most frequently sighted large whale species. The Estimated Angle and Distance Training Exercises and Experiments were completed with improvements following Scientific Committee suggestions. Photo-identification data for 12 Bryde's whales and 2 sperm whales were collected. A total of 23 biopsy (skin and blubber) samples was collected from 1 blue, 1 sei, 16 Bryde's and 5 sperm whales using the Larsen biopsy rifle/darts system. In the case of Bryde's whale, 3 samples were collected from sub-area 1 (west of 180°E) and 13 samples from sub-area 2 (east of 180°E). A total of 153 marine debris objects were observed.

In discussion, an enquiry was made whether the numbers of sightings had been expected to be as low as encountered. In response, it was pointed out that the main objective of the cruise had been to investigate the easterly and southerly distribution of Bryde's whales, which could be addressed despite low sighting numbers.

On behalf of the Working Group, Kato thanked the Cruise Leader, researchers, Captain and crew, and the Steering Committee for completing the 6th cruise of the IWC-POWER programme. The Government of the USA had granted permission for the vessel to survey in their waters, without which this survey would not have been possible. The Government of Japan generously provided the vessel and crew. The Government of Republic Korea provided a researcher. Furthermore, the IWC Secretariat was thanked for providing support. The Working Group recognised the value of the data contributed by this and the other POWER cruises, collected in accordance with survey methods agreed by the Committee, covering many regions not surveyed in recent decades, and addressing an important information gap for several large whale species. The Working Group encouraged the future provision of abundance estimates arising from these data.

5.2 IWC-Southern Ocean Research Partnership (IWC-SORP)

No new information from the IWC-Southern Ocean Research Partnership programme on abundance estimates or survey plans for estimating abundance required consideration during this meeting. The Working Group **looks forward** to receiving information from future IWC-SORP projects in the future.

5.3 National Programs

SC/67a/ASI01 proposed a cetacean sighting survey conducted by COMHAFAT in coastal waters of western North Africa in the winter of 2018. The study area is set in the coastal waters of Guinea to Liberia, except for shallow waters less than 20m (for safe sailing). Zigzag track lines with around 1,100 n.miles total length are placed in the area. A 15-day survey period is planned for the 2018 winter season (in January and/or February of 2018). The survey is started off Conakry, Guinea and finished off Palmas Cape in Liberia. The research vessel, *General Lansana Conte* of Guinea (198 tons), will be engaged. Researchers from COMHAFAT member states will conduct the survey. Scientists from non-member states may attend if COMHAFAT and vessel capacity allow this. Cetacean searching will be conducted using line transect methodology, under good weather conditions (Beaufort wind scale of 3 or less and greater than 2 n.miles in visibility). Researchers will search the sea surface for cetaceans from the vessel following the pre-determined track lines at around 10 knots. The normal closing mode survey will be carried out, in which closure is conducted for all cetacean species encountered on the track lines.

In discussion, an explanation was given that the planned tracklines did not include the coastal waters beyond the 20m isobath due to limitations of time available for the survey, and furthermore that the survey will be a multispecies survey targeting small and large cetaceans.

The Working Group **welcomed** this multispecies survey in these waters since there have been few previous surveys of this area. It **endorsed** the proposal and **encouraged** future presentation of abundance estimates from this survey. It was noted that no IWC oversight was needed for this survey.

SC/67a/ASI02 presented a plan for a systematic vessel based dedicated sighting survey in the eastern Okhotsk Sea (the eastern part of the sub-area 12NE for common minke whales as defined for the RMP *Implementation*) by Russia in 2017. The research vessel *Vladimir Safonov* is a stern trawl type research vessel with a barrel for observation. The objective of the survey is to obtain information on distribution and abundance of large whales using normal closing mode. The period of the survey will be from 4 August to 7 September (35 days), and the vessel will cover the research area from 51°N-57°N and west of the Kamchatka Peninsula to 152°E. The research area will consist of a single block. During transit to the research area, the vessel will conduct a sighting survey in passing mode to enhance research capability of the crew and researchers. The distance and angle estimation training and experiments will be conducted during this survey. Photo-identification of cetaceans such as northern right whales, gray whales and humpback whales will be also be attempted. When peeled skin is found after breaching, the vessel will try to collect a DNA sample using a landing net.

In discussion, the proponents of the survey explained that no biopsy samples would be taken due to safety constraints on board. The researchers expect to encounter minke, killer, northern right and gray whales in the study area.

The Working Group **welcomed** and **endorsed** the plan to survey the eastern Okhotsk Sea, noting that Miyashita had been appointed to provide IWC oversight.

SC/67a/ASI04 presented the research plan for the NEWREP-A dedicated sighting survey in the 2017/18 austral summer season. The main objective of the survey is the systematic collection of sighting data aimed to produce abundance estimates of Antarctic minke whale and other large whale species. The survey plan follows the IWC's 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme (RMS)'. The survey is planned to be conducted in the eastern part of Antarctic Area V (165°E-170°W), which includes the Ross Sea, and the western part of Area VI (170°W-145°W). Whale sightings will be conducted under Normal Passing (NSP) and Independent Observer (IO) modes. The duration of the survey including transit is planned to be 130 days and the number of days dedicated to research in Antarctic waters to be 80 days. The survey will be conducted using two research vessels, *Yushin-Maru No. 2* (*YS2*) and an undetermined vessel with similar platforms. Both vessels will be equipped with a top barrel (TOP), an independent observer platform (IOP) and an upper bridge platform (UBP). For the sighting survey under IO mode, two researchers are required on board each vessel. SC/67a/ASI04 provides details of the stratification of the research area, trackline design, sighting effort and mode, distance and angle experiment and data entry system. Krill and oceanographic surveys and feasibility studies on biopsy sampling and telemetry for Antarctic minke whales will be also conducted (see details in the appendices of ASI04). After validation, sighting and associated data will be submitted to the IWC Secretariat. A cruise report will be prepared immediately after the survey is completed, and will be presented to the 2018 Scientific Committee meeting.

In discussion, the question was asked why Antarctic minke whales, not other large whale species, would be targeted in a feasibility study for telemetry with trials for attaching tags from the bow of the large vessel. The proponents explained that Antarctic minke whales are the focal species of the NEWREP-A research program and that the expert panel evaluation had requested these trials. Furthermore, it was explained that employment of zodiacs for tagging was not feasible under the survey conditions far-offshore and would not be considered due to safety requirements. The timing of the survey was discussed, following a suggestion that conducting the survey earlier in the year could potentially provide more sightings. Clarification was provided that the time period proposed had been selected for reasons of consistency and comparability with previous surveys.

The Working Group **welcomed** the proposed NEWREP-A multi-disciplinary survey involving a dedicated cetacean sighting survey, krill survey and oceanographic sampling survey, in addition to conducting biopsy and tagging experiments.

The Working Group **endorsed** the cetacean abundance estimation component of this proposal and the appointment of Matsuoka to provide IWC oversight.

SC/67a/ASI06 presented the research plan for the NEWREP-NP dedicated sighting survey in the North Pacific in 2018. The main objective of the survey is the systematic collection of sighting data to produce abundance estimates of common minke whales. The survey plan follows the IWC's 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme (RMS) (IWC, 2012)'. The survey will be conducted using the research vessel *Yushin-Maru No. 2* between 11 May and 25 June 2017. The vessel is equipped with a top barrel (TOP), an independent observer platform (IOP) and an upper bridge platform (UBP). SC/67a/ASI06 provides details of the stratification of the research area, trackline design, sighting effort and mode, distance and angle experiment, and the data entry system. The research area comes between 41°N and 46°N and 136°E and146°E (a part of sub-areas 10E and 11). Given the objective of whale abundance estimation, distance and angle estimation experiments will be conducted. Biopsy and photo-id experiments on large whales will be also conducted. After validation, sighting and associated data will be submitted to the IWC Secretariat. A cruise report will be prepared immediately after the survey is completed, and will be presented to the 2018 Scientific Committee meeting.

The Working Group **welcomed** the proposed NEWREP-NP multi-disciplinary survey involving a dedicated cetacean sighting survey, in addition to conducting biopsy sampling and photo-identification.

The Working Group **endorsed** the cetacean abundance estimation component of this proposal and the appointment of Matsuoka to provide IWC oversight.

SC/67a/ASI08 provided a plan for a systematic vessel-based dedicated sighting survey in the North Pacific during 2017 by Japan. It was noted that this survey is not conducted under NEWREP-NP. The main objective of this cruise was to examine distribution and estimate abundance of common minke whales for management and conservation purposes. The survey was being conducted using the research vessels *Yushin-Maru* and *Yushin-Maru No. 3* from 28 April to 27 May 2017 in the area north of 35°N, south of 43°N and between 140 and 146°E (a part of sub-areas 7CS and 7CN for the RMP *Implementation* for minke whales). Cruise tracks were designed systematically and the start point of the track lines were chosen randomly. Given the objective of whale abundance estimation, distance and angle estimation experiments will be conducted. Biopsy skin samples of blue, fin, sei, Bryde's, humpback and North Pacific right whales will be collected. Photo-identification experiments on blue, North Pacific right and humpback whales will also be conducted. Data related to abundance estimates will be stored at the Institute of Cetacean Research (ICR) and submitted to the IWC Secretariat based on the Scientific Committee Guidelines (IWC, 2012). The report of the sighting survey will be submitted to the 2018 Scientific Committee meeting.

The Working Group **endorsed** the cetacean abundance estimation component of this proposal and the appointment of Matsuoka to provide IWC oversight.

SC/67a/ASI10 provided a plan for a dedicated sighting survey for common minke whale conducted by Korea using the research vessel *Tamgu 3* in the Yellow Sea of Korea in spring, 2018. This survey will complement surveys conducted in Korean waters during previous years. Another two strata further offshore to the west are planned to be covered in 2018. The first objective of this survey is to obtain information on the distribution and abundance of common minke whales for stock assessment purposes. The second objective is to collect general information on the distribution of other cetaceans in the area. Transect lines totalling 741.6 n miles in length and using closing mode will be searched with both binoculars and the naked eye. Other research activities such as biopsy sampling or photo identification will be conducted during the survey.

The Working Group **endorsed** the cetacean abundance estimation component of this proposal and the appointment of Park to provide IWC oversight.

Three cruise reports of national research programs were available (SC/67a/ASI03, SC/67a/ASI05, SC/67a/ASI07). It was **agreed** that these documents would not be discussed because they contained no new abundance estimates and their contents did not contribute to improving the design of future surveys. Summaries of these documents are presented in Appendix 5.

National research programs were **encouraged** to provide estimates of abundance in future cruise reports for review by the Working Group.

6. METHODOLOGICAL MATTERS

6.1 Model-based abundance estimates and amendments to the RMP Guidelines

6.1.1 Review of intersessional work and pre-meeting

Bravington reported on the pre-meeting on model-based abundance estimation (Appendix 6). Abundance estimates from line-transect surveys can nowadays be derived statistically using spatial models, as well as the more familiar Horvitz-Thompson (HT) approaches. Spatial models have potential advantages in reducing bias resulting from patchy coverage, and in providing more reliable estimates of variance. In recent years, the Committee has recognised the need to develop its expertise in evaluating spatial-model-based abundance estimates, which are fairly complex, and also in deciding whether an estimate based on the simpler HT formulae can safely be used in cases when the strict assumptions underpinning HT do not apply (e.g. design reflects uneven coverage). To further this process, a workshop was held on 7-8 May, run by David Miller (CREEM) and Mark Bravington (CSIRO). The workshop explored some issues around the current state of spatial modelling for cetacean abundance estimation, and introduced software (ltdesigntester) for exploring the reliability of HT-based abundance estimates of specific surveys, either post hoc or in the design phase. Bravington provided an overview of preliminary workshop conclusions and highlighted potentially controversial points. Details may be found in Appendix 6.

The Committee has for some time been considering the need to amend the RMP guidelines (IWC, 2012) to incorporate abundance estimates produced using methods (e.g. spatial models, mark-recapture models) not yet considered by the Guidelines. One of the tasks of the pre-meeting was to consider such amendments, but time constraints meant that these amendments could not be discussed in detail. The Working Group **agreed** that an intersessional e-mail group under Zerbini (Item 8) would be tasked to propose amendments for discussion at next year's meeting.

6.2 Review of new survey techniques/equipment

SC/67a/NH09 reported on a new, innovative method to potentially study large whales using Very High Resolution (VHR) satellite imagery. Results from the first study using the WorldView-3 satellite for whales were presented. This satellite has a maximum spatial resolution of 31cm and is the highest resolution satellite presently in orbit. In order to investigate the possibility of identifying, counting and differentiating between mysticete species, satellite images from four different locations were acquired to target the breeding or feeding grounds of four candidate species: fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), southern right (*Eubalaena australis*) and gray whales (*Eschrichtius robustus*). Visual and spectral analysis of each species and their surrounding environment were conducted. All species were successfully manually detected; this included the first observations from satellite for fin and gray whales. The visual analysis highlighted morphological differences between some of the targeted species with some species more discernible than others, such as the gray and fin whales, which were more confidently identified due to their calm behaviour and light body colouration. The white head callosities of southern right whales were observed on some individuals. Non-whale features such as boats and planes were also observed and clearly distinct from the surveyed whale species. These results show the potential

Table 4
Work plan.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
2, 5 and 6	(1) Develop a process to facilitate the review of abundance estimates in a timely fashion prior or during the annual meetings. (2) Identify minimum requirements for presentation and review of abundance estimates for inclusion in the IWC consolidated table. (3) Develop processes to validate non-standard software, non-standard methods and how to consider estimates computed from population models. (4) Consider how to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the SC. (5) Amend the RMP Guidelines, particularly in regard to methods so far not included in the guidelines (e.g. spatial modelling and mark-recapture).	Review report from the intersessional e-mail group.
3	Review estimates of abundance of North Atlantic humpback whales and Asian coastal and river dolphins.	Review report from the intersessional email group.
4	Incorporate the estimates agreed at this meeting, upload them to the IWC website and continue to update the IWC Abundance Table intersessionally (Allison).	Review intersessional progress.
5.1	2017 IWC-POWER cruise in the Bering Sea. Planning Meeting for the 2018 IWC-POWER cruise.	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.

of using satellite imagery to study baleen whales. The next objective is to trial the automation or semi-automation of whale detection, because manually counting whales from satellite images is very time-consuming. Furthermore, it is intended to address the question of how deep below the sea surface whales are likely to be detected.

The influence of sea state on detection of whales by satellite imagery was discussed. Earlier studies trying to detect blue whales were not successful, mainly due to sea state issues. Despite the higher resolution of the WorldView-3 satellite, detections in sea states higher than 3 on the Beaufort scale are still problematic. Future applications of this technique were also discussed. Given an automated detection processes, the technique could be used to analyse occupancy or relative abundance of cetaceans, particularly for remote, inaccessible habitats with calm seas. It was suggested that areas of priority for investigation so could be identified by the IWC. The potential difficulty in species identification was discussed. Currently the method has been used only in areas of known species occurrence, with limited chances for species misidentification. Exploratory studies in areas of unknown species occurrence may be difficult. However, it was noted that at this stage, the study mainly represented a proof of concept. It was suggested that for further proof of concept analyses of other areas may be supported by existing acoustic or satellite tag data. The potential application to small cetaceans was also discussed. Since the method had not been able to detect any calves of large whales, which are larger in size than many small cetaceans, it was concluded that it was unlikely that small cetaceans could be detected. Moreover, it was noted that it is unlikely that the spatial resolution of the satellite would be further increased in the near future, because the current resolution satisfies commercial needs.

Until automated detection is available, crowd funding and citizen science projects were suggested for cost-efficient evaluation of satellite images. Furthermore, application of high-resolution satellite imagery for ship strike assessments was raised as potentially valuable.

Bravington *et al.* (2016) described a new method for computing abundance estimates and other population parameters integrating mark-recapture methods and relatedness of individuals inferred from genetics. This method is currently referred to as Close-Kin Mark-Recapture (CKMR). A summary of this paper and discussion by the Scientific Committee is provided in Annex I, item 6.2.1.

7. OTHER

7.1 IWC-IDCR/SOWER cruise data analysis and special volume

Donovan reported that the editorial work on the SOWER volume of the *Journal of Cetacean Research and Management* is expected to be completed in October, during a three-day meeting that will follow the POWER Cruise Planning Meeting.

8. WORK PLAN

Based upon the experience gained at this meeting, the Working Group noted that a process needed to be developed to facilitate the review of: (a) new abundance estimates in a timely fashion prior or during the annual meeting; and (b) existing estimates that had not yet been endorsed by the Committee. This process should include identifying minimum requirements for the presentation and review of abundance estimates for inclusion in the IWC consolidated table. The Working Group also noted that this process should consider how to validate non-standard software, non-standard methods, and how to address issues related to estimates computed from population models. The Working Group **agreed** that an email correspondence group under Zerbini would be tasked to develop this process intersessionally.

The **agreed** work plan is provided in Table 3.

9. ADOPTION OF THE REPORT

The report was adopted on 17 May 2017 at 22:07. The Chair thanked the rapporteurs, Herr, McKinlay and Olson, for their wonderful job recording the discussions during the Working Group sessions and for the timely completion of the report. The Chair also thanked the following members of the Scientific Committee who reviewed documents on behalf of the Working Group during the meeting: Givens, Palka, Punt and Wade.

REFERENCES

Baker, C.S., Hamner, R.M., Cooke, J., Heimeier, D., Vant, M., Steel, D. and Constantine, R. 2013. Low abundance and probable decline of the critically endangered Maui's dolphin estimated by genotype capture-recapture. *Animal Cons.* 16: 224-33.

Baker, C.S., Steel, D., Hamner, R.M., Hickman, G., Boren, L., Arlidge, W. and Constantine, R. 2017. Estimating the abundance and effective population size of Maui dolphins using microsatellite genotypes in 2015-16, with retrospective matching to 2001-16. Department of Conservation, New Zealand. 75pp.

Bravington, M.V., Skaug, H.J. and Anderson, E.C. 2016. Close-Kin Mark-Recapture. *Stat. Sci.* 259-74.

Burdin, A.M. and Sychencko, A.O. 2015. Status of western gray whales off northeastern Sakhalin Island, Russia in 2014. Paper SC/66a/BRG16 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 12pp. [Paper available from the Office of this Journal].

Cooke, J.G., Weller, D.W., Bradford, A.L., Sychencko, O., Burdin, A.M., Lang, A.R. and Brownell, R.L., Jr. 2016. Updated population assessment of the Sakhalin gray whale aggregation based on a photoidentification study at Piltun, Sakhalin, 1995-2015. Paper SC/66b/BRG25 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 14pp. [Paper available from the Office of this Journal].

Dares, L.E., Araujo-Wang, C., Chu Yang, S. and Wang, J.Y. 2017. Spatiotemporal heterogeneity in densities of the Taiwanese humpback dolphin (Sousa chinensis taiwanensis). *Estuar. Coast. Shelf Sci.* 187: 110e-17.

Dawson, S.M., Slooten, E., Du Fresne, S.P., Wade, P.R. and Clement, D. 2004. Small-boat surveys for coastal dolphins: line-transect surveys of Hector's dolphins. *Fish. Bull.* 201: 441-51.

Do, C., Waples, R.S., Peel, D., Macbeth, G.M., Tillett, B.J. and Ovenden, J.R. 2014. NeEstimator v2: re-implementation of software for the estimation of contemporary effective population size (Ne) from genetic data. *Molecular Ecology Resources* 14: 209-14.

Durban, J., Weller, D., Lang, A. and Perryman, W. 2015. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. *J. Cetacean Res. Manage.* 15: 61-68.

Givens, G.H., Edmondson, S.L., George, J.C., Suydam, R., Charif, R.A., Rahaman, A., Hawthorne, D., Tudor, B., DeLong, R.A. and Clark, C.W. 2016. Horvitz–Thompson whale abundance estimation adjusting for uncertain recapture, temporal availability variation, and intermittent effort. *Environmetrics* 27(3): 134-46. May 2016.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., MacLeod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. 2016. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. 40pp. [Available at: *http://bit.ly/2pXU2E0*].

Hamner, R.M., Constantine, R., Mattlinc, R., Waples, R. and Baker, C.S. In press. Genotype-based estimates of local abundance and effective population size for Hector's dolphins. *Biol. Cons.* [Available at: *http://dx.doi.org/10/1016/j.biocon.2017.02.044*].

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.S., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2016. Abundance of whales in east and west Greenland in 2015. Paper SC/D16/AWMP06rev1 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 38pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2012. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2014. Report of the Scientific Committee. Annex Q. Report of the *ad hoc* group to develop a list of 'accepted' abundance estimates. *J. Cetacean Res. Manage. (Suppl.)* 15:416-17.

International Whaling Commission. 2017. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

Laake, J.L., Punt, A.E., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2012. Gray whale southbound migration surveys 1967-2006: an integrated re-analysis. *J. Cetacean Res. Manage* 12(3): 287-306.

Mackenzie, D. and Clement, D. 2014. Abundance and distribution of ECSI Hector's dolphin. New Zealand Aquatic Environment and Biodiversity Report No. 123 to the Ministry for Primary Industries. 79pp. [Plus supplementary material].

Mate, B.R., Ilyashenko, V.Y., Bradford, A.L., Vertyankin, V.V., Tsidulko, G.A., Rozhnov, V.V. and Irvine, L.M. 2015. Critically endangered western gray whales migrate to the eastern North Pacific. *Biol. Lett.* 11: 20150071. 4pp.

Matsuoka, K. and Hakamada, T. 2014. Estimates of abundance and abundance trend of the blue, fin and southern right whales in Areas IIIE-VIW, south of 60°S, based on JARPA and JARPAII sighting data (1989/90-2008/09). Paper SC/F14/J05 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 27pp. [Paper available from the Office of this Journal]

Minton, G., Peter, C., Poh, A.N.Z., Ngeian, J., Braulik, G.T., Hammond, P.S. and Tuen, A.A. 2013. Population estimates and distribution patterns of Irrawaddy dolphins (*Orcaella Brevirostris*) and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in the Kuching Bay, Sarawak. *Raffles Bull. Zool.* 61(2): 877-88.

Paudel, S., Pal, P., Cove, M.V., Jnawali, S.R., Abel, G., Koprowski, J.L. and Ranabhat, R. 2015. The Endangered Ganges River dolphin Platanista gangetica gangetica in Nepal: abundance, habitat and conservation threats. *Endangered Species Research* 29: 59-68. [DOI: 10.3354/esr00702].

Paxton, C., Burt, M., Hedley, S., Víkingsson, G., Gunnlaugsson, T. and Desportes, G. 2009. Density surface fitting to estimate the abundance of humpback whales based on the NASS-95 and NASS- 2001 aerial and shipboard surveys. *NAMMCO Sci. Publ.* 7: 143-60.

Paxton, C.G.M., Burt, M.L., Hedley, S., Víkingsson, G.A., Gunnlaugsson, T. and Desportes, G. 2007. Density surface fitting to estimate the abundance of humpback whales based on the NASS-95 and NASS-2001 aerial and shipboard surveys. *NAMMCO Sci. Publ.* 7: 25pp.

Pike, D.G., Gunnlaugsson, T., Oien, N., Desportes, G., Vikingsson, G.A., Paxton, C.G.M. and Bloch, D. Unpublished. Distribution, abundance and trends in abundance of fin and humpback whales in the North Atlantic. ICES CM 2005 Session R (Marine mammals, monitoring techniques, abundance estimation and interaction with fisheries) Document 12. ICES CM 2005 Session R: 12pp.

Pike, D.G., Gunnlaugsson, T. and Víkingsson, G.A. 2002. Estimates of humpback whale (*Megaptera novaeangliae*) abundance in the North Atlantic, from NASS-95 shipboard survey data. Paper SC/54/H10 presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). [Paper available from the Office of this Journal].

Pike, D.G., Gunnlaugsson, T., Víkingsson, G.A., Desportes, G. and Mikkelsen, B. 2010. Estimates of the abundance of humpback whales (*Megaptera novaeangliae*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. Paper SC/62/O13 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 15pp. [Paper available from the Office of this Journal].

Pike, D.G., Paxton, C.G.M., Gunnlaugsson, T. and Víkingsson, G.A. 2009. Trends in the distribution and abundance of cetaceans from aerial surveys in Icelandic coastal waters, 1986-2001. *NAMMCO Sci. Publ.* 7: 117-42.

Rone, B.K., Zerbini, A., Douglas, A., Weller, D. and Clapham, P. 2016. Abundance and distribution of cetaceans in the Gulf of Alaska. *Marine Biology* 164(23). Doi 10.1007/s00227-016-3052-2.

Sutaria, D. and Marsh, H. 2011. Abundance estimates of Irrawaddy dolphins in Chilika Lagoon, India, using photo-identification based mark-recapture methods. *Marine Mammal Science* 27: E338–E48. Doi:10.1111/j.1748-7692.2011.00471.x.

Urbán R., J., Weller, D., Tyurneva, O., Swartz, S., Bradford, A., Yakovlev, Y., Sychenko, O., Rosales N, H., Martínez A., S. and Gómez-Gallardo U., A. 2013. Report on the photographic comparison of the Sakhalin Island and Kamchatka Peninsula with the Mexican gray whale catalogues. Paper SC/65a/BRG04 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 5pp. [Paper available from the Office of this Journal].

Vacquié-Garcia, J., Lydersen, C., Marques, T.A., Aars, J., Ahonen, H., Skern-Mauritzen, M., Øien, N. and Kovacs, K.M. 2017. Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endang. Spec. Res.* 32: 59-70. DOI: 10.3354/esr00791.

Waples, R.S., Antao, T. and Luikart, G. 2014. Effects of overlapping generations on linkage disequilibrium estimates of effective population size. *Genetics* 197: 769.

Waples, R.S. and Do, C. 2008. LdNe: A program for estimating effective population size from data on linkage disequilibrium. *Molecular Ecology Resources* 8: 753-56.

Weller, D.W., Campbell, G.S., Debich, A., Kesaris, A.G. and Defran, R.H. 2016. Mark-recapture abundance estimate of California coastal stock bottlenose dolphins: November 2009 to April 2011. NOAA-TM-NMFS-SWFSC-563. [Available from: *http://www.noaa.gov*].

Yakovlev, Y.M., Tyurneva, O.N. and Vertyankin, V.V. 2013. Photographic identification of the gray whale (*Eschrichtius robustus*) offshore northeastern Sakhalin Island and the southeastern shore of the Kamchatka Peninsula, 2012: Results and discussion. In: Western 9Okhotsk-Korean) Gray Whale Research and Monitoring Programme in 2012, Sakhalin Island, Russia. Volume 2: Results. Paper WGWAP 13/8, IUCN.

Appendix 1

AGENDA

1. Introductory items
   1.1 Opening remarks
   1.2 Election of the Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of the Agenda
   1.5 Documents available
2. Terms of reference and approach
3. Evaluations of abundance estimates and updates of the IWC consolidated table
   3.1 Evaluation of new abundance estimates
      3.1.1 Large whales
         3.1.1.1 North Atlantic minke whales
         3.1.1.2 North Atlantic humpback whales
         3.1.1.3 North Atlantic fin whales
         3.1.1.4 North Atlantic (Svalbard) bowhead whales
         3.1.1.5 Bering-Chukchi-Beaufort Seas bowhead whale
         3.1.1.6 Okhotsk Sea bowhead whale
         3.1.1.7 North Pacific gray whales
         3.1.1.8 North Pacific sei whales
         3.1.1.9 North Pacific Bryde's whales
         3.1.1.10 Southern Hemisphere right whales
      3.1.2 Small cetaceans
         3.1.2.1 Small cetaceans in rivers, estuaries and restricted coastal habitats in Asia
         3.1.2.2 Other small cetaceans
   3.2 Update of the IWC abundance table
4. Consideration of approaches to specify the status of stocks
5. Research programs – design and planning of abundance surveys
   5.1 IWC-POWER cruises
   5.2 IWC-Southern Ocean Research Partnership (IWC-SORP)
   5.3 National programs
6. Methodological matters
   6.1 Model-based abundance estimates and amendments to the RMP Guidelines
      6.1.1 Review of intersessional work and pre-meeting
   6.2 Review of new survey techniques/equipment
7. Other
   7.1 IWC-IDCR/SOWER cruise data analysis and special volume
8. Work plan

Appendix 2

TERMS OF REFERENCE OF THE *AD HOC* WORKING GROUP ON ABUNDANCE ESTIMATES, STATUS AND INTERNATIONAL CRUISES

The following are the Terms of Reference for the new *ad hoc* Working Group on Abundance Estimates, Status and International Cruises.

(1) Review of new abundance estimates on behalf of other sub-committees/working groups.
(2) Development of a biennial document compiling agreed abundance estimates including a basin wide summary.
(3) Development of a summary of information on the status of stocks (based on completed assessments or *Implementations*).
(4) Consideration of the design and analyses of IWC research projects related to abundance estimation including relevant IWC-SORP projects, IWC-POWER cruises and progress on IWC-SOWER related work.

Appendix 3

TABLES OF 'ACCEPTED' ABUNDANCE ESTIMATES

The aim of the tables of 'Accepted' Abundance Estimates is: (i) to collate information in a consistent way on abundance estimates accepted by the Scientific Committee for various purposes; and (ii) to provide a simplified table of abundance estimates suitable as a broad overview for the Commission and the public. See IWC (2014) for further details on the objectives.

(1) Accepted abundance estimates for Scientific Committee. The aim is to provide information consistently in a single table to represent an initial summary of the Committee's current set of 'accepted' abundance estimates. Work will be required to examine the comments and commonalities in order make the tables more consistent.
(2) Broad overview estimates for the Commission and general public.

IWC (2014) envisaged the broad overview estimates as a separate table. They are included here in the same table as (1) above but shown as being either on, or recommended for inclusion on, the IWC website. The advantage of using a single table is that it is easier to maintain and less prone to error when updating as data would not need to be entered or changed in multiple places. Different subsets can be used for different purposes.

Estimates for disjoint areas are summed if they were from the same year or years close together in time. These combined estimates are highlighted in grey. Approximate 95% confidence intervals for summed estimates are calculated from the CVs of the estimates and assuming a log-normal error distribution. In the interests of simplicity and a common approach, any additional variance estimate (available in only some cases) has been ignored for this purpose.

Only the most recent estimates for a species and ocean basin are given for the broad overview. Information on trend should be considered as an additional step to be pursued in the future, recognising the need for more consideration inter alia of information from modelling exercises.

The tables include notes about early values of the estimates which were later updated (or corrected) to explain from where different values have come and to ensure the most recent agreed values are used.

The key to the table columns is given below.

REFERENCE

International Whaling Commission. 2014. Report of the Scientific Committee. Annex Q. Report of the *ad hoc* group to develop a list of 'accepted' abundance estimates. *J. Cetacean Res. Manage. (Suppl.)* 15:416-17.

Heading	Contents
Area	If *Areas* are identified in an RMP context these should be used. If estimates pertaining to only a portion known range are agreed to be included (e.g. for AWMP) a comment should be included to show that this constitutes only part of the population. Otherwise use broad categories (e.g. Schedule *Management Areas*) and indicate whether coverage is total or partial.
Category	As described below. In each case if not clear add an asterisk to indicate that the estimate needs to be considered further. Use either: (1) acceptable for use in in-depth assessments or for providing management advice; (2) underestimate - suitable for AWMP usage or other 'conservative' management but not reflective of total abundance; (3) while not acceptable for use in (1) or (2), adequate to provide a general indication of abundance; (P) Provisional or Preliminary estimates (will be omitted from published tables); (X1) Category (1) estimates that have been superseded by newer estimates (will be omitted from published tables); or (ND) Not discussed. Used to show other estimates which have not been discussed by the Scientific Committee, but which may be discussed in future. They are shown 'Greyed out' and will be omitted from published tables.
Evaluation extent	Degree to which the estimate is considered originally by the sub-committee concerned. Use: (1) estimate was examined in detail by the sub-committee; (2) estimate was partially examined by the sub-committee but method is standard; (3) degree to which the estimate was considered by the sub-committee is unclear but method is standard; (4) estimate was partially considered by the sub-committee and a new method was used; or (5) degree to which the estimate was considered by the sub-committee is unclear and a new method was used.
RMP/AWMP status	Status in RMP trials. Use: 'I' agreed to be suitable for use in an actual *CLA* calculation to produce a catch limit; 'C' used in the RMP trial conditioning as an absolute estimate of abundance; 'C_{min}' used in the RMP trial conditioning a minimum estimate of abundance; 'CP' provisional estimate suitable for use in conditioning but further analysis needs to be considered before use in an actual *CLA* or *SLA* calculation; 'T' used in RMP/*SLA* trials but further analysis needs to be considered before use in an actual *CLA* or *SLA* calculation; 'S' agreed to be suitable for use with a *SLA* to produce strike limits; 'E' suitable for conditioning *Evaluation* and *Robustness Trials*, and for *Implementation Reviews*. 'R' Suitable for conditioning *Robustness Trials* or suitable for conditioning some *Evaluation* or *Robustness Trials*, or *Implementation Reviews* where the value is used as a minimum estimate of abundance.
Date stamp	The year to which estimate applies. This will normally be the year of the survey unless the estimate is based on multiple years or a population assessment model. (Note: Consideration needs to be given as to whether estimates from such models are acceptable for this table, in contrast to, for example, mark-recapture based estimates which do require model-processing.)
Range of years	The years concerned when the estimate applies to surveys over a number of years.
Method	LT: line transect (or distance-sampling): MR: mark-recapture; SM: spatial modelling; LT+SM: distance-sampling with spatial modelling; CC: Cue counting; PA: population assessment; PId: Photo-identification of individuals; SC: Strip census; GMR: Genetic mark recapture.
Correction (Corr)	Where applicable, indicate if the estimate is corrected for A: availability (corrects for the time the whales are available at the surface); P: perception bias (corrects for missed sightings); A+P: availability and perception bias; or adjustment for $g(0)<1$ applied. Note. Care should be taken regarding the interpretation of $g(0)$ because the distinction between availability and detection bias for ship-board surveys is somewhat arbitrary and dependent on the exact analysis method employed.
Estimate	Estimate of 1+ abundance unless otherwise indicated.
CV	CV of estimate from survey sampling error only.
CV (AV)	CV with Additional Variance component arising from annual distributional changes added.
95% CI	Approximate 95% confidence intervals (or equivalent) rounded to three significant figures of upper limit.
Areal coverage	Areal coverage as a percentage.
IWC reference	The reference to when and where the estimate was discussed in the Scientific Committee.
Original reference	The reference of the analysis presented originally.
Comments	Brief comments on survey and any difficulties encountered.
Program	Survey program/organiser.
On web?	Is estimate listed on the IWC website? Y: Yes. R: Recommended for inclusion. N: Not recommended for inclusion.

Appendix 4

TABLE OF AGREED ABUNDANCE ESTIMATES DURING THE 2017 SCIENTIFIC COMMITTEE MEETING

Area	Cat.	Eval. extent	RMP/AWMP status	Date stamp	Range of years	Method	Corr.	Estimate	CV	Approx. 95% CI	Original reference	Comments	Aerial coverage	Programme	On web?
North Atlantic common minke whales															
West Greenland	1	1	S	2015	2015	SC	A+P	5,241	0.49	2,114-12,992	Hansen *et al*. (2016); SC/67a/Rep06	-	-	-	R
West Greenland	1	1	S	2007	2007	SC	A+P	9,853	0.43	4,433-21,900	Hansen *et al*. (2016); SC/67a/Rep06	-	-	-	R
East Greenland	1	1	S	2015	2015	LT	A+P	2,681	0.45	1,153-6,235	Hansen *et al*. (2016); SC/67a/Rep06	-	-	-	R
Iceland	Not Ac	-	-	2016	2016	-	-		-	-	SC/67a/NH05	Coverage too poor. Could re-stratify to use as minimum estimate.	-	-	-
ES	P	-	-	-	2014-16	-	-	12,846	-	-	SC/67a/RMP03	Final estimate to be calculated on completion on full survey cycle.	-	-	-
EW	P	-	-	-	2014-16	-	-	16,537	-	-	SC/67a/RMP03	As above	-	-	-
CM	P	-	-	-	2014-16	-	-	57,472	-	-	SC/67a/RMP03	As above	-	-	-
North Atlantic fin whales															
West Greenland	1	1	S	2015	2015	LT	P	465	0.35	233-929	Hansen *et al*. (2016); IWC/67a/Rep06	-	-	-	R
North Atlantic humpback whales															
West Greenland	1	1	S	2015	2015	LT	A+P	1,008	0.38	493-2,062	Hansen *et al*. (2016); IWC/67a/Rep06	-	-	-	R
East Greenland	1	1	S	2015	2015	LT	A+P	4,288	0.38	2,097-8.770	Hansen *et al*. (2016); IWC/67a/Rep06	-	-	-	R
(Iceland)	-	-	-	-	-	-	-	-	-	-	-	Several estimates to be reviewed intersessionally.	-	-	-
North Atlantic bowhead whales															
Svalbard	3	1	-	2015	2015	LT	A	343	0.488	136-862	Vacquié-Garcia *et al*. (2017)	Partial coverage and high CV.	-	-	R
North Pacific bowhead whales															
Okhotsk Sea	3	1	-	2016	1995-2016	MR	A+P	218	0.22	142-348	SC/67a/NH10	(Require copy of time series	-	-	-
North Pacific gray whales															
Sakhalin Is.	3	4	-	1995	1995-2015	MR:PA	A+P	74	0.06	65-82	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin Is.	3	4	-	2015	1995-2015	MR:PA	A+P	191	0.04	175-208	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin and Kamchatka	3	4	-	1995	1995-2015	MR:PA	A+P	129	0.08	107-149	SC/67a/NH11	(Require copy of time series).	-	-	-
Sakhalin and Kamchatka	3	4	-	2015	1995-2015	MR:PA	A+P	282	0.05	255-312	SC/67a/NH11	(Require copy of time series).	-	-	-
N California-N Vancouver Is.	1	1	-	2015	-	P Id	-	243	0.08	-	Calambokidis *et al*. (2017)	SD=18.9; N_{min}=228.	-	-	-
California	2	1	-	-	2014/15	-	-	28,790	-	23,620-39,210	Durban *et al*. (2017)	Suitable for use in *SLA* and conditioning range-wide model. Some methodological issues.	-	-	-
California	2	1	-	-	2015/16	-	-	26,960	-	24,420-29,830	Durban *et al*. (2017)	As above	-	-	-

Cont.

Area	Cat.	Eval. extent	RMP/AWMP status	Date stamp	Range of years	Method	Corr.	Estimate	CV	Approx. 95% CI	Original reference				Com ments
North Pacific Bryde's whales															
1W	1	1	I	2011	2008-15	LT	-	15,422	0.289	-	SC/67a/RMP04	*g*(0)=1. Could be updated if *g*(0) estimated in future. See SC/67a/RMP04 *re* additional variance.	78.4	POWER /JARPNII	-
1E	1	1	I	2011	2008-15	LT	-	6,716	0.216	-	SC/67a/RMP04	As above	92.4	POWER /JARPNII	-
2	1	1	I	2014	2008-15	LT	-	4,161	0.264	-	SC/67a/RMP04	As above	78.9	POWER /JARPNII	-
W N Pacific	-	-	-	-	2008-15	LT	-	26,299	0.185	18,000-38,000	-	Combined estimate ~ 26,000	-	-	R
Māui dolphin															
North Island, NZ	1	1	-	-	2015-6	MR	-	63	0.11	-	Baker *et al.* (2012)	Based on assumption of closure.	-	-	-
Hector's dolphin															
Cloudy Bay, NZ	1	1	-	-	2011-12	MR	-	269	0.12	-	Hamner *et al.* (in press)	Based on assumption of closure	-	-	-

References

Baker, C.S., Steel, D., Hamner, R.M., Hickman, G., Boren, L., Alridge, W. and Constantine, R. 2017. Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes in 2015-16, with retrospective matching to 2001-16. Department of Conservation, Auckland. 75pp.

Calambokidis, J., Laake, J. and Perez, A. 2017. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996-2015. Paper SC/A17/GW05 presented to the rangewide workshop on gray whales, April 2017 (unpublished). 69pp. [Paper available from the Office of this Journal].

Durban, J.W., Weller, D.W. and Perryman, W.L. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Paper SC/A17/GW06 presented to the rangewide workshop on gray whales, April 2017 (unpublished). 5pp. [Paper available from the Office of this Journal].

Hamner, R.M., Constantine, R., Mattlinc, R., Waples, R. and Baker, C.S. In press. Genotype-based estimates of local abundance and effective population size for Hector's dolphins. *Biol. Cons.* [Available at: *http://dx.doi.org/10/1016/j.biocon.2017.02.044*].

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.S., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2016. Abundance of whales in east and west Greenland in 2015. Paper SC/D16/AWMP06rev1 presented to the AWMP Greenland Workshop, December 2016, Copenhagen, Denmark (unpublished). 38pp. [Paper available from the Office of this Journal].

Vacquié-Garcia, J., Lydersen, C., Marques, T.A., Aars, J., Ahonen, H., Skern-Mauritzen, M., Øien, N. and Kovacs, K.M. 2017. Late summer distribution and abundance of ice-associated whales in the Norwegian High Arctic. *Endang. Spec. Res.* 32: 59-70. [Available at: *DOI: 10.3354/esr00791*].

Appendix 5

SUMMARIES OF CRUISE REPORTS OF NATIONAL SURVEYS

SC/67a/ASI03 presented the cruise report of a dedicated cetacean survey conducted in the northern part of the Sea of Okhotsk (north of 57°N) in 2016 by Russia using the research vessel *Vladimir Safonov,* from 5 August to 10 September 2016. Of the two blocks surveyed in the research area, a western and an eastern block, the former had already been covered in a 2015 survey, and the latter (Shelikhov Gulf) had last been covered in 1992 by a Japanese survey. Because of bad weather conditions, the percentage of coverage on effort was 63% and 70% only in the western and eastern blocks, respectively. A total distance of 1,067 n.miles was covered in closing mode in the research area and 1,348 n.miles in passing mode during transit. The following species were sighted: common minke whale (19 school/21 individuals), like-minke whale (2/2), fin whale (5/6), humpback whale (3/3), killer whale (7/27), sperm whale (2/3), Dalli type Dall's porpoise (20/60), Truei type Dall's porpoise (1/5), Harbour porpoise (9/22), unidentified type Dall's porpoise (62/171), white whale (32/255), unidentified large cetacean (4/5) and unidentified small cetacean (1/3).

SC/67a/ASI05 reported on a systematic large-scale vessel-based sighting survey successfully conducted in 2016 by Japan, to examine the distribution and abundance of large whales in the western North Pacific. The research area was between 35°N and 43°N and 140°E and 150°E (sub-areas 7CN, 7CS, 7WR and 7E in the RMP *Implementation* for common minke whales). The survey was conducted between 29 July and 6 September 2016. The research vessels *Yushin-Maru* and *Yushin-Maru* No. 2 were engaged for this survey. A total of 2,791.8 n.miles was searched in the research area. Coverage of the planned cruise track lines was 94.6% for the 7CN and 7CS and 67.6% for the 7WR and 7E areas, respectively. In total, five large whale species including fin (4 schools/6 individuals), Bryde's (125/160), common minke (12/12), humpback (2/2) and sperm (103/393) whales were sighted during the cruise. Photo-identification images were collected from one humpback whale. Biopsy skin samples using a Larsen system were successfully collected from fin (1) and humpback (1) whales, respectively. These data have been submitted to the IWC Secretariat in a form based on the Scientific Committee guidelines. The IWC oversight report is provided as an attachment to the cruise report (SC/67a/ASI05).

SC/67a/ASI07 reported the results of the 2016/17 NEWREP-A dedicated whale sighting survey in Antarctic Area V (south of 60°S). Two dedicated sighting vessels were engaged and successfully conducted the survey for 33 days, from 13 December 2016 to 14 January 2017 in the western sector of Areas V (130°E-165°E), using two survey modes (Normal Passing mode (NSP) and Independent Observer mode (IO)), and based on IWC/IDCR-SOWER survey procedures. The total searching distance in the research area was 2,937.1 n.miles, including 1,542.0 n.miles covered in NSP and 1,395.1 n.miles in IO mode. The survey coverage was 77% in the northern stratum and 91% in the southern stratum. Five baleen whale species, blue (11 schools/13 individuals), fin (21/67), Antarctic minke (115/223), southern right (1/1) humpback (253/516) and at least three toothed whale species (sperm (30/30), southern bottlenose (4/8), killer (4/26)), were sighted in the research area. Estimated Angle and Distance Experiments were completed as in previous years. Routine photo-identification and biopsy sampling of large whales were also conducted, and a total of 20 individual photos (9 blue, 1 southern right and 10 humpback whales) were obtained. Furthermore a total of 10 individual biopsy samples were collected from 2 blue, 1 southern right and 7 humpback whales using the Larsen system. A total of eight marine debris items was observed. A feasibility study on biopsy sampling on Antarctic minke whales was conducted and 15 biopsy trials were performed. Location data from three of the satellite tags deployed on Antarctic minke whales were received. These data have already been submitted to the IWC Secretariat in terms of Scientific Committee guidelines. The IWC oversight report is attached to the report (SC/67a/ASI07).

Appendix 6

REPORT OF THE PRE-MEETING ON MODEL-BASED ABUNDANCE ESTIMATION (BLED, 7-8 MAY 2017)

Abundance estimates from line-transect surveys can be derived statistically using 'spatial models' (AKA 'density surface models', and several other names; see below), as well as the more familiar stratified (AKA 'Horvitz-Thompson-like', or HT; Borchers and Burnham, 2004) approaches. Spatial models have potential advantages in reducing bias resulting from patchy coverage, and in providing more reliable estimates of variance. The Scientific Committee has recognised the need to develop its expertise in evaluating spatial-model-based abundance estimates, which are fairly complex, and in deciding whether an estimate based on the simpler HT formulae can be used safely in cases when the strict assumptions underpinning HT do not apply (e.g. uneven coverage of the region).

To further this process, a pre-meeting was held on 7-8 May, (convened by David Miller, CREEM and Mark Bravington, CSIRO). The pre-meeting explored some issues related to the current state of spatial modelling for cetacean abundance estimation, and introduced software named 'ltdesigntester' for exploring the reliability of HT-based abundance estimates of specific surveys, either *post hoc* or in the design phase. This software, its accompanying report[1] are available at *http://converged.yt*. See both that report and the earlier paper by Hedley and Bravington (2014) for more detailed background to discussions.

SECTION A: INTRODUCTION

The IWC Scientific Committee (SC) often has to consider abundance estimates derived from line-transect surveys which have been analysed using 'design-based estimators', but where for various reasons it is not clear whether the resulting estimates and CVs are trustworthy for, say, RMP purposes.

[1]Miller, D.L., and Bravington, M.V. 2017. When can abundance surveys be analyses with 'design-based' methods? (unpublished). 30pp. [Available from the author, *http://converged.yt*].

The Scientific Committee has therefore in recent years (up to 2016) considered revising its formal Guidelines to take advantage of metholodogical developments, in particular the increased flexibility offered by 'model-based' abundance estimates, constructed statistically around smoothed estimates of animal density across space. As background for that revision, Hedley and Bravington (2014) describes the randomisation assumptions *required* by design-based *principles*; it also introduces some of the practical issues associated with model-based estimates, which are more flexible but also more complicated to implement. In section 11 of that document, the authors note that it may sometimes be possible to derive acceptable estimates and CVs using a design-based calculation - a 'Horvitz-Thompson-like' estimate - even when the underlying design-based assumptions are not strictly met, provided that (among other things) achieved coverage is sufficiently uniform. This has been common practice at the IWC and elsewhere, but generally on an *ad hoc* basis with no clear criteria for 'how bad is too bad?'. For such cases, Hedley and Bravington (2014) recommend instead that HT acceptability needs to be verified on a case-by-case basis, using diagnostics derived from model-based analysis.

Miller and Bravington (2017)[2] follow up on that suggestion. They start by again briefly reviewing the main differences between HT and model-based estimates, explains where problems can occur with the former, and through simulation demonstrates how those problems and whether they might be present may be checked for using model-based criteria. The idea is to consider a range of scenarios about underlying density gradients, then fit different spatial models (including a 'null model' that is HT-equivalent) to data simulated from the actual survey tracks and each density scenario, then check the consistency of point estimates and variance estimates across the different models. Software implementing these criteria/checks is available in the R package ltdesigntester, available from: *http://github.com/dill/ltdesigntester*.

SECTION B: SUMMARY OF DISCUSSIONS

1. General comments

- Spatial models *can* give a way to avoid the bias in abundance-estimation that may result from applying a 'standard' HT estimator when its assumptions are not met, e.g. if coverage is incomplete or uneven.
- Even when there is little bias in HT estimates as a result of good coverage, spatial models can perform much better in capturing true uncertainty (for example, systematic patterns in distribution are not classed as 'variance' by spatial models, but generally are by HT) and of giving more *stable* variance estimates. HT requires many transects per stratum for reliable variance-estimation; 20 has been suggested by experienced practitioners, but many surveys considered by the IWC have far fewer transects per stratum.
- Spatial models also provide a clean and simple way to obtain abundance estimates and variances for any desired subregion of a surveyed area. This can be very difficult for HT estimates.
- Spatial models avoid the unpleasantness of post-hoc (re) stratification, which is sometimes an operational necessity with HT, but which makes variance calculations, in particular, rather dubious.
- Spatial models can incorporate environmental covariates such as depth (as distinct from 'observational covariates' such as Beaufort state, and 'sighting-level covariates' such as group size) to explain distributions, as well as or instead of purely spatial (lat/long) 'explanatory covariates'. This can be very informative for management advice on certain issues and for ecological insights, although there are complications when used for abundance estimation *per se*; see below.
- Most applications of spatial modelling to cetacean abundance and distribution have used the family of statistical models known as GAMs, and in particular the implementation in the widely-used R package mgcv (Wood, 2006). There are other frameworks for spatial models which may also prove useful in future, but (in the view of the workshop leaders) GAMs and mgcv in particular so far have the best integration with other aspects of abundance estimation (e.g. detection functions – note that here this term is taken to encompass all aspects of detection probability, including strip widths, $g(0)$ and availability), the widest range of modelling options, the most extensibility and the most 'case law'. Practical discussions at the workshop were all based on the DSM toolbox for GAM-based spatial models (see e.g. Miller *et al.*, 2013) for reference, although there have been numerous extensions since then), although some of the general principles should also apply to other types of spatial models.
- Over the last 10 years, there have been extensive mathematical and computational developments in spatial modelling and related techniques, coupled with widespread practical experience in many fields well beyond whales and abundance estimation - this includes mission-critical applications in e.g. medical statistics and electricity-grid management. There is both a coherent underlying statistical theory for GAMs, and reliable computational engines through software such as mgcv. However, the power and flexibility of GAMs do come with terms and conditions. The underlying principles of statistical inference - the very reasons some credence can be given to abundance estimates, for example - are at the limit of their range with GAMs. The ease of fitting GAMs nowadays disguises the underlying complexity, and with models that are so fundamentally complex, *ad hoc* approaches to inference cannot be trusted to give reliable results (whereas *ad hoc* tweaks can sometimes be justified for simpler types of model, such as HT abundance estimates in 'good' surveys). For example, GAMs constitute a particular type of random-effect model, and bootstrapping is well-known to be statistically incompatible with random-effect models (there is an extensive literature starting with Laird and Louis, 1987). Developing new varieties of spatial model, and extending the types of inference e.g. to variable selection, are tasks for the GAM professionals only.
  - Not all spatial models are equal. Within mgcv, for example, there are different ways of representing spatial effects which, while likely to give similar results within the spatial range of 'good' survey data, may behave differently near the edges of the surveyed region and especially beyond. In addition there are also well-formulated spatial models outside what mgcv offers, such those used by Illian *et al.* (2012), which will have somewhat different properties, though there is as yet less practical experience with non-mgcv frameworks. Furthermore

[2]Miller, D.L., and Bravington, M.V. 2017. When can abundance surveys be analyses with 'design-based' methods? (unpublished). 30pp. [Available from the author, *http://converged.yt*].

there are yet other approaches to spatial modelling which, unlike mgcv and INLA, do not have a solid basis in statistical theory and computational practice. Unless and until the necessary theory and practical experience are developed, it would be rather difficult to evaluate abundance estimates from such models.

- There are limits to what a spatial model can fix. In particular, low numbers of encounters are problematic; spatial models have to estimate more parameters than HT (especially, the degree of spatial wiggliness [yes, that really is the correct term!]). Hence, in a setting where HT can be expected *a priori* to work reasonably but sightings are few, spatial models perhaps require more sightings for reliable performance. And although spatial models can alleviate some problems of patchy coverage, there are again limits: extrapolation comes with big risks, and it is not yet clear how far the current generation of spatial models 'do the right thing', i.e. of automatically reporting a very high CV when large extrapolations are involved.
- The DSM approach to abundance estimation is multi-stage. The first stage is to fit detection functions, $g(0)$, etc. using familiar tools; then the results are incorporated into the second stage of spatial modelling, and the uncertainty associated with the detection-function stage is propagated automatically. Some other approaches (e.g. INLABRU) fit detection functions simultaneously with *all* parts of the abundance-estimation model. The considerable appeal of multi-stage modelling is that detection-functions etc. require expertise and often experimentation to fit, and sometimes need case-specific flexibility which is difficult to build into an all-in-one model; it is desirable to be able to concentrate separately on this stage. The appeal of all-in-one is that, at least in principle, it can be more statistically efficient (because the number of sightings in different weather-conditions conveys some information about how the overall detection probability varies with weather, even in a spatial model). The workshop presenters suggested that the first approach is perhaps more valuable in practice.

2. Abundance estimates from spatial models: general points

First addressed was the more straightforward case of single survey where group size variations are unimportant. More complex issues are covered in the next section. Although this section is fairly general, it overlaps somewhat with suggestions for specific diagnostics that need to be reported whenever a spatial abundance estimate is being put forward for endorsement by the Scientific Committee.

- Whale densities can be modelled using just spatial covariates, or environmental covariates, or both. For *abundance estimation* per se within the region of the survey, spatial alone should usually be reliable (i.e. purely spatial covariates are sufficient, even if not optimal). There is some theory to suggest that this may be true even if the ideal environmental covariates could be identified, which itself is a big ask. As to the alternatives, the following comments are offered.
    - If using *just* enviro covariates to explain density, then the abundance estimate is susceptible to bias unless exactly the right covariates have been used, and measured on the right scales. This risk cannot be checked reliably *post hoc* from the model.
    - It is appealing to consider including both environmental *and* spatial terms, in the hope that the latter will 'mop up' any modest remaining variations in density that are unexplained by the environmental terms. Unfortunately, this is not what tends to happen, at least with current models; the spatial terms and the environmental terms tend instead to fight for control of the model, and the outcome is not necessarily sensible (although overall predictions within the survey area are not necessarily bad). This is a topic of active research, and until it is resolved, it seems wisest to stay away from abundance estimates involving environmental covariates, at least for core management purposes.
    - If abundance estimates using environmental covariates are to be considered, it is particularly important to explore sensitivity to choosing different covariates, and/or combining them in different types of smoother.
- There are different flavours of spatial smoother available as GAMs (e.g. tensor product smooths, thin-plate splines, Duchon splines, 'shrinkage' versions of all those, Soap-film smooths where coastlines impinge, etc. Although there are reasons to prefer certain choices in some cases, the different methods generally give similar results when applied to reasonable line-transect datasets, at least within the broad extent of the survey. Consequently, there is in general no particular need to present estimates from different flavours of spatial model as 'sensitivity checks', provided the diagnostics are acceptable for the one model that is presented. Nor is there any need in general to present extensive simulation results to justify standard spatial modelling approaches; the underlying tools have been thoroughly investigated in settings which include outside abundance estimation.
    - The foregoing does not apply if substantial extrapolation is entailed. Desirable behaviour for a smoother should normally be to report rapidly-increasing CVs as the amount of extrapolation increases, in which case it should not matter much which smoother is used; however, not all current smoothers do this reliably (unmodified Thin-Plate Splines in particular; Wood, pers. comm.). Hence, if making substantial extrapolations, it is important to at least verify that different smoothers agree (or e.g. that the choice of a Soap 'boundary' in parts of the region without a hard boundary does not make much difference).
    - Large-scale extrapolation is of course undesirable. Bravington noted, however, that some degree of extrapolation is inevitable whenever spatial models are applied to line-transect data. From a statistical perspective, the 'survey region' is meaningless to the spatial model (unlike for a design-based HT estimate); it is simply the set of points where densities are to be predicted, and is in principle unrelated to where the data were collected, which is a very small subset of the prediction region close to the tracklines. All surveys have, for example, corners that would be 'outside the surveyed area' in certain reasonable definitions, e.g. the convex hull of the tracklines, or the 'x-y range' in a 45°-rotated coordinate system. This is not necessarily a problem - modern spatial models can cope with some limited extrapolation - but does indicate that there can be no hard-and-fast guideline for 'how much extrapolation is too much'; human judgement is required.
        - o Observation conditions along the track, as well as purely the presence of tracklines, are relevant in assessing extrapolation. If tracklines near the

edge of the region of interest tend to be in poor observation conditions, then the spatial model may effectively have no statistical information near that edge, and in practice faces the same issues as when it is asked to 'extrapolate'.
  - o If there are concerns about extrapolation, then it is important to report not just the overall CV on abundance, but also separate CVs for the 'well-surveyed' and the near 'unsurveyed' areas. If the model is behaving well, the latter should be much higher.
- 'Spatial abundance estimation' entails not just a spatial model of school density, but also detection-function fitting and possibly school size modelling (see below). For a reliable overall CV, it is important to combine all sources of statistical uncertainty from the various steps ('variance propagation'). This is not necessarily simple with spatial models (e.g. the well-known three-part formula for HT variance does not apply). In the past software has not been available to do this properly (so developers had to write special-purpose code, as with SPLINTR when applied to Antarctic minkes), but new versions of DSM and other approaches like INLABRU will make this straightforward in future.
- Thanks to modern software like 'mgcv', spatial abundance estimates for straightforward cases are easily obtained, with not much more work than for an HT estimate. Nevertheless, spatial modelling is emphatically not a push-button process; there are many choices to make, implicitly or explicitly, and they can affect the result appreciably. It is essential that spatial-model-based abundance estimates be accompanied by a commentary explaining which particular choices were made, and why each choice is either clearly sensible in its own right or largely unimportant to the result. Hedley and Bravington (2014) covers numerous aspects, two simple examples being:
  - choice of coordinate system (lat/long needs adjustment to preserve distance in isotropic smooths; reparametrisation to offshore and alongshore distance to allow anisotropic smoothers; etc.); and
  - explaining why extrapolation is not a concern for the survey in question (since the 'prediction region' over which abundance is being estimated is also a choice of the analyst).

3. Diagnostics

The workshop suggested the following minimum set of diagnostics as required to assess adequacy of the output; this list should be reviewed as experience accumulates. Clearly, the points being made here require some understanding of spatial modelling issues; Hedley and Bravington (2014) gives more detail.

- Plotting the fitted density surfaces (and tracklines) for common sense consideration (regarding hotspots, edge effects, etc.)
  - There are different ways to plot density surfaces (colour-maps, contour plots, dot-plots), and people vary as regards which type they find easiest to interpret.
- Tabulate the observed and expected number of sightings grouped by potentially important covariates: e.g. observation covariates that are in detection function (or could be); environmental covariates; specific parts of the region (within/outside 20km of the coast). Expected numbers per grouping-level need to be reasonably large, say 10, for this to be useful, but it has helped diagnose spatial-model misfits in the past.
- Size of segments: there can be difficulties if these are set too big or too small. This requires common sense plus robustness checks; see Hedley and Bravington (2014) for the authors' opinions. There is the potential to develop DSM to handle fine-scale clustering (AKA local autocorrelation) automatically, which would alleviate this rather tedious problem; for one approach, see Skaug (2006).
- Response distribution for counts: the presenters suggested that it is usually safe to use Tweedie (constrained to ensure shape parameter exceeds 1.2) or NegBin, though a Quasi-Poisson might also work in some cases. As long as the results pass a diagnostic check (e.g. QQ plot), it is not necessary to explore other options; overall results should not be sensitive to the choice.
- There is a well-known suite of standard statistical diagnostics for GAMs, and especially for 'mgcv'. See Wood *op cit.* including for the acronyms used below. Specific issues for the low-expected-value count data found in line-transects surveys are:

deviance residuals are not useful.

  - RQR (randomised quantile residuals; results based on Dunn and Smyth (1996) are better, and should be plotted against observation-covariates or environmental covariates of interest. Having said that, the power of any residual-based diagnostic is limited with small-count data, and one presenter reported much better experiences from the observed/expected counts check above.
  - EDF (estimated degrees-of-freedom) checks on smooth terms are very important, and it is also important to report the estimated smoothing parameter itself (there can be some problems if it is very large, implying a completely smooth model).
  - Convergence failures *can* happen, but mgcv in particular is generally diligent in issuing warnings.
  - Concurvity checks if environmental covariates are used.

Overall, it was agreed that it would be useful to develop a worked example of 'good diagnostic practice' for a spatial model that does seem acceptable, and for one that does not (perhaps a version of the former with deliberately distorted data).

4. School size

Discussion was restricted to cases where schools are not too big; cases such as tropical dolphins with physically enormous schools of hundreds or thousands of animals always require special attention.

School size normally affects sighting probability, and obviously matters for abundance. Historically though, it has not played a large part in at least the DSM framework for spatial modelling. This may not matter much; if most sightings are single animals, with just a few schools seen; in that case simply replacing 'number of schools per segment' by 'number of animals seen per segment' may be good enough, even though not strictly correct because detection probabilities are affected. More generally, the implicit assumption of most DSMs has been that even if school size varies, it does so homogenously throughout the region of interest (i.e. it is not a case of big schools in one place and small schools in another), even though school density may vary substantially. If so, then it is valid to:

- first fit detection functions, presumably including school size as a covariate;
- then estimate the average true school size for the whole region (there are standard methods for that), and the average detection probability of a school for each survey segment depending on the observation conditions there; and
- then fit a DSM.

Variance propagation is still not straightforward unless observation conditions are constant, because bad weather can often affect overall detectability of big schools differently to small schools; in particular, the 3-term HT variance decomposition is not strictly valid. Nevertheless, correct variance-propagation is not much more complicated than for standard DSMs, and overall the homogenous-school-size approach to DSMs is reasonably simple.

For many species though, it is too simple. If school sizes vary through the region, then it somehow necessary to use more than one spatial model. There are two main options:

- one model (or set of models) for how true school size varies (mean, variance, etc.), and one for school density; and
- separate spatial models for each category of school size.

Neither is ideal; the former is difficult to set up correctly with off-the-shelf statistical models, and the latter will simply run out of data for some categories (as in this case each category fails to 'borrow strength' from what is seen at other categories). The workshop presenters reported encouraging results from a new approach that extends the separate-models idea to 'borrow strength' from all categories of school size, and stays within the GAM family where inference and variance-propagation are at least tractable.

When most school size estimates are biased, which is often the case in passing-mode surveys, then dealing with school size becomes even more problematic; it may no longer even be possible to fit detection functions as a first stage, because true school size is unknown. This is more-or-less the situation of Antarctic minke whales in SOWER. While such situations can be handled statistically - given ample data, good protocols and years of analytical effort, as with SOWER - it is unlikely that off-the-shelf spatial-models will ever be available for such cases.

School size in spatial models entails extra diagnostics; suggestions may be found in Hedley and Bravington (2014).

5. Time as well as space

DSMs make it straightforward to fit multiple surveys at once, e.g. from several years in the same regions. This is very useful for checking the consistency of possible environmental drivers of distribution, but also useful for purely spatial models. The density surface itself can be allowed to vary from year to year, while enforcing the same smoothing parameters (degree of wiggliness); this is helpful in estimation, and is usually biologically reasonable. The same applies to detection functions. It was noted that this leads to some covariance between estimates for different years; this does need to be taken into account when using the results for management decisions, but there is no major conceptual problem in doing so, and something similar is already required to deal with 'Additional Variance' (using IWC terminology).

Within-survey time effects are a different issue. GAMs do now allow space-time interactions to be fitted, i.e. 'moving maps', and this is potentially powerful in dealing e.g. with platform-of-opportunity sightings over long periods. Such models have occasionally been used, e.g. in fisheries, to describe seasonal movements. However, there are some pitfalls for abundance estimation, e.g. that existing models have no way to constrain the total number of animals to be constant through the survey, and that migration generally provides a hard problem for any survey. Reliability for abundance estimation *per se* thus has to be seen as untested for now, though with sufficient supporting evidence, e.g. through simulation, such estimates might be considered acceptable.

6. Acceptability of HT when assumptions are not met

HT estimators are simple, and can *sometimes* work reliably even if the underlying assumptions are not met: e.g. that the design was randomised and/or the coverage was not as planned (Hedley and Bravington, 2014). However, then the onus is on the analyst to show that it is necessary to move to a spatial model. The ltdesigntester software was developed to assist with this, without requiring the analyst to develop the entire spatial-modelling skill set.

Regardless of randomisation or otherwise, gradients in animal density need not imply bias in HT, unless coverage is uneven. Assessing the latter is not as simple as just looking at tracklines, because observation conditions also matter and may not be homogeneous across the region. This interacts with the type of model that is fitted; omitting weather from the detection function is particularly dangerous, since claims about pooling robustness (even if detection-on-the-trackline really is certain) do not apply when animal density varies substantially within a stratum. Even if weather is included in detection functions, very poor weather over a substantial part of the survey region can still lead to bias in HT estimates (since reliable stratification may not be possible) and especially to unreliable variance estimates.

Variance for HT estimates is not straightforward. There are several ways to calculate it, and the default in DISTANCE is probably not the best in most cases (Fewster *et al.*, 2009). There is a well-known problem that HT can interpret systematic trend in abundance as variance; although there are ingenious methods for tackling that (Fewster, 2011), they appear to be rather more complicated than just fitting a spatial model (at least in the view of the workshop presenters).

The ltdesigntester software (*http://github.com/dill/ltdesigntester*) which was demonstrated appears to be a useful tool for investigating HT reliability, and also how different flavours of spatial model can vary when applied to difficult situations (e.g. extrapolation). It was noted that there are some limitations of the way performance is summarised in the report; histograms for different models are not comparable between the different models fitted to the same data because the scale is not consistent, although they do reflect the model's ability to assess its own performance. Miller reported that the code is expected to migrate eventually into the existing software DSsim (*http://github.com/DistanceDevelopment/DSsim*) for simulation-based testing of survey designs, which is widely used by the line-transect-survey community.

REFERENCES

Borchers, D. and Burnham, K.P. 2004. General formulation for distance sampling. pp.6-29. *In*: Buckland, S.T., Anderson, K.P., Burnham, K.P., Laake, J., Borchers, D. and Thomas, L. (eds). *Advanced Distance Sampling*. Oxford University Press, Oxford. 595pp.

Dunn, P.K. and Smyth, G.K. 1996. Randomized quantile residuals. *J. Comp. Graph. Stat.* 5: 236-44.

Fewster, R.M. 2011. Variance estimation for systematic designs in spatial surveys. *Biometrics* 67(4): 1518-31.

Fewster, R.M., Buckland, S.T., Burnham, K.P., Borchers, D., Jupp, P.E., Laake, J. and Thomas, L. 2009. Estimating the encounter rate variance in distance sampling. *Biometrics* 65(1): 225-36.

Hedley, S. and Bravington, M. 2014. Comments on design-based and model-based abundance estimates for the RMP and other contexts. Paper SC/65b/RMP11 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 33pp. [Paper available from the Office of this Journal].

Illian, J.B., Sørbye, S.H. and Rue, H. 2012. A toolbox for fitting complex spatial point process models using integrated nested Laplace approximation (INLA). *Ann. Appl. Stat.* 6(4): 1,499-530. Doi:10.1214/11-AOAS530.

Laird, N.M. and Louis, T.A. 1987. Empirical bayes confidence intervals based on bootstrap samples. *J. Am. Stat. Assoc.* 82: 739-57.

Miller, D.L., Burt, M.L., Rexstad, E.A. and Thomas, L. 2013. Spatial models for distance sampling data: recent developments and future directions. *Methods in Ecol. Evol.* 4: 1,001-10.

Skaug, H.J. 2006. Markov modulated Poisson processes for clustered line transect data. *Environ. Ecol. Stat.* 13: 199-211.

Wood, S.N. 2006. *Generalized Additive Models: an introduction with R*. Chapman and Hall, Boca Raton, Florida. 391pp.

Annex R

Ad hoc Working Group on IWC Global Data Repositories and National Reports (GDR)

Members: Double, Miller, B. (co-Convenors), Aisha, Allison, Baker, Bell, Brownell, Cipriano, De Freitas, Donovan, Enmynkau, Fortuna, Fruet, Hielscher, Hubbell, Hughes, Iñíguez, Kelkar, Leaper, Lovell, Lundquist, Mallette, Moronuki, Olson, Palka, Panigada, Redfern, Reeves, Ritter, Rosenbaum, Rowles, Slugina, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenors opening remarks

Double introduced the terms of reference for the group, which were to conduct an assessment of the utility and support requirements of all IWC databases relevant to the work of the Scientific Committee. Specifically the group will:

(1) collate summary information on all IWC databases relevant to the Scientific Committee (including data availability considerations);
(2) summarise data use by the Scientific Committee for each database;
(3) provide recommendations to improve integration, content and workflows;
(4) review technical progress on existing databases;
(5) consider needs and specifications for potential new databases, including developing simple technical guidelines on new proposals; and
(6) produce a budget and work plan for the implementation and development of existing and new databases.

1.2 Election of Chair and appointment of rapporteurs

Double was elected Chair and Brendan Miller as co-Chair. Leaper acted as rapporteur.

1.3 Adoption of Agenda

The adopted agenda is given as Appendix 1.

2. PROGRESS WITH EXISTING IWC DATABASES

2.1 Review of existing IWC databases

The Secretariat currently holds or is developing 18 databases (Table 1). In addition the Secretariat holds three web applications which include databases (Table 2). The Working Group reviewed the list of databases in Table 1 and focussed on the technical and financial support required and the priority to complete that work (Table 3).

2.2 National Progress reports

There was considerable discussion about National Progress reports. The number of countries reporting has dropped from around 20 in 2000 to around 15 in recent years with only 12 in 2017. The drop in reporting coincided with the change from paper submissions to fully electronic. The current system does not identify a Scientific Committee document as a progress report (i.e. there is no SC/67a/ProgRep XXXX). The Working Group **agreed** that returning to having an individually identifiable SC report from each country would be very valuable. This would help coordinators in the country pass back information to contributors and would allow the Committee to easily see each countries' report. It was agreed to develop a system to generate a PDF file from the data submitted for each country individually. The PDF report would also include additional information such as the names of national and regional coordinators for each country (the coordinators would be viewed as the 'authors' of the report which it was felt might improve reporting rates). In addition the system could also aggregate data on specific issues. For example tables of bycatch and ship strikes that are currently considered each year by the Committee (within the HIM Working Group). It was noted that the Commission Bycatch Mitigation Initiative coordinator might also assist with promoting submission of information in National Progress reports.

It was **agreed** that large whale direct catch data no longer needed to be submitted through National Progress reports because these data are required by the Schedule and entered into the catch database. However it was also **agreed** that these data needed to be easily accessible to the Committee and will require tables of catches for the year to be available as an SC report and also appended to each National Progress SC report.

A number of other changes to National Progress reports were agreed. These are listed in Table 4. The intention is to reduce the workload of data entry while still retaining all the data that are used by the Committee.

3. POTENTIAL FUTURE IWC DATABASES (OBJECTIVES AND WORK PLAN INCL. COSTS)

3.1 Development of simple technical guidelines for new database proposals

The Working Group developed a pro-forma for new database requests and major alterations to existing databases. The pro-forma will be completed by the proponents and reviewed by the relevant sub-committee or working group, together with technical input from the Secretariat, similar to the procedures for funding proposals. The pro-forma is given in Appendix 2. This included the following technical guidelines:

- all new scientific database requests must be submitted to the Scientific Committee for discussion, approval, prioritisation and funding. They must be submitted using a database proforma **after** being discussed by the relevant sub-committee;
- all agreed development work will be overseen by the IWC Secretariat and the Committee where specific input is needed;
- where possible, all databases must use open source software;
- programming languages, database engines and other technologies used must be discussed and agreed with IWC Secretariat to minimise development, infrastructure and maintenance costs;
- all completed source code and database schemas must be provided to and held by the IWC Secretariat;
- all databases will have a 5-year review cycle to ensure code and databases are kept up-to-date and secure;
- where appropriate, new databases should be developed in a way that will allow expansion and interaction from other databases and applications. This is to be discussed with the IWC Secretariat;
- where user accounts are required, they should be authenticated by a central IWC authentication server to minimise login credentials for users of multiple databases.

Table 1
Databases/repositories held by the IWC Secretariat.

Database	Status	Data owner/manager	Database technologies	Application technologies	Display technologies	Storage location	Technical lead	Technical support required	Financial support required
Progress Reports (~6,780 records)	Live	Scientific Committee/ Greg Donovan	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	-	Server infrastructure and basic maintenance: £1,200/year
Ship Strikes (>1,000 reports, >190 cases)	Live	Ship Strike Data Review Group	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	Creation of bulk uploader	Server infrastructure and basic maintenance: £1,200/year; bulk uploader development costs: £tbc
Research Requests	Live	Greg Donovan	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	-	Server infrastructure and basic maintenance: £,1200/year
IWC photographic cruise database and archive (over 110,000 images)	Live	Greg Donovan	Lightroom	-	-	IWC storage	Greg Donovan	Jess Taylor (contract)	Funding available now but may need after 2018
IWC biopsy sampling database	Under development	Greg Donovan	At present, Access	-	-	IWC storage	Greg Donovan	Jess Taylor (contract)	Funding available now but may need after 2018
SH blue whale catalogue	Awaiting deployment	-	PostgreSQL	Python	HTML, JavaScript	IWC web servers (awaiting deployment)	-	Server setup	Server infrastructure and basic maintenance: £1,800/year
WNP gray whale catalogue	Under consideration	Greg Donovan	TBD	TBD	TBD	TBD	Greg Donovan	Will be needed	Will be funded by a voluntary contribution
Document Web Archive	Live	-	MySQL	PHP	HTML JavaScript	IWC web servers	Brendan Miller	-	Server infrastructure and basic maintenance: £1,200/year
Bibliographic reference database (about 49,000 references)	Live	Greg Donovan	EndNote	-	-	IWC storage	Greg Donovan	-	Minimal
Individual Catch Database (~2.3 million records)	Live	Cherry Allison	Text/Excel	-	-	IWC storage	Cherry Allison	-	-
Catch Summary Database (~3 million catches)	Live	Cherry Allison	Excel	-	-	IWC storage	Cherry Allison	-	-
Discovery Marking Data	Live	Cherry Allison	Text/Excel	-	-	IWC storage	Cherry Allison	-	-
Sightings Data (IWC-DESS)	Live	Cherry Allison	Paradox	-	-	IWC storage	Cherry Allison	-	-
New integrated sightings, photo-identification	Under development, SC Steering Group	Greg Donovan	TBD	TBD	TBD	TBD	TBD	Yes	Yes but money for development available in Cruise budget
Small Cetaceans Catches (Bycatch and Direct)	Retired	Cherry Allison	MS Word	-	-	IWC storage	Cherry Allison	-	-
Compendium of Whale Watching Regulations	Outdated	-	Text	-	-	-	-	New data manager	-
IWC Database of Recommend-ations	In planning	Sarah Smith/ Sarah Ferriss	-	-	-	IWC web servers	Brendan Miller	-	-
Entanglement Response	In planning	David Mattila	-	-	-	IWC web servers	Brendan Miller	-	-

Table 2
Web applications which include databases held by IWC Secretariat.

Database	Status	Data owner/manager	Database technologies	Application technologies	Display technologies	Storage location	Technical lead	Technical support required	Financial support required
Cetacean Diseases of Concern Intranet	In development	Claire Simeone	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	Content completion	Server infrastructure and basic maintenance: £1,200/year
WW Handbook	In development	Sarah Ferriss	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	Content completion, database development, application development	Server infrastructure and basic maintenance: £1,200/year
JCRM Submission Site	Live	Jessica Peers	MySQL	PHP	HTML, JavaScript	IWC web servers	Brendan Miller	-	Server infrastructure and basic maintenance: £1,200/year

Table 3
Database usage by the Scientific Committee, any database development and data entry required, and the priority to complete that work.

Database	Status	Use by Scientific Committee	Work required	Priority to complete
Progress Reports	Live	Time series data on bycatch and entanglements and other anthropogenic impacts on large and small cetaceans	Complete changes agreed at SC/67a (see Table 4)	**High;** Approx. 1.5 weeks developer time
Ship Strikes	Live	Time series data of ship strikes on large whales	Migration script or 'brute force' data entry of 100+ records from other repository	In progress by Secretariat
Research Requests	Live	Portal to request data or samples held by the IWC	None required	N/A
IWC photographic cruise database and archive	Live	Keyworded data archive linked to cruise records, e.g. photo-ID, biopsy, scarring, health status etc.	Updates only	In progress by Secretariat
IWC biopsy sampling database	Under development	Facilitate stock structure analyses	Updates only	In progress by Secretariat
SH blue whale catalogue	Awaiting deployment	MR abundance estimation for population assessments, population structure	Server setup and deployment – SC budget allocated	**High**
WNP gray whale catalogue	Under consideration	MR abundance estimation for population assessments, population structure	Possible migration to new system	Process to be specified
Document Web Archive	Live	For everything	Updates only	In progress by Secretariat
Bibliographic reference database	Live	SC reports, communication	Updates only	In progress by Secretariat
Individual Catch Database	Live	Population assessments, catch limits, distribution and movement	Online portal. Idiosyncrasies within data. Creation of a database accounting for differences between total catches and those with individual data. Requires full documentation.	**High**
Catch Summary Database	Live	Population assessments, catch limits, distribution, movement	Online portal.	**High**
Discovery Marking Data	Live	Populations structure and movement, catch allocation	None required	N/A
Sightings Data (IWC-DESS)	Retired (see below)	Population assessments, abundance estimation	Data will be integrated into the new sightings, photo-ID, database	N/A
New integrated sightings, photo-ID, biopsy	Under development, SC Steering Group	Population assessments, abundance estimation	Updates only once developed	In progress by Secretariat, funding available
Small Cetaceans Catches (bycatch and direct)	Retired	Not used currently	None	N/A
Compendium of Whale Watching Regulations	Outdated	Global comparison of whale-watching regulations, assessment of best practice	None – not a database	N/A
IWC Database of Recommendations	In planning	Communication with Commission, assessment of progress and response	Develop database	Proposal will be presented at SC67b
Entanglement Response	In planning	Develop best practice, information sharing and capacity development	Develop database; funding already available	**High** – final proposal will be presented at SC/67b
Cetacean Diseases of Concern	Intranet in development		Finalise website	Part of document archive; complete at SC/67b
WW Handbook	In development		Finalise website, develop database	Part of document archive; in progress by Secretariat
JCRM Submission Site	Live	*JCRM* Journal management system (submission to publication)	Customise some features	**Medium**; current system functional

Table 4

Recommended changes to the current National Progress Reports schema.

All sections
Create facility to create pdf reports for each nation, and for each section
Submit pdf reports by nation as papers to Scientific Committee including national and regional coordinators as authors
Add ‘Choose not to enter data/No data’ option for all sections for national coordinator
Provide examples of data entry and the appropriate ways to aggregate data as alternative to submitting individual records
Add hyperlink to web page explaining ‘RMP Small Area’
Option to use drag and drop pointer to indicate ‘local area’ - provide guidance on how to complete

Cetacean databases and archives
New section. Facility to pre-populate from past records from 2019 on. Proposed fields:
- Database/archive name
- Description of database/archive: content, temporal & geographic coverage, data access – provide guidance on how to complete
- Data/archive type: sightings, photo-id, tissue samples, genetic, telemetry, strandings, other
- Number of records - text field to allow descriptors
- Database/archive manager/curator
- Contact details

Systematic surveys
New section. Proposed fields:
- Survey name
- Description of survey: purpose geographic area, methods used, survey dates. Provide guidance on how to complete. Include associated databases in ‘Cetacean databases’ section
- Contact details

Sightings
Remove section from National Progress Reports - see new ‘Systematic surveys’ section above

Natural marking
Remove section from National Progress Reports - see new ‘Cetacean database’ section above

Telemetry and artificial marking
Remove section from National Progress Reports - see new ‘Database’ section above

Tissue and biological samples
Remove section from National Progress Reports - see new ‘Database’ section above

Direct catches of large whales
Remove section from National Progress Reports – these data are collected through a separate process – a summary of catches will be submitted at each Scientific Committee meeting and a summary table appended to each National Progress Report

Non-direct anthropogenic mortality of large whales
Change title to ‘Vessel strike of large whales’
Include prompt to ship strike database once basic data entered
Change field name to ‘Submitted to IWC or national Ship Strike Database?’
Replace sex specific fields to No. individuals seriously injured, injured, unknown

Fishery bycatch of large whales
Include guidance to include entanglement information in this section

Direct catches of small cetaceans
No changes

Non-direct anthropogenic mortality of small cetaceans
Change title to ‘Vessel strike of small cetaceans’
Replace sex specific fields to ‘No. individuals seriously injured, injured, unknown’

Fishery bycatch of small cetaceans
No changes

Strandings (and floating carcasses)
Remove field: Total stranding events
Add comment field to describe the stranding event(s) – add guidance on how to complete
Amend field title to ‘Total number of individuals stranded’

There are a number of databases which receive funding from IWC but are not hosted by the Secretariat (e.g. Pollution 2020). The new pro-forma is intended to adequately describe the form and function of these external databases and specify data availability arrangements with the Scientific Committee. This information will assist the assessment of any associated funding proposals.

3.2 Global database for disentanglement activities
The Committee has recommended the development of a database for the IWC’s Global Whale Entanglement Response Network (GWERN). This was discussed as an example of a well-advanced proposal for a new database that could be used as a test of the new pro-forma. Mattila agreed to fill out the pro-forma using the specification for the GWERN database.

It was noted that there had been consideration of a global bycatch database. It had been agreed in 2016 that this was a very ambitious project that could be developed in a modular fashion starting with components (such as the GWERN database) for which there was already a clearly defined need and objectives. The GWERN database would be constructed in a modular fashion beginning with the data currently recommended for collection in GWERN’s consensus field data form. If, as anticipated this initial database is successful, then the database could be expanded in the future to include other modules and sources of data. Hence the initial structure needs to be carefully designed to allow for future expansion.

3.3 Development of a database of IWC recommendations
Another database proposal is in development by the Scientific and Conservation Committees jointly. This will be for a web-accessible database of Scientific Committee recommendations. Rendell noted that the proposal for this was still in draft form but he would complete the pro-forma for the 2018 meeting. This would provide another opportunity to review the pro-forma and refine as needed.

4. ADOPTION OF REPORT
The report was adopted on 17 May at 15:00.

Appendix 1

AGENDA

1. Introductory items
    1.1 Opening remarks
    1.2 Election of the Chair
    1.3 Appointment of Rapporteurs
    1.4 Adoption of agenda
    1.5 Documents available
2. Terms of Reference: This *ad hoc* working group will conduct an assessment of the utility and support requirements of all IWC databases relevant to the work of the Scientific Committee. Specifically it will:
    - collate summary information on all IWC databases relevant to the Scientific Committee (including data availability considerations);
    - summarise data use by the Scientific Committee for each database;
    - provide recommendations to improve integration, content and workflows;
    - review technical progress on existing databases;
    - consider needs and specifications for potential new databases, including developing simple technical guidelines on new proposals; and
    - produce a budget and workplan for the implementation and development of existing and new databases.
3. Progress with existing IWC databases
    3.1 Review of existing IWC databases including:
        3.1.1 Content and engagement
        3.1.2 Use by the Scientific Committee
        3.1.3 Management and workflows
        3.1.4 Potential for integration with other databases and workflows
    3.2 Recommendation for further development or integration of existing databases
    3.3 Indicative future support and funding requirements for existing IWC databases
4. Potential future IWC databases (objectives and work plan including costs)
    4.1 Development of simple technical guidelines for new database proposals
    4.2 Global database for disentanglement activities
    4.3 Global bycatch database

Appendix 2

DATABASE REQUEST PRO FROMA

This pro forma is to be used for new database requests, and major alterations to existing databases

Date	Request type	Related sub-committee
	New database/alteration *(delete as appropriate)*	

1. Database title
Please provide the title of the database.

2. Brief overview of the database or alteration
Give a very brief overview on your proposal and its expected usage within the IWC community. Be succinct and clear as this may be used to summarise your request in a report.

3. Identified scope and usage within the IWC and its committees
Please explain what data the database will hold, and how the database will be used within the IWC and its committees; to what questions of importance to the IWC will this database contribute?

4. Proposed database schema or architecture
Please provide an overview of the proposed database schema or architecture. Where possible, please consider providing an entity relationship diagram.

5. Interaction with other databases
Will the database be required to interact with any other databases or applications?

6. How will the data be populated?
Please explain how the data will be populated. Please consider the following: will the data be entered by the public or a select group? Will the data be verified after entry? Will it be web or mobile accessible?

7. Other similar databases
Please list any other databases that capture similar data either within the IWC or externally.

8. Timetable for key planning activities

Activity to be undertaken	Key person(s)	Start (mm/yy)	Finish (mm/yy)

9. Proposed completion dates

Expected outputs	Completion data (mm/yy)

10. Associated people

Name	Affiliation	Role within database

11. Data ownership and sharing
Please state your expected data availability arrangements including data ownership and data sharing agreements.

12. Total costs
Please provide a breakdown of costs. These may require discussion within the IWC Secretariat.

Type	Description	Cost (GBP)
Planning costs (e.g. travel/subsistence)		
Development costs (e.g. salaries, contractors, software)		
Ongoing costs (e.g. servers, back-ups, maintenance)		
Equipment costs		
Expected ongoing data co-ordinator costs		
Expected ongoing and one-off data entry costs		
Other costs		
Total		

13. Funds and contributions
Please provide details of any existing funds or potential contributions

Type	Description	Cost (GBP)
Existing funds		
Potential contributions		
Total		

14. Have you read and agree to the IWC Database Guidelines? (please tick)
The guidelines can be found at the end of this pro forma. To ensure you have the latest version please contact the IWC Secretariat.

Yes	
No	

IWC Database Guidelines Version 2017.05

To standardise the creation of databases, repositories, catalogues and applications, the following guidelines should be adhered to.

- All new scientific database requests must be submitted to the scientific committee for discussion, approval, prioritisation and funding. This must be submitted using a database proforma **after** being discussed by the relevant sub-committee.
- All agreed development work will be overseen by the IWC Secretariat, and the Committee where specific input is needed.
- Where possible, all databases must use open source software.
- Programming languages, database engines and other technologies used must be discussed and agreed with IWC Secretariat to minimise development, infrastructure and maintenance costs.
- All completed source code and database schemas must be provided to and held by the IWC Secretariat.
- All databases will have a 5-year review cycle to ensure code and databases are kept up-to-date and secure.
- Where appropriate, new databases should be developed in a way that will allow expansion and interaction from other databases and applications. This is to be discussed with the IWC Secretariat.
- Where user accounts are required, they should be authenticated by a central IWC authentication server to minimise login credentials for users of multiple databases.

Annex S

Report of the *Ad Hoc* Working Group on Photo-Identifcation

Members: Olson (Convenor), Al Jabri, Bell, C., Bell, E., Brownell, Cabrera, Castro, Cerchio, Clapham, Collins, Cooke, de Freitas, Donovan, Double, Enmynkau, Findlay, Fortuna, Fruet, Gallego, Galletti, Genov, Givens, Hughes, Iñíguez, Jackson, Kaufman, Kitakado, Lang, Lee, Lindquist, Mallette, Mate, Matsuoka, Miller, Minton, Miyashita, Mizroch, Morita, Natoli, Øien, Palka, Panigada, Phay, Redfern, Reeves, Reyes, Ritter, Robbins, Rodriguez-Fonseca, Rosenbaum, Rowles, Slugina, Stimmelmayr, Torres-Flórez, Urbán, Vermeulen, Víkingsson, Walters, Weinrich, Weller, Woo Kim, Yasokawa, Zerbini

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Olson welcomed participants.

1.2 Election of Chair
Olson was elected as Chair.

1.3 Appointment of rapporteurs
Minton undertook the duties of rapporteur.

1.4 Adoption of agenda
The adopted agenda is given in Appendix 1.

1.5 Documents available
Documents identified as containing information relevant to the *ad hoc* Working Group were: SC/67a/PH01-05 and SC/67a/SH15.

2. HUMPBACK WHALE CATALOGUES

SC/67a/PH03 provided an Interim Report for the Antarctic Humpback Whale Catalogue. College of the Atlantic has maintained the Antarctic Humpback Whale Catalogue (AHWC) since 1987. During the past year, the AHWC catalogued 820 photo-identification images representing 709 individual humpback whales submitted by 25 individuals and research organisations. Photographic comparison yielded 183 re-sights of individuals already known to the catalogue. As of May 2017, the total number of catalogued whales identified in AHWC by fluke, right dorsal fin/flank and left dorsal fin/flank photographs is now 7,476, 414 and 408 respectively. The AHWC is available on-line at *http://www.flickr.com/ahwc*. AHWC began investigating the utility of an automated image recognition system in collaboration with Happywhale (see SC/67a/PH02). Initial testing yielded a high matching success rate for high quality photographs (81% were correctly identified) but substantially lower success rate as photo quality degraded (75% of low quality photos were not identified). The report drew attention to a paper by Acevedo *et al*. (in press) that uses opportunistically collected data curated by the AHWC.

The AHWC wishes to acknowledge the enormous contribution our late friend, colleague and co-author Carole Carlson (1947-2017) made to the study of individually identified whales and to our collective understanding of humpback whales and their lives.

The Working Group **welcomed** this report, and was pleased to see the developing relationship between Happywhale and the Antarctic catalogue. The use of the catalogue to produce published studies helpful for conservation and management purposes was praised. The Working Group is keen to explore how this catalogue can be further used to help inform population assessments, given that the opportunistic nature of data collection for the catalogue presents challenges for mark-recapture analyses. The Working Group **encouraged** regular communication between the catalogue holders and the SH sub-committee coordinating stock assessments to explore potential.

The Working Group discussed the reasons for the limitations on the geographical range of contributions to this catalogue to date (for example, it does not yet contain any contributions from South Africa). Until now, the labour-intensive nature of manual matching has prevented the catalogue from being able to realistically seek and incorporate contributions from the entire Antarctic region. With the possibility of wide-scale use of automated matching on the horizon, it may become possible to incorporate contributions from much wider geographical ranges, but this will require careful consideration of the research questions that could and should be addressed through use of the catalogue, and mindfulness of the limitations or biases that may result from combining opportunistically collected data with that from dedicated cetacean surveys.

3. BLUE WHALE CATALOGUES

SC/67a/PH01 reported the results of the comparison of Antarctic blue whale identification photographs from two new sources of contributions to the existing Antarctic Blue Whale Catalogue. Previously, photo-identification data from this catalogue have produced information on inter-annual whale movement (Olson *et al.*, 2016), within-season sighting rates (Matsuoka and Pastene, 2009; Olson *et al.*, 2016), and they were the basis for a pilot capture-recapture study (Olson and Kinzey, In press). The two new sources include the South African Antarctic Blue Whale Survey 2013/14 (Findlay *et al.*, 2014) and the personal photographs of Paul Ensor (Cruise Leader, IWC/SOWER). Twenty-five new individual blue whales were identified: sixteen from the South African survey and nine from the personal photographs. There were no matches between the two collections or between either of these collections and the Antarctic Catalogue. The contributions bring the total number of identified Antarctic blue whales to 441, represented by 321 right sides and 336 left sides. This number is 15-19% of the most recently accepted abundance estimate of 2,280 from 1997/98 (CV=0.36; Branch (2007). To date only 3% (14/441) of whales in the catalogue have been re-sighted inter-annually. The low re-sighting rate may be explained by an increasing population size (Branch, 2007). The current 3% re-sighting rate is too low to produce a precise abundance estimate in a capture-recapture model. The lack of matches between the new South African photos, which were all from Area III, and existing catalogue photos from IWC Management Area III is notable, as 45% of the Antarctic catalogue comprises photos from Area III. The photographs from the 1980s and 1990s (Ensor) are a valuable contribution to the catalogue; a future recapture of any of the identified whales from these decades would improve the estimate of survival in an abundance model. The continued collection of Antarctic blue whale identification photographs provide data for capture-recapture estimates of abundance as well as information on the movement of individual blue whales within the Antarctic region.

The work was **commended** by the Working Group. The authors noted that the patterns of movement which show a combination of small ranges of movement from some individuals and much longer ranges from others was similar to that found in the Discovery tag data (Branch *et al.*, 2007). There are plans for a more thorough analysis of movements using a combination of these two data sets (photo-identification and Discovery tag). New photographs for this catalogue are continuing to come forward from various sources.

SC/67a/PH04 provides a progress report on the Southern Hemisphere Blue Whale Catalogue (SHBWC), for the period between June 2016 and May 2017. The catalogue contains a total of 1,520 individual blue whale photo-identifications from Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific, Australia, Timor L'este, New Zealand, Southern Africa, Madagascar and Sri Lanka. This represents an increase of approximately 13% over last year. Overall, 17 blue whale research groups from all regions are contributing to the SHBWC. To date matches have only been found within regions, but not between regions.

Due to the increasing number of photos and individuals in the catalogue, and the resulting workload associated with matching each new individual, regional coordinators have proposed a revision to the prioritisation of scheduled work for the 2017-18 period. In order to inform the ongoing IWC Southern Hemisphere blue whale population assessments, within-region comparisons should be prioritised above between-region comparisons. Under this option, new contributions made before 2017 would be matched to individuals from the same region before the end of 2018. However between-region comparisons between Australia, New Zealand, Indonesia and the other regions would be expected to be 40-45% complete by December 2018.

New Terms of Reference for the SHBWC agreed by the IWC in 2016 have been signed by new groups joining the SHBWC and the groups that are already members are expected to sign the new updated agreement. Migration of the entire SHBWC to the IWC server is ongoing and the database software is undergoing further improvements in order to comply with the new IWC photo-identification catalogue guideline requirements. The SHBWC English manual was updated in 2016.

The Working Group **commended** the substantial amount of work conducted by the SHBWC and **recommended** that it continue. The Group **agreed** to the prioritisation of within-region matching over between-region matching for the 2017-18 schedule. Priorities for the sub-committee on other Southern Hemisphere Whale Stocks population assessments currently are Chile and Australia. An intersessional working group was convened to facilitate the preparation of these data for use in an abundance estimate and also to determine which regional data set (Chile or Australia) is most ready for analysis (see Intersessional Working Groups, below). The Working Group discussed the possibility that Happywhale (SC/67a/PH02) is developing automated matching algorithms for blue whales, and if so, whether this would be worth exploring as a means to help reduce matching times and workload for this catalogue.

The new IWC data requirements, which necessitate the uploading of dates and latitude/longitude coordinates with each individual photo file, present a barrier to some contributors and are potentially causing backlog in the uploading of photographs. The Working Group **agreed** that a temporary work-around will be constructed in the software to allow contributors to bulk upload photographs and then provide the ancillary data immediately afterward in a separate format (e.g. Excel sheet).

4. OTHER WHALE PHOTO-IDENTIFICATION CATALOGUES

SC/67a/PH02 provided an update on the web-based marine mammal photo-identification crowd-sourcing platform known as Happywhale. As of April 2017 the system had been online at Happywhale.com for 20 months. The system is in continued development, guided by user feedback in pursuit of the dual, complementary goals of engaging citizen scientists and using that engagement to generate high quality, low cost marine mammal photo-ID data together with web-based tools of value to marine mammal scientists. By means of an automated notification system, all image contributors are notified of any identifications made, matches found, and repeat sightings, with links to the data online. Since inception the project has received submissions of over 41,000 images contributed by over 1,000 scientists and citizen scientists. Within these images 32 cetacean species have been recorded. Individual identification efforts have been focused on humpback whales in collaboration primarily with Cascadia Research Collective, Allied Whale and Alaska Whale Foundation. The site currently displays encounters of 4,813 humpback whale individuals in 10,124 encounters. Development has been focused on image management efficiency, with the implementation of an automated individual identification image recognition algorithm for humpback fluke matching now available to collaborating research Groups. The system has found long-distance matches between image catalogues that would not otherwise have been compared, and has also contributed to entanglement response efforts by identifying whales along the California coast. Wider collaboration is anticipated, especially across the northeast Pacific. The increased efficiency and automation of the system now enables ocean-basin wide population studies at a scale and economy not previously feasible without web-based collaboration and automation.

The Working Group was impressed by this update on Happywhale and is encouraged by the new possibilities that automated matching presents. There were some concerns about data ownership and data sharing agreements, which can present hurdles for contributions to shared catalogues. While most contributors adhere to the default option of public domain/open access, there are restrictions that can be placed on how contributor's data are viewed and used. Similarly, if and when matches are found, contributors are notified and can decide together how to respond. It was clarified that while the database contains images of 32 cetacean species, the automated matching function is currently working only for humpback whales.

SC/67a/SH15 presented preliminary results on Bryde's whale sighting data and photo-identifications from the years 2000-17, collected opportunistically on whale watch vessels in Ecuador and Peru, and from a humpback research vessel in Panama. Results included sightings of 81 groups/102 individuals of Bryde's whales. Sixty-four individuals were photo-identified. Of these, three were re-sighted. The

Table 1

Summary of the work plan for the *ad hoc* Working Group on Photo-identification.

Item	Intersessional 2017/18	2018 Annual Meeting (SC/67b)
(1) SHBWC photo data from Chile and Australia	Fill data gaps, assess appropriateness for abundance estimates	Provide info on data readiness to SH
(2) Appendices for photo-ID guidelines	Begin compilation of technical appendices	Provide list of appendices for review

nine-month interval between re-sightings of one of the individuals shows the first long-distance seasonal migration in the southeast Pacific between Ecuador and northern Peru. The estimated distance between these two sightings is 294km. Bryde's whales were sighted in all months of the year except November, although it was acknowledged that the sightings were potentially biased by the sampling effort which coincided with whale-watching during periods of peak humpback whale densities.

The Working Group **welcomed** this information about such a little-known population. The challenge in identifying Bryde's whales individually was noted. It was suggested that the authors write a technical report describing their methods and provide it to the Working Group.

Minton described for the Working Group a partially IWC-funded collaboration between Arabian Sea Whale Network (ASWN) cetacean researchers and Flukebook.org to create a regional online data archiving tool based on the open source Wildbook/Flukebook platform. The database will accommodate many different data types (e.g. survey effort, sightings, photo-identification, genetic sampling, satellite tagging), allowing members of the Arabian Sea Whale Network to store and analyse data in a common format. The new functionality in Flukebook that is created through the project will become open source and available to the cetacean research community at large. The project will also collaborate with other regional networks focusing on humpback whale conservation and research in the Southwest Indian Ocean, such as the Indocet network, which includes researchers from the southwest Indian Ocean, and which is also working with Flukebook to create their own regional matching platform. More information about the ASWN is given in SC/67a/CMP07.

The Working Group was pleased to learn of the ASWN's progress, and especially that it was able to use its IWC grant to leverage additional funding.

5. GUIDELINES FOR IWC DATABASES AND CATALOGUES

This agenda item refers to a set of guidelines that the Scientific Committee has requested the Working Group develop in support of IWC work conducting cetacean population assessments through photo-identification databases.

The document is intended to provide guidance for photo-identification catalogues contributing photos and data to the IWC and/or being funded by the IWC. The aim is that catalogues adhere to common standards for photograph subject and quality, data submission and reporting, at a level sufficient to allow the IWC to meet its population assessment goals.

SC/67a/PH05 is the draft of the guidelines brought forward from the intersessional group (see below) that the Working Group reviewed, discussed, and edited. Clarifications and improvements were made to the document, which are reflected in the finalised guidelines included as Appendix 2 of this report. The guidelines will be made available online on the IWC website.

6. INTERSESSIONAL WORKING GROUPS

Three intersessional correspondence groups and one steering group convened during SC/66b were relevant to the aims of the *ad hoc* Working Group. ICG-05 was formed to identify specific scientific questions that the Antarctic Humpback Whale Catalogue could help to address and which geographic regions are highest assessment priority for matching. An on-going, reciprocal exchange of information was established between Scientific Committee members and the curators of the Catalogue regarding these topics and the intersessional group completed its objectives in May 2017. ICG-06 sought to clarify relationships between initiatives providing opportunistic sightings data and existing catalogues, and the role that they might play within the context of the IWC's use of photo-identification data. Details related to this intersessional group are given in Annex H (Report of the sub-committee on other Southern Hemisphere Whale Stocks). ICG-19 was convened to continue the development of IWC guidelines for photo-identification catalogues that was started during SC/66b. These guidelines were finalised during this meeting. SG-09 organised a one-day workshop bringing together researchers from South America to discuss standardisation and integration of photo-identification catalogues for blue and humpback whales. The workshop was held just after the SOLAMAC conference in Valparaíso, Chile, on 2 December 2016. A full workshop report is given in SC/67a/Rep03 (see also Annex H).

7. CONCLUSIONS AND RECOMMENDATIONS

The Working Group finalised the photo-identification guidelines. It was suggested that additional text focusing on specific technical aspects of photo-identification such as GPS logging, photo quality coding, etc. should be developed and appended to the guidelines.

7.1 Work plan

The Working Group agreed to review, in detail, the status of the regional holdings in the Southern Hemisphere Blue Whale Catalogue for the Chilean and Australian populations in order determine data gaps that could be filled by the contributing regional research groups. The data sets would then be assessed as to readiness for use in a capture-recapture abundance framework. An intersessional working group under Olson and Jackson was established to carry out this work in order to provide information as to data readiness to the sub-committee on other Southern Hemisphere Whale stocks at SC/67b.

Upon the completion of the Photo-identification Guidelines, the *ad hoc* Working Group **agreed** to begin a compilation of appendices on technical topics. An intersessional group was formed under Olson to undertake this work. Table 1 outlines the work plan.

There are no budgetary implications for this work plan. Intersessional email groups are given in Annex W.

8. ADOPTION OF REPORT

This report was adopted at 11:37 on 16 May 2017.

REFERENCES

Acevedo, J., A. Aguayo-Lobo, J. Allen, N. Botero-Acosta, J. Capella, C. Castro, L. Dalla Rosa, J. Denkinger, F. Félix, L. Flórez-González, F. Garita, H. M. Guzmán, B. Haase, G. Kaufman, M. Llano, C. Olavarría, A. S. Pacheco, J. Plana, K. Rasmussen, M. Scheidat, E. R. Secchi, S. Silva and P. T. Stevick. In press. Migratory preferences of humpback whales between feeding and breeding grounds in the eastern South Pacific. *Mar. Mamm. Sci.*

Branch, T.A. 2007. Abundance of Antarctic blue whales south of 60°S from three complete circumpolar sets of surveys. *J. Cetacean Res. Manage.* 9(3): 253-62.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B.G., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and northern Indian Ocean. *Mammal Rev.* 37(2): 116-75.

Findlay, K., Thornton, M., Shabangu, F., Venter, K., Thompson, I. and Fabriciussen, O. 2014. Report of the 2013/14 South African Antarctic blue whale survey, 000°-020°E. Paper SC/65b/SH01 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 33pp. [Paper available from the Office of this Journal].

Matsuoka, K. and Pastene, L. 2009. Summary of photo-id information of blue whales collected by JARPA/JARPA II and preliminary analysis of matches in the feeding grounds. Paper SC/61/SH3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 5pp. [Paper available from the Office of this Journal].

Olson, P.A., Double, M.C., Matsuoka, K. and Pastene, L.A. 2016. Photo-identification of Antarctic blue whales 1991 to 2016. Paper SC/66b/SH11 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].

Olson, P.A. and Kinzey, D. In press. Using Antarctic blue whale photo-ID data from IDCR/SOWER: capture-recapture estimates of abundance. *J. Cetacean Res. Manage. (Special Issue 4)*: 7pp.

Appendix 1

AGENDA

1. Introductory items
    - 1.1 Opening remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of Agenda
    - 1.5 Documents available
2. Humpback whale catalogues
3. Blue whale catalogues
4. Other whale photo-ID catalogues
5. Guidelines for IWC catalogues
6. Intersessional working groups
7. Conclusions and recommendations
    - 7.1 Work plan
8. Adoption of Report

Appendix 2

IWC GUIDELINES FOR PHOTO-IDENTIFICATION CATALOGUES

Paula Olson, Jennifer Jackson, Greg Donovan

Members: Olson (Convenor), Al Jabri, Bell, C., Bell, E., Brownell, Cabrera, Castro, Cerchio, Clapham, Collins, Cooke, de Freitas, Donovan, Double, Enmynkau, Findlay, Fortuna, Fruet, Gallego, Galletti, Genov, Givens, Hughes, Iñíguez, Jackson, Kaufman, Kitakado, Lang, Lee, Lindquist, Mallette, Mate, Matsuoka, Miller, Minton, Miyashita, Mizroch, Morita, Natoli, Øien, Palka, Panigada, Phay, Redfern, Reeves, Reyes, Ritter, Robbins, Rodriguez-Fonseca, Rosenbaum, Rowles, Slugina, Stimmelmayr, Torres-Flórez, Urbán, Vermeulen, Víkingsson, Walters, Weinrich, Weller, Woo Kim, Yasokawa, Zerbini.

BACKGROUND

The International Whaling Commission (IWC) has a history of using data and analyses from photo-identification catalogues to assist with its work. Within this document the term 'photo-identification catalogue' describes a database that includes whale identification photographs with corresponding dates and geographic positions. Photo-identification data have been used to identify patterns of movement, residency, habitat use, population structure and to estimate abundance and other population parameters (Bradford *et al.*, 2008; Calambokidis *et al.*, 2009; Carroll *et al.*, 2011; Hammond *et al.*, 1990; Koski *et al.*, 2010; Wedekin *et al.*, 2010; Whitehead *et al.*, 2008).

Recognising the great value of such studies (IWC, 1990), the IWC has supported the development of photo-identification catalogues to facilitate assessment work (e.g. Southern Hemisphere humpback whales, Southern Hemisphere blue whales and Pacific gray whales). Such catalogues can also assist in providing information on entanglement, ship strikes and health status (Knowlton *et al.*, 2012).

The IWC has supported (financially or by submitting photographs from IWC cruises) what can broadly be considered two types of photo-identification catalogues:

(1) 'independent' catalogues that are pertinent to specific on-going assessments but for which maintenance and control belongs outside the IWC; and
(2) 'repository' catalogues that have IWC oversight.

Table 1

Examples of results from ocean-wide photo-identification catalogue reconciliations.

Acevedo, J. *et al.* 2007. Migratory destinations of humpback whales from the Magellan Strait feeding ground, southeast Pacific. *Mar. Mamm. Sci.* 23(2): 453-463.
Constantine, R. *et al.* 2012. Abundance of humpback whales in Oceania using photo-identification and microsatellite genotyping. *Mar. Ecol. Prog. Ser.* 453: 249-261.
Garrigue, C. *et al.* 2011. Movement of individual humpback whales between wintering grounds of Oceania (South Pacific), 1999 to 2004. *J. Cetacean Res. Manage.*, 3: 275-281.
Mizroch, S.A. *et al.* 2004. Estimating the adult survival rate of Central North Pacific humpback whales. *J. Mammal.* 85(5): 963-972.
Weller, D.W. *et al.* 2012. Movements of gray whales between the western and eastern North Pacific. *Endang. Spec. Res.* 18(3): 193-199.
Publications from YoNAH - North Atlantic humpback whales
Smith, T.D., *et al.* 1999. An ocean-wide mark-recapture study of the North American humpback whale (*Megaptera novaeangliae*). *Mar. Mamm. Sci.* 15:1-32.
Stevick, P.T. 2001. Errors in identification using natural markings: rates, sources, and effects on capture-recapture estimates of abundance. *Can. J. Fish. Aquat. Sci.* 58: 1,861-1,970.
Stevick, P.T., *et al.* 2003. North American humpback whale abundance and rate of increase four decades after protection from whaling. *Mar. Ecol. Prog. Ser.* 258: 263-273.
Stevick, P.T. *et al.* 2006. Population spatial structuring on the feeding grounds in North Atlantic humpback whales (*Megaptera novaeangliae*). *J. Zool.* 270(2), 244-255.
Publications from SPLASH - North Pacific humpback whales
Barlow, J. *et al.* 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Mar. Mamm. Sci.* 27(4): 793-818.
Calambokidis, J. *et al.* 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. Final report for Contract AB133F-03-RP-00078. 57pp. Available from: *http://www.cascadiaresearch.org/files/Projects/Archived_projects/SPLASH/SPLASH-contract-Report-May08.pdf.*
Straley, J. *et al.* 2009. Assessment of mark-recapture models to estimate the abundance of a humpback whale feeding aggregation in Southeast Alaska. *J. Biogeography* 36(3): 427-438.

Repository catalogues are supported for the general value of their data and potential use for assessment in the future whether or not they are currently being used by the IWC in an on-going assessment (e.g. the Antarctic Humpback Whale Catalogue). Catalogues can move from one status to another during the progress of assessments. In repository status, catalogue holders need only submit an annual report (see reporting, below). For an on-going assessment, the data requested may include full catalogues, re-sighting records, and possibly additional, associated data (behaviour, sex, age class, etc.). In this case, if an independent catalogue has received funding it would provide a summary report in addition to the contributed data.

Conservation and scientific benefits of shared catalogues

Photo-identification catalogues are usually compiled from regional surveys in an area that typically represents only part of the range of the focal species. The effective study and management of whales at the population level benefits from a broad (full range if possible) spatial coverage. These are wide ranging animals that travel across regional and international boundaries and comprehensive research and management depends on the collaboration among researchers as well as governments. An important role for the IWC, in being able to provide the best scientific basis for conservation and management advice, is to encourage such collaboration to allow broad and robust assessments of cetaceans.

For example, to understand broad ecological patterns or undertake range-wide assessments, it is necessary to combine ('reconcile') catalogues amongst research groups. The comparison of photo-identification catalogues between regions can reveal whale movement patterns, migration routes, and determine breeding and feeding area linkages. Using photo-identification data from throughout a species or population's range allows for a greater understanding of population structure and provides data for a more comprehensive abundance estimate. Examples of outputs from some large ocean-wide catalogue reconciliations are given in Table 1.

Data access for shared catalogues

For population assessments where there is no reconciled IWC catalogue or for which the IWC has not developed a data availability agreement, the IWC uses analyses of data from multiple catalogues but the data themselves are not necessarily available to all Committee members (or even shared among the different contributors). However, any scientist (including catalogue holders of contributed data) may submit a request for data access to the data owner(s) through the IWC and its usual data availability process[1]. Such requests are facilitated if the request is submitted to the Scientific Committee for endorsement before being submitted to the data owners. Requests are handled on a case-by-case basis by the IWC Data Availability Group (Chair, Vice-chair and Head of Science) that works to facilitate an appropriate data sharing agreement although the ultimate decision remains with the data owner. Requests must include a proposal that specifies the intended analysis and how it benefits the Scientific Committee and/or adds to the scientific knowledge of the species in question.

Data sharing agreements are in place for established IWC collaborative catalogues, such as the Antarctic Humpback Whale Catalogue and the Southern Hemisphere Blue Whale Catalogue. Researchers studying populations that

[1]For more information, see the IWC Scientific Committee Data Availability protocol, Procedure B (*https://iwc.int/data-availability*).

correspond to these species and geographic designations are encouraged to join these collaborative catalogues and make use of the reciprocal data sharing agreements.

All catalogues sponsored in whole or in part by the IWC **must** have a data availability agreement that facilitates access for Scientific Committee members. These agreements should ensure that proposals endorsed by the IWC Scientific Committee for its work will be granted with agreed safeguards with respect to publication rights; the protocols for data access will be published on the IWC website.

OBJECTIVES OF THE GUIDELINES

To date, the IWC collaborative catalogues have been developed on an *ad hoc* basis responding to specific needs. Whilst this has worked to a greater or lesser extent – we envision that IWC assistance to facilitate collaboration amongst research groups and the development of reconciled catalogues may increase (e.g. with gray whales in the western North Pacific). It is therefore important to develop guidelines for photo-identification catalogues either: (a) being sponsored by the IWC; or (b) contributing photo data/ analyses of such data to the IWC for assessment purposes. The conditions for these two types may vary in some instances. The aim is that catalogues adhere to common standards (e.g. with respect to photograph subject and quality, data submission, maintenance and reporting) such that they provide data at a level sufficient to allow the IWC to meet its population assessment and conservation goals. The guidelines are general in scope and intended for use by all kinds of photo-identification projects of large whales. This may be expanded to small cetaceans in due course. They are not guidelines on field techniques, although appendices providing examples of good practice may be developed at a later stage. The guidelines should be regularly reviewed and updated (approximately every three years unless justification arises to do so more frequently).

For use in population assessments, photo-identification catalogues must be fully reconciled internally. Identification photographs should be submitted to the IWC (see discussion below) with at least date and location data.

CATALOGUE CONTRIBUTIONS FOR POPULATION ASSESSMENT - PROTOCOLS

I. Photo subjects for large whales, by species

Primary photo subjects commonly used in bold (varies by region):

- blue whales – left and right side with dorsal fin, fluke if available;
- fin whales – dorsal fin and flank; chevron and blaze (requires 3-4 photos of each side);
- sei whales – dorsal fin, flank (requires 2 photos of each side);
- Bryde's whales - left and right side with dorsal fin;
- minke whales and dwarf minke whales - left and right side with dorsal fin;
- humpback whales – fluke; left and right dorsal fin and/or flank if no fluke available;
- Omura's whales – left and right side with blaze, chevron, and dorsal (requires 2-3 photos of each side);
- gray whales - left and right side with dorsal hump; fluke;
- right whales – callosity patterns; vertical view of head, lateral left and right sides of head;
- bowhead whales – vertical view, entire dorsum; and
- sperm whales – fluke.

Fluke, dorsal side, and flank photos should be linked for individual whales whenever possible. Note: Prominent scars or other physical anomalies should be photographed wherever they appear on the body.

II. Catalogue organisation

The objective is to facilitate matching, either new photographs within an existing catalogue[2] and/or between catalogues[3]. There are several ways to achieve this, such as grouping photographs within a catalogue based on similar natural markings – colour or dorsal fin shape, for example – that facilitates the inter-matching process. New identification photos can then be compared first to similarly marked animals, speeding up the process to finding a match, if it exists[4]. See Gendron and Ugalde de la Cruz (2012), Agler *et al.* (1990), and Allen *et al.* (1994) as examples for blue whales, fin whales, and humpback whales, respectively. This can be an appropriate way to organise catalogues, whether the catalogue is in printed or electronic format. (Note that data sets that are not organised in this recommended format are still of value and can be 'salvaged.')

III. Internal catalogue reconciliation

The inter-matching of photographs can be conducted manually (by eye) or computer-assisted (generally custom software and often species specific). Using the manual method, photographs can be compared in printed format, electronic format or a combination of both formats. This step may vary by species, by catalogue size, and by the staffing and funding resources available to the catalogue. All methods are valid as long as a clean validated dataset is produced.

Matches must be **unequivocal**, based on good quality photographs, and exhibiting a minimum of three match points[5]. All inter-matches should be confirmed by a second matcher. For IWC catalogues, the IWC **must** conduct/oversee cross-matching exercises on catalogue subsets to confirm internal reconciliation (and estimate errors) at specified intervals.

IV. Image quality coding

The quality coding of photographs is undertaken by most catalogues to ensure (as much as possible) that there is an equal probability that matches will be recognised and to reduce the amount of bias highly distinctive or indistinctive individuals might otherwise produce. It is essential that such coding is used in IWC catalogues and that the method is documented. Typically catalogues use 3, 4, or 5 quality categories (excellent-poor) in their coding systems, based on features such as the angle and distance of the animal relative to the camera, lighting, and focus. See Friday *et al.* (2000) and Mizroch and Harkness (2003) for examples of quality coding. Catalogues that have already been coded need not change their system. For the IWC, photographs of upper quality only are to be submitted (i.e. top 2 of 3 codes; top 3 of 4; top 4 of 5). Details will be agreed upon for individual catalogues.

Note the important difference between quality and distinctiveness. Photo quality is based on the features of the photo (above) regardless of how well the whale in the photo is marked. The tendency is to code the photo of an indistinctive whale with few natural marks as a poor-quality photo; this bias must be avoided as must the reverse.

[2]Reconciling a catalogue internally.
[3]Reconciling two or more catalogues.
[4]After this first comparison, a new photo should still be matched to entirety of catalogue.
[5]A match point is a unique physical feature recognisable in both photographs (e.g. a nick in the dorsal fin, a specific swirl or spot(s) in the pigmentation, a scar).

Table 2

Submission of photos and data to the IWC from three different kinds of catalogues.

'Independent' catalogues for use in assessments, not held by the IWC	IWC funded catalogues	
	Partially funded catalogue, with IWC oversight	Fully funded catalogue, held at IWC
Images	**Images**	**Images**
Photo format in the highest jpg resolution available* (RAW is too large)**	The highest resolution available (including RAW if available)	The highest resolution available (including RAW if available)
Best identification photo(s) per individual	Best identification photo(s) per individual, per region	Best identification photo(s) per individual per sighting
Higher quality photographs only (to be agreed on a case by case basis)	Higher quality photographs only (to be agreed on a case by case basis)	Higher quality photographs only (to be agreed on a case by case basis)
Associated data can be included in the metadata of images (but this is not required)	Associated data included to the extent possible	Associated data included to the extent possible
Associated data[1]	**Associated data**[1]	**Associated data**[1]
Data submitted as a flat file (i.e. in Excel) and in IWC-specified order (on a case by case basis; the IWC will inform research groups specifically)	Data submitted as a flat file (i.e. in Excel) and in IWC-specified order (on a case by case basis; the IWC will inform research groups specifically)	The data will be held by the IWC in an appropriate database format
Include a record for every year (or season) that an individual is photographed (only one set of identification photo(s) is submitted)***	All sightings will be documented (within and between years)	All sightings will be documented (within and between years)

[1]This will include some or all of the following (to be specified on a case by case basis and dependent on availability). **At a minimum: whale identification number; image file name; photo subject (e.g. left side); date (**A resource for data standards regarding dates is ISO 8601: *https://www.iso.org/iso-8601-date-and-time-format.html*)**; position expressed as lat/lon (**Researchers are encouraged (but not required) to use a GPS logger to embed GPS data directly into the photos' metadata. It is also possible to add location data to photos using easily available, inexpensive software). (If only a rough location is known submit the approximate lat/lon but identify it as approximate.). Additional data: behaviour; sex; mother or calf designation; biopsy sample number; satellite tag number; comments. Comment to be qualitative, e.g. info on association with another known individual, unusual behaviour, unusual scar.

*Note that it is better to collect fewer photos of the highest resolution than more photos in a lower resolution. Low resolution photos are unusable for photo-identifcation.

**RAW format might be accepted for archive purposes if the IWC is the main holder of single range-wide catalogue. Otherwise it is expected that research groups will archive their original photos and submit highest resolution copies to the IWC.

***There may be assessments that wish to examine the fluidity of inter-seasonal residencies, in which case all records within a season would be requested.

V. Submissions to the IWC

Submission of photos and data varies by the type of catalogue in relation to the IWC (Table 2).

(1) Independent catalogues for use in assessments; catalogue not held by IWC

These catalogues are pertinent to specific on-going assessments but maintenance and control belongs outside the IWC.

(2) IWC partially funded catalogue, with IWC oversight

These are catalogues for which the IWC provides funding and has an agreed oversight role. It is important that these catalogues meet IWC standards with respect to use of data and analyses in assessments. With these catalogues, the Scientific Committee can request additional photographs or data should it need to for an assessment. These may be repository or independent catalogues.

(3) IWC fully funded catalogues

These are catalogues that are funded by the IWC (and held by, although not necessarily in, the Secretariat). For these catalogues, all photographs and available data are required to be held in the database. These will be repository catalogues.

VI. Archiving

Following accepted best practice, all catalogues should back-up and archive their photos and data in multiple places including long-term offsite storage (e.g. backed up on 2-3 hard drives as well as on an institutional or cloud server). IWC funded catalogues are obligated to do this and to include confirmation of archival storage in their report to the IWC (see below).

VII. Reporting

A report should be submitted to the IWC for every year of funding; in a few cases this is an annual report. Templates for such reports will be provided by the IWC (they may vary if an assessment is on-going, for example). Normally the report would include the geographic areas, years/seasons, and number of individuals compared to the existent catalogue, along with results of the comparisons yielding the number of matches, the number of newly identified individuals, and the subsequent total number of identified individuals in the catalogue. The report should also contain a detailed Methods section that describes how inter-matching and quality coding were conducted. Data archival locations should be listed and recent publications generated from catalogue data should be provided. It is suggested that established long-term catalogues include a periodic error estimation in their reporting. Information on validation and error checking should be included in the report.

For a report example, see a recent annual report from the Antarctic Humpback Whale Catalogue, Stevick *et al.* (2015). Reports are required from both assessment and repository catalogues.

N.B. Technical appendices including examples of good practice may be attached to these guidelines that will be regularly updated.

REFERENCES

Agler, B.A., Beard, J.A., Bowman, R.S., Corbett, H.D., Frohock, S.W., Hawvermale, M.P., Katona, S.K., Sadove, S.S. and Seipt, I.E. 1990. Fin whale (*Balaenoptera physalus*) photographic identification: methodology and preliminary results from the western North Atlantic. *Rep. Int. Whaling Comm. (special issue)* 12: 349-56.

Allen, J.M., Rosenbaum, H.C., Katona, S.K., Clapham, P.J. and Mattila, D.K. 1994. Regional and sexual differences in fluke pigmentation of humpback whales (*Megaptera novaeangliae*) from the North Atlantic Ocean. *Can. J. Zool. - Revue Canadienne de Zoologie* 72(2): 274-79.

Bradford, A.L., Weller, D.W., Wade, P.R., Burdin, A.M. and Brownell, R.L. 2008. Population abundance and growth rate of western gray whales *Eschrichtius robustus*. *Endang. Species Res.* 6: 1-14.

Calambokidis, J., Barlow, J., Ford, J.K.B., Chandler, T.O. and Douglas, A.B. 2009. Insights into the population structure of blue whales in the Eastern North Pacific from recent sightings and photographic identification. *Mar. Mamm. Sci.* 25(4): 816-32.

Carroll, E.L., Patenaude, N., Childerhouse, S., Kraus, S.D., Fewster, R.M. and Baker, C.S. 2011. Abundance of the New Zealand subantarctic southern right whale population estimated from photo-identification and genotype mark-recapture. *Mar. Biol.* 158: 25-65.

Friday, N., Smith, T., Stevick, P. and Allen, J. 2000. Measurement of photographic quality and whale distinctiveness for the photographic identification of humpback whales, *Megaptera novaeangliae*. *Mar. Mamm. Sci.* 16(2): 355-74.

Gendron, D. and Ugalde de la Cruz, A. 2012. A new classification method to simplify blue whale photo-identification technique. *J. Cetacean Res. Manage* 12(1): 79-84.

Hammond, P.S., Mizroch, S.A. and Donovan, G.P. 1990. *Report of the International Whaling Commission (Special Issue 12). Individual Recognition of Cetaceans: Use of Photo-Identification and Other Techniques to Estimate Population Parameters*. International Whaling Commission, Cambridge, UK. [vi]+440pp.

International Whaling Commission. 1990. Report of the Workshop on Individual Recognition and the Estimation of Cetacean Population Parameters, La Jolla, 1-4 May 1988. *Rep. Int. Whaling Comm. (special issue)* 12:3-40.

Knowlton, A.R., Hamilton, P.K., Marx, M.K., Pettis, H.M. and Kraus, S.D. 2012. Monitoring North Atlantic right whale *Eubalaena glacialis* entanglement rates: a 30 yr retrospective. *Mar. Ecol. Prog. Ser.* 466: 293.

Koski, W.R., Zeh, J., Mocklin, J., Davis, A.R., Rugh, D.J., George, J.C. and Suydam, R. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. *J. Cetacean Res. Manage.* 11(2): 89-100.

Mizroch, S.A. and Harkness, S.A.D. 2003. A test of computer-assisted matching using the North Pacific humpback whale, *Megaptera novaenagliae*, tail flukes photograph collection. *Mar. Fish. Rev.* 65(3): 25-37.

Stevick, P.T., Fernald, T., Carlson, C. and Allen, J.M. 2015. Interim Report: IWC Research Contract 16, Antarctic Humpback Whale Catalogue. Paper SC/66a/SH14 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 7pp. [Paper available from the Office of this Journal].

Wedekin, L.L., Neves, M.C., Marcondes, M.C.C., Baracho, C., Rossi-Santos, M.R. and Engel, M.H. 2010. Site fidelity and movements of humpback whales on the Brazilian breeding ground, southwestern Atlantic. *Mar. Mam. Sci.* 26(4): pp.787-802.

Whitehead, H., Coakes, A., Jaquet, N. and Lusseau, S. 2008. Movements of sperm whales in the tropical Pacific. *Mar. Ecol. Prog. Ser.* 361: 291-300.

Annex T

Report of the *ad hoc* Working Group on Interactions between the Scientific Committee and the Conservation Committee

Members: Parsons, Rojas-Bracho (co-Convenors), Arguedas, Montezuma, Bell, Brockington, Cipriano, Cosentino, Donovan, Fortuna, Holm, Iñíguez-Bessega, Leslie, Long, Mattila, Panigada, Rendell, Ritter, Rose, Rowles, Simmonds, Sequeira, Stachowitsch.

1. OPENING REMARKS

Parsons welcomed members.

2. ELECTION OF CHAIR(S) AND APPOINTMENT OF RAPPORTEUR(S)

Parsons was elected Chair, with Rojas-Bracho as co-Chair. Cipriano was appointed rapporteur.

3. ADOPTION OF AGENDA

The Agenda is given as Appendix 1.

4. REVIEW OF AVAILABLE DOCUMENTS

Documents available to the Working Group included: the 2016 Report of the joint Conservation Committee and Scientific Committee Working Group (IWC/M17/CCSC/Info01), the agenda for the 2017 joint Conservation Committee and Scientific Committee Working Group (IWC/M17/CCSC03; whose meeting will be held immediately after SC/67a), the 2016 Conservation Committee Report (IWC/66/Rep05), the Conservation Committee's draft 2016-20 Strategic Plan and the Conservation Committee's 2016-20 work plan. To aid discussions about joint work with the Conservation Committee, the IWC's Five Year Strategic Plan for Whalewatching 2011-16 was also circulated.

5. REVIEW PROGRESS OF THE JOINT INTERSESSIONAL CC/SC WORKING GROUP

Resolution 2014-4 states:

'THE COMMISSION:

DIRECTS the Scientific Committee to continue to improve its work towards conservation-related matters including and increase allocation of funding to conservation oriented research, such as investigation on conservation or mitigation measures, while talking into consideration other core activities as provided by the Convention; and

AGREES to establish a working group between the Conservation Committee and the Scientific Committee in order to propose a procedure to facilitate the implementation and follow up of conservation recommendations.'

The passage of Resolution 2014-4 created the Joint Conservation Committee and Scientific Committee Working Group (Joint CC/SC WG), which first met immediately after the 2016 Scientific Committee meeting (SC/66a). The Scientific Committee routinely deals with a large number of conservation-related issues and has considerable conservation science expertise. The role of the Joint CC/SC WG is to develop a procedure to facilitate the implementation and follow up of conservation recommendations, which could in turn increase the efficiency of communication between the Scientific Committee and Conservation Committee about new and emerging conservation issues. However, the 2016 half day Joint CC/SC WG meeting had limited time to discuss issues and, participants of the *ad hoc* Working Group indicated there was uncertainty on who from the Scientific Committee could attend.

The Scientific Committee's *ad hoc* SC/CC WG was formed by the Scientific Committee Chair, to consider mechanisms to consider ways to enhance communication between the Scientific Committee and Conservation Committee about existing and emerging conservation issues (perhaps, but not necessarily, through the Joint CC/SC WG). This report from the *ad hoc* Working Group will be presented at the 2017 Joint CC/SC WG meeting which will take place immediately after this SC/67a meeting.

Rendell (Vice-Chair of the Conservation Committee) provided an update to the group, on recent activities of the Joint CC/SC WG and its Terms of Reference (see Appendix 2).

As identified in its Terms of Reference, some key roles of the Joint CC/SC WG are to: (a) summarise key conservation-related recommendations; (b) sort these into key issues and key areas; (c) identify recommendations that have or have not been addressed; and (d) investigate strategies for facilitating implementation of conservation-related recommendations.

Rendell drew attention to IWC/66/CC25 (see also IWC/66/Rep05, Item 3.3) and summarised the recommendations made by the Joint CC/SC WG which were endorsed by the Commission at IWC/66. The Joint CC/SC WG has recommended the development of a database for tracking Scientific Committee recommendations relevant to conservation issues and will continue these discussions at its 2017 meeting.

The *ad hoc* Working Group raised the need to consider how the CC/SC WG can better communicate and interact with the Scientific Committee, deal with redundancy in the agendas of these two groups, leverage Scientific Committee expertise to improve the effectiveness of actions responsive to such recommendations, and transfer responsibilities for some conservation-related initiatives that might be implemented more effectively by the Conservation Committee, given its expertise and membership. These considerations will be discussed at the upcoming Joint CC/SC WG meeting.

Some concerns about moving issues from the Scientific Committee to the Conservation Committee were expressed by members of the group, as the Conservation Committee may lack the expertise needed for some issues, and may need Scientific Committee assistance in the development of effective responses to requests from the Commission.

It was noted that there may be a proposal for the Conservation Committee to move to a schedule of annual meetings, to take place either soon after the annual Scientific Committee meetings, or separated in time from Scientific Committee meetings (although having standalone meetings has additional budgetary requirements).

It was also noted that, even if there was an extended Conservation Committee meeting, discussions during that meeting will often need to cover a wide range of issues – even in a two-day meeting, the Conservation Committee can

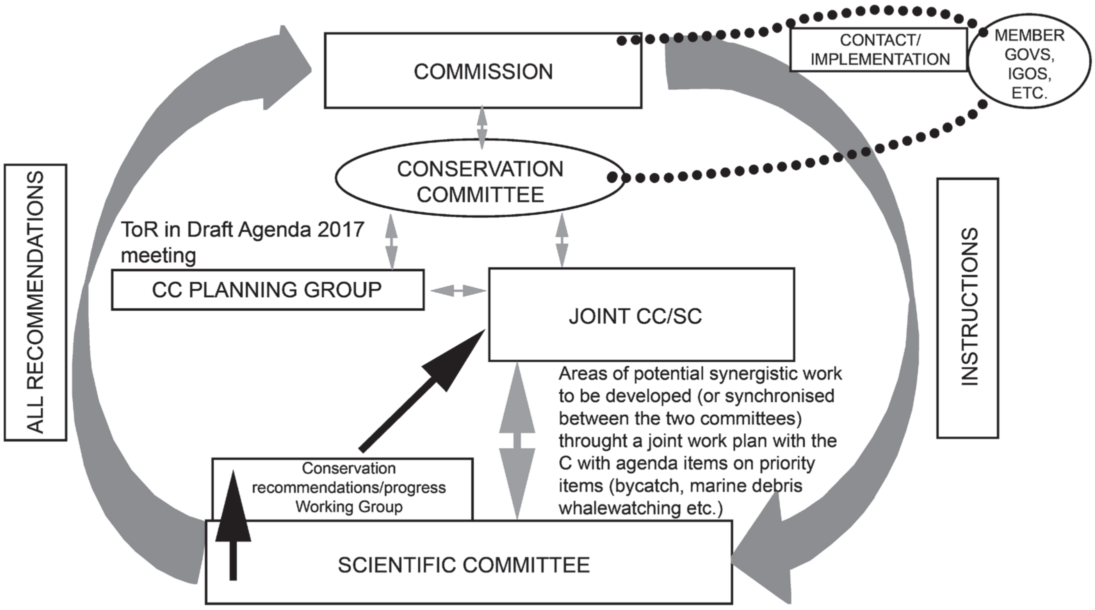

Fig. 1. Proposed Scientific Committee and Conservation Committee communication structure.

receive information and reports, but may not have sufficient time to fully discuss, consider and act upon those issues. Some suggestions for ways to address these concerns were identified (see Item 6).

The draft Conservation Committee Work Plan for the period 2016-20 states the need to '**Establish regular joint meetings (including agreeing Terms of Reference) of the Conservation Committee/Scientific Committee to facilitate the progression of recommendations'. The Conservation Committee Work Plan also calls for progress reports on conservation-related SC recommendations that have been successfully addressed, including 'a report to the Commission synthesising progress in addressing IWC Recommendations on the mitigation and management of anthropogenic noise'.

Moreover, IWC/66/CC25 (see also IWC/66/Rep05, Item 3.3) highlighted the need for identifying, and improved communication about, conservation-related recommendations from the SC, and determining when such recommendations have or have not been successfully addressed. A key goal identified in IWC/66/CC25 was to 'help identify repeated Recommendations in order that the Scientific and Conservation Committee can better target efforts to address the concerns raised'.

Developing a mechanism to review progress on conservation-related scientific recommendations is thus a priority, as with Resolution 2014-4 the Commission:

> 'REQUESTS the Scientific Committee, including its sub-committees and working groups, to improve reporting efficiency by providing consolidated reports covering the two-year intersessional period whenever possible'.

At present, a summary of recommendations, including the highlighting, collating, and summarising of recommendations of importance for the Commission, its bodies and Contracting Governments, is drafted by the Scientific Committee Chair, Vice Chair and the IWC Head of Science, a time consuming and onerous task. The Scientific Committee Chair had requested that the *ad hoc* Working Group should discuss the best internal process to draft such a document in an efficient and timely fashion, before IWC/67.

There was much discussion about how to best compile and prioritise the list of Scientific Committee conservation recommendations. One proposal was that a summary sheet of recommendations relevant to the Conservation Committee be compiled annually by a small *ad hoc* group, with the recommendations being sorted into categories related to Conservation Committee priority topics. It was noted that some additional annotation might be required to explain the context of the recommendations. There was also discussion on whether this compilation could be conducted during the Scientific Committee plenary period (in evening sessions) or whether it would be more effectively and accurately compiled immediately after the Scientific Committee meeting.

Others suggested that the recent exercise to highlight recommendations while compiling the annual Scientific Committee Report currently fulfilled this need.

The *ad hoc* Working Group agreed that no new summary process need be considered. The Joint CC/SC WG should take time to assess the effectiveness of the new format for highlighting recommendations used for the SC/66b and SC/67a Reports.

6. PROCEDURES TO INTERACT WITH THE CONSERVATION COMMITTEE AND OTHER COMMISSION BODIES

6.1 Facilitating Communication between the Scientific Committee, joint CC/SC Working Group, Conservation Committee, and Commission

The relationship between the SC, the Joint CC/SC WG, and the Commission was considered. The current Terms of Reference of the Joint CC/SC WG were presented (Appendix 2).

A wide-ranging and productive discussion ensued, and it was eventually **agreed** that continuation of this *ad hoc* Working Group beyond the current SC was not necessary, although that decision could be re-examined at a later date. Proposed new communication structures amongst the Scientific Committee, Conservation Committee and the CC/SC WG are presented in Fig. 1.

In relation to improving communications between the Scientific Committee and the Conservation Committee, the Working Group **recommended** that in the future a Scientific Committee working group be convened to collate (with assistance from the Secretariat) a draft summary of recommendations and issues related to the Conservation

Committee's Strategic Plan. This can be presented to the joint Conservation Committee and Scientific Committee Working Group for discussion. This new working group would meet near the end of the annual Scientific Committee meetings, and be composed of Convenors of Scientific Committee sub-committees and working groups dealing with Conservation Committee priority topics, and Scientific Committee members familiar with the relevant issues.

The Working Group also **agreed** that a better way to communicate back to Scientific Committee members the priorities of, issues of concern to and activities conducted by the Conservation Committee (and potentially other Commission bodies) was needed.

One approach to accomplish better communication would be to have a briefing by the Scientific Committee Chair and the Secretariat for Convenors soon after the Commission meeting (this could be accomplished by email). The Convenors could then pass the relevant information on to their sub-committees/working groups intersessionally.

To improve the effectiveness of the Conservation Committee, the *ad hoc* Scientific Committee/Conservation Committee Working Group **recommended** that:

(a) the Joint Conservation Committee and Scientific Committee Working Group consider meeting for a longer period to consider agenda items related to each priority topic area; and
(b) the Joint Conservation Committee and Scientific Committee Working Group consider whether membership of the joint Conservation Committee and Scientific Committee Working Group be expanded so that relevant Convenors of Scientific Committee sub-committees and/or key Scientific Committee members could attend the Joint Conservation Committee and Scientific Committee Working Group meetings, depending on agenda. This will allow Scientific Committee members to offer input and assist discussion under relevant priority items (e.g. whalewatching, bycatch, marine debris, ship strikes).

6.2 Priority issues to be considered at intersessional focus meetings

It was suggested that a potential way forward on priority conservation issues – where concentrated, expert scientific input could greatly improve conservation action – is to review the scientific aspects of a priority conservation issue (e.g. bycatch, noise) at an intersessional meeting on a focussed topic, with both Scientific Committee and Conservation Committee members, so that efficient progress can be made on conservation priorities.

A joint session was conducted between the *ad hoc* SC/CC WG and the Sub-Committee on Whalewatching, to discuss how the SC and Conservation Committee (specifically the sub-committee on Whalewatching and the Conservation Committee Standing Working Group on Whalewatching) can improve communication, prevent redundancy and develop joint activities (see Annex N, Item 4.1.2). They proposed an intersessional joint meeting (see the recommendation below for details), which could serve as a model for intersessional collaborations.

The Working Group **agreed** that the intersessional meeting that was proposed by the Sub-Committee on Whalewatching between it and the Conservation Committee's Standing Working Group on Whalewatching – to discuss the latter's new Five-Year Strategic Plan for Whalewatching (see Annex N, Item 4.1.2) – could be a good model to increase Scientific Committee and Conservation Committee collaboration and communication. Similar meetings could be conducted by other sub-committees.

6.3 Synergies between the SC and CC

6.3.1 Interaction between WW and the Conservation Committee Standing Working Group on Whalewatching (joint meeting with WW)

The joint session between the *ad hoc* SC/CC WG and the Sub-Committee on Whalewatching, to discuss how the Scientific Committee and Conservation Committee can improve communication, prevent duplication of efforts and develop joint activities (see 6.2 above and Annex N, Item 4.1.2) was considered to be very successful and could serve as a model for other sub-committees to better communicate and collaborate with the Conservation Committee and progress conservation-related issues.

6.3.2 Terms of Reference of SC sub-committees and relationship to the Conservation Committee

Recognising that several sub-committees of the Scientific Committee have Terms of Reference that are directly relevant to the Conservation Committee's Strategic Plan and priority items, ways of better communicating Conservation Committee areas of interest to Scientific Committee sub-committee members were briefly discussed.

To improve communication between the Conservation and Scientific Committees, the Working Group **recommended** to:

(a) highlight relevant Conservation Committee issues at the beginning of each meeting;
(b) highlight issues of interest to the Conservation Committee as a summary table in the work plans of sub-committees; and
(c) potentially have an agenda item discussing Conservation Committee priorities and discussing potential joint meetings or work in sub-groups agendas.

6.4 Voluntary conservation reports

It was noted that the voluntary conservation reports provided by some Contracting Governments to the Conservation Committee could provide valuable information for both the Scientific Committee and Conservation Committee.

7. PROPOSALS AND WORK PLAN

As it was agreed that the *ad hoc* Working Group had completed its work, no proposals or work plan were discussed.

8. ADOPTION OF AGENDA

The report was adopted at 17:59 on 16 May 2017.

Appendix 1

AGENDA

1. Opening remarks
2. Election of Chair(s) and appointment of rapporteur(s)
3. Adoption of Agenda
4. Review of available documents
5. Review progress of the Joint Intersessional Working Group CC/SC
6. Procedures to interact with the Conservation Committee and other Commission bodies
   - 6.1 Terms of Reference of SC/CC group
   - 6.2 Consideration of intersessional focus meetings
   - 6.3 Synergies between the SC and CC
     - 6.3.1 Interaction between WW and the CC WW WG
     - 6.3.2 Terms of Reference of SC sub-committees and relationship to the CC
   - 6.4 Progress reports and voluntary conservation reports
7. Proposals and work plan
8. Adoption of Report

Appendix 2

TERMS OF REFERENCE FOR THE JOINT CONSERVATION COMMITTEE AND SCIENTIFIC COMMITTEE WORKING GROUP

The Joint Conservation Committee and Scientific Committee Working Group (CC/SC WG) is tasked with facilitating the communication, implementation, and follow-up of conservation recommendations.

The CC/SC WG shall:

(1) review, collate and prioritise conservation recommendations made by the Scientific and Conservation Committees where further efforts/actions are needed, in the first instance focussing on those from 2010 onwards;
(2) report, as appropriate, to the Commission on progress in delivering conservation recommendations;
(3) develop clear procedures/strategies for effectively transmitting and facilitating the implementation of conservation recommendations to and from the CC/SC WG to the appropriate Committees and sub-committees/ working groups, including for further technical work;
(4) provide advice to the Conservation Committee on those priority conservation recommendations it could assist in implementing;
(5) provide feedback to the Scientific Committee on further advice and/or actions to assist in the implementation of conservation recommendations; and
(6) respond to specific requests for support in facilitating the implementation of conservation recommendations from the Scientific and/or Conservation Committees.

The CC/SC WG will be comprised of nominees from the Scientific Committee, Conservation Committee and Contracting Governments. Additional expertise may be included as appropriate at the discretion of the Scientific Committee and Conservation Committee Chairs.

Annex U

Statements on the Agenda

ANNEX U1

STATEMENT BY THE ICELANDIC, JAPANESE AND NORWEGIAN DELEGATIONS CONCERNING DNA REGISTER SYSTEMS

Members of the Scientific Committee and the Commission are aware that the Governments of Iceland, Japan and Norway have, on a voluntary basis, implemented national DNA register systems to provide for effective monitoring of whale meat products in the market and that information on these DNA register systems has been provided to the Commission.

This statement is to reassert the position of the Governments of Iceland, Japan and Norway that the monitoring of markets is outside the jurisdiction and competence of the IWC and that for this reason, inclusion of items related to DNA identification of market products on the agenda of the Scientific Committee and its Working Groups is inappropriate. For this reason, representatives of the Governments of Iceland, Japan and Norway and their appointed scientists will not participate in Scientific Committee discussions of this matter.

However, the Governments of Iceland, Japan and Norway will provide additional information on their DNA register systems as they deem appropriate including information on technical aspects of these systems. Further, we urge that the future work of the Scientific Committee on matters related to the use of DNA technologies and analyses take the position of our Governments into account. In this regard, documents dealing with the marketing of whale meat products should not be submitted to or discussed by the Scientific Committee.

ANNEX U2

STATEMENT BY THE JAPANESE DELEGATION CONCERNING WHALEWATCHING

It is the Government of Japan's position that whalewatching is outside the competence of the IWC. Further, the IWC has limited financial and human resources and should be focusing its efforts on important matters such as stock assessments.

ANNEX U3

STATEMENT BY THE JAPANESE DELEGATION CONCERNING SMALL CETACEANS

Resolution 1999-9 on Dall's porpoise is clearly outside the jurisdiction of the IWC and therefore Japan continues not to provide data concerning small cetaceans at this year's Scientific Committee meeting. Furthermore Japan will not participate in the meeting of the Standing Sub-Committee on Small Cetaceans and discussions in other Sub-Committees and/or Working Groups where issues on small cetaceans be dealt with. It is unfortunate that the political attempt to expand the scope of the IWC's influence to include small cetaceans by Resolution 1999-9 has prevented the continued voluntary scientific co-operation of Japan in the field of small cetaceans.

However Japan will make its data on small cetaceans available following this year's Scientific Committee meeting through appropriate means such as the website of the Fisheries Agency of Japan. Finally although Japan may not make any comments on the draft report of the Standing Sub-Committee on Small Cetaceans and relevant parts of draft reports related to small cetaceans prepared by other Sub-Committee and/or/or Working Group, this should in no way be taken to mean that Japan concurs with or supports the contents of the report.

ANNEX U4

STATEMENT BY THE RUSSIAN FEDERATION CONCERNING THE AGENDA

The Russian Federation has stated repeatedly the objections on spreading IWC jurisdiction beyond the Convention boundaries. Items 13 (Bycatch), 17 (Small Cetaceans) and 18 (Whalewatching) of the proposed Agenda are such a case. Russian delegates will participate in discussions on the above-mentioned items and will present the data but that will be done on voluntary basis. All Scientific Committee recommendations on these items will not be considered as obligatory by the Russian Federation.

ANNEX U5

STATEMENT BY THE JAPANESE DELEGATION CONCERNING CONSERVATION MANAGEMENT PLANS (CMP)

Japan has committed to conservation of threatened whale stocks including the western gray whale. With this in mind, every year, it submitted 'Status report of conservation and researches on the western North Pacific gray whales in Japan' to the Sub-Committee on Bowhead, Right and Gray Whales (BRG), and has decided to continue the submission of the same document to the Sub-Committee on Conservation Management Plans (CMP) responding to the recent reformulation of sub-committees. However, it must not be construed to prejudice Japan's position that the Conservation Committee is not consistent with the International Convention for the Regulation of Whaling because the Committee negates one of the objectives of the Convention: sustainable use of whales.

Annex V

Matters Related to Working Methods

1. BACKGROUND INFORMATION

This document summarises issues raised during the intersessional period that are relevant for Committee working methods (known as 'SC Handbook') and Rules of Procedure discussion and proposes potential solutions for full consideration by the Committee. The objective is to agree a consolidate set of revisions to working methods and Rules of Procedure at the 2018 meeting, which will be forwarded to the Commission for its endorsement.

The following sub-sections summarise issues related to: (i) communication within the Committee; (ii) RoPs on Invited Participants, Observers and Local Scientists; (iii) role and genesis of the Convenors group; and (iv) RoPs and best practices on meeting papers.

Finally, an Appendix is provided that updates the 'IWC Southern Ocean Research Partnership Research Fund: Assessment Panel and Criteria'.

1.2 Communicating with the whole Committee, the Commission and other of its Bodies

When introducing changes in organisational aspects of the Committee, it is clear that maintaining good communication channels and procedures is important for reducing unnecessary misunderstandings. Formal communication with the whole Committee is through circulars sent out by the Secretariat to the SC emailing list, which includes SC members of the past 2-3 years. Communication with intersessional groups, including the Convenors' group, is through specific emailing lists (see *https://iwc.int/correspondence-groups*). The Committee Chair and the Secretariat maintain the communication between the Commission and its other bodies. The Committee Chair has an institutional email (*sc.chair@iwc.int*) which is available to all.

Recent structural changes in the organisation of the Committee (i.e. number and scope of sub-committees and working groups; biennial workplan and priorities) have been handled by different Convenors in different ways. Some used the existing 2016 sub-committees and working group emailing lists to communicate intersessionally with their members. However, to avoid misunderstanding on sub-groups' agendas and priority topics (e.g. issues on declining papers) and to improve discussions at the next SC meeting (e.g. correct timing for organising joint sessions and discussing cross-cutting topics/species), the SC Chair and Convenors/Co-Convenors will take steps to ensure that a more structured intersessional exchange on the annotations of the Draft SC Agenda will be carried out, which will provide full details well before the deadline for submission of the draft SC Agenda.

1.2 Intersessional groups *[to be used to update the SC Handbook]*

There are three types of intersessional groups.

Steering Groups (SG): these are groups that have been set up to ensure that particular meetings, workshops or identified pieces of work are completed by SC/67a. They have the authority to make decisions on behalf of the Committee within the context of their terms of reference (e.g. not exceeding budget, agreeing participants, agreements on parameters for analyses). Their size is limited and members are agreed at the meeting although the Convenor may request additional members or respond to late requests to be members. The expected outcomes will be either a workshop/meeting report or an analytical paper.

Intersessional Correspondence Groups (ICG): these are groups that have been set up to ensure progress on particular topics within the intersessional period. Membership is more flexible and open. It is expected that a written report/working paper on their progress will be submitted to the appropriate sub-group or to the Committee at the annual meeting after the intersessional period.

Advisory Groups: these are occasional groups established by the Committee to provide scientific and technical advice on specific issues if requested by a Contracting Government or the Scientific Committee.

All these groups need to be confirmed annually or they are automatically eliminated.

2. INFORMATION ON SCIENTIFIC COMMITTEE CODE OF CONDUCT AND RULES OF PROCEDURE

2.1 Types of Scientific Committee members *[to be used to update the SC Handbook]*

According to our Rules of Procedure, the Scientific Committee comprises of four types of participants:

(1) *National Delegates* ('scientists' nominated by the Commissioner of each Contracting Government; this category includes delegates identified by CGs and that are granted support from the Fund to Strengthen the Capacity of Governments of Limited Means to Participate in the Work of the IWC).
(2) *Invited Participants* ('qualified scientists' necessary to further the SC workplan and agenda).
(3) *Observers* from Inter-Governmental Organisations, non-member governments and accredited Non-Governmental Organisations ('representatives with particular relevance to the work of the Scientific Committee', representatives and 'scientifically qualified observer[s]' respectively).
(4) *Local scientists* (self-nominated scientists connected with Universities, other scientific institutions or organisations of the country where the Annual meeting takes place).

Thus National Delegates are expected to be primarily scientists. IPs and observers must have scientific background with 'relevant expertise'. IPs' presence should be based on their particular relevance to the work of the Scientific Committee in any given year.

All Committee members must be accredited. National Delegates and Observers are accredited by Contracting Governments, IGOs and 'accredited NGOs' through Credentials (see Commission's Rule of Procedure C). The Chair of the Scientific Committee decides upon the acceptability of accredited NGO nominations but may only reject a nomination after consultation with the Chair and Vice-Chair of the Commission (see Item 2.2. below). Invited Participants and local scientists are accredited by the Chair of the Scientific Committee through a formal Letter of Invitation sent by the Secretariat.

Remote participation is now possible only for specific meetings and sessions and it does require to be accredited through one of the above categories. Remote participation may entail the signing of a confidentiality agreement.

Heads of National Delegations are the only voting members of the Committee.

2.2 Acceptability of nominations and rejection procedure *[to be used to update the SC Handbook]*

The Chair of the Scientific Committee decides upon the acceptability of any nomination (except those of National Delegates). Nominations can be rejected only after consultation with the Chair and Vice Chair of the Commission.

2.3 Nomination deadlines *[to be used to update the SC Handbook]*

The Rules of Procedure identify nomination deadlines for attendees at the Scientific Committee.

(1) National Delegates (by Contracting Government), Observers (by IGOs and accredited NGOs): 45 days before the annual meeting.
(2) Invited Participants (by SC chair and convenors): 120 days before the annual meeting.

In exceptional circumstances, the SC Chair, in consultation with the Convenors and Secretariat, may waive the above time restrictions.

2.4 Invitation letter for Invited Participants and Rules of Debate *[to be used to update the SC Handbook]*

The Secretariat sends an invitation letter 60 days before the Annual meeting.

Under the Committee's Rules of Procedure, Invited Participants may present and discuss papers, and participate in meetings (including those of subgroups). They are entitled to have access to all Committee documents and papers.

Invited Participants may participate fully in discussions pertaining to their area of expertise. However, discussions of Scientific Committee procedures and policies are in principle limited to Committee members nominated by member governments.

Invited Participants are also urged to use their discretion as regards their involvement in the formulation of potentially controversial recommendations to the Commission (i.e. management recommendations); the Chair (of the Plenary or sub- group meetings, i.e., sub-committee or working group) may at their discretion rule them out of order.

2.5 Scientific and Working Papers *[to be used to update the SC Handbook]*

Any scientist (i.e. not only those accredited for attendance) may submit a scientific paper for consideration by the Committee. Papers must be based on science and facts and shall not contain disrespectful statements to any participating person, organisation or government.

Scientific papers will be considered for discussion and inclusion in the papers of the Committee only if they are received by the Secretariat on or by the end of the first day of the annual Committee meeting, intersessional meeting or any sub-group. Exceptions to this rule may be granted by the Chair of the Committee, where there are extenuating circumstances.

Working papers must be submitted to the Chair (of the Plenary or sub-group meetings) who may reject them at their discretion. Working papers are intended to expedite resolution of disagreements or stimulate debate within the meeting. They officially disappear at the end of the meeting unless appended to the Committee or sub-committee reports with the author's permission, or with the agreement of the Chair and the Head of Science, be upgraded to a primary paper (See the SC handbook for more details).

2.5.1 Deadlines for meeting papers [to be used to update the SC Handbook]

Given a constantly increasing workload, the restructuring of some aspects of the Committee's work and the move to a biennial workplan, it is important not to waste Committee members' energy in preparing manuscripts that will not be discussed at a specific meeting. It is, therefore, proposed to reinstate a formal process through circular communications to encourage the submission to the relevant convenor(s) of a 'tentative title and brief description of likely content of potential papers' for approval by convenor(s). These Circulars could be sent after the Committee meeting in Autumn and at the beginning of each year. They will encourage the submission to a dedicated email address (e.g. *tentativepapers@iwc.int*) of the Secretariat of: (a) a title; (b) very brief description of likely content; and (c) potential relevant sub-group/s, to be submitted. Possible 'informal deadlines' for these pre-submissions could be at any time during the year, but certainly at least six weeks before the 'documents deadline' (i.e. seven weeks before the current pre-deadline document and eight weeks before the current official deadline on the first day of SC plenary).

Practical ways to forward this information to relevant Convenors/Co-Convenors will be explored immediately after this meeting. It is necessary that all tentative draft Agendas and workplans of all sub-groups are made available as background material.

If the Committee wants to introduce a change in the official deadline on the 'first day of Plenary', this is the paragraph that needs amending:

> E. Scientific Papers and Documents
>
> […]
>
> 4. Scientific and Working Papers.
>
> […]
>
> (b) Scientific papers will be considered for discussion and inclusion in the papers of the Committee only if the paper is received by the Secretariat on or by the first day of the annual Committee meeting, intersessional meeting or any sub-group. Exceptions to this rule can be granted by the Chair of the Committee where there are exceptional extenuating circumstances.
>
> […]

3. PROCESS TO IDENTIFY INVITED PARTICIPANTS

3.1 Who is in charge?

The identification of Invited Participants is the duty/right of the Chair of the Scientific Committee, supported by the Convenors/Co-convenors of all sub-committees and working groups, no matter the funding source. See 3.2 for details on convenors' appointment and potential adjustments. The process is outlined in our Rules of Procedure and its interpretation has been developed over many years. The primary objective with respect to an IP is that the Chair and convenors agree that the person can make a positive contribution to the work of the Scientific Committee at a particular meeting.

3.2 Types of Invited Participants and their evaluation

As noted in the Scientific Committee Handbook, IPs fall into two broad categories: (a) those who are nominated by the Chair/Convenors (i.e. experts that are needed to advance the work of the SC at any particular meeting) that are funded by the IWC if money is available; and (b) those that are self-funded but whom the convenors and the Chair agree can make a useful contribution. In terms of need to prove their necessary expertise and scientific qualities or need to be accredited, there are no differences between these two categories. However, for the latter (and for observers) the requirement is that they have sufficient background to understand the technical discussions for which they will be contributing. In recent years, it has been practice to ask new IPs to submit a short CV explaining their background to allow the Chair, in consultation with the Head of Science and the relevant convenor/s, to determine suitability using their best judgement.

In terms of evaluating the scientific qualifications of potential IPs, there is no formal requirement that they have a specific level of academic degree or have been a primary author of a paper - the need is for the CV to allow a judgment of their ability to contribute to the Committee's work on one or more topics. Their acceptability is usually based on their relevance to the work of the Scientific Committee in any given year.

As noted in the SC Rules of Procedure, rejections of IPs or Observers can be decided only upon consultation with the Chair and Vice Chair of the Commission.

Convenors themselves maybe Invited Participants and are selected directly by the SC Chair and Vice-Chair (with advice from the Head of Science), being a form of 'Friends of the Chair' type of group[1] (see section 5 below for the full rationale on this).

3.3 Potential inconsistencies

The Committee's RoPs on: (a) the process of identifying IPs; (b) establishing the final list; and (c) send out invitations are not straightforward and need some tidying. See section 4 below.

National Delegates are not required to demonstrate their scientific eligibility to contribute to the Committee's work. The evaluation of their scientific quality and relevant experience is the responsibility of Governments. The Commission does not have an equivalent set of working methods and procedures to codify this.

4. CURRENT RULES OF PROCEDURE AND PROPOSED CHANGES

[Key changes: (1) ***added text***; (2) ~~deleted text~~.]

4.1 National Delegates and Secretariat

This is the existing rule relevant to National Delegates designation:

1. The Scientific Committee shall be composed of scientists nominated by the Commissioner of each Contracting Government which indicates that it wishes to be represented on that Committee. Commissioners shall identify the head of delegation and any alternate(s) when making nominations to the Scientific Committee. ***National delegates are also those that are granted support from the Fund to Strengthen the Capacity of Governments of Limited Means to Participate in the Work of the IWC.*** The Secretary of the Commission and relevant members of the Secretariat shall be ***ex-officio*** non-voting members of the Scientific Committee.

Note, an '*ex officio* member' is a member of a body who is part of it by virtue of holding another office.

4.2 Inter-Governmental Organisations and Non-Contracting Governments

This is the existing rule relevant to IGOs and non-CGs representatives (observers) designation. No changes are proposed.

2 The Scientific Committee recognises that representatives of Inter-Governmental Organisations with particular relevance to the work of the Scientific Committee may also participate as non-voting members, subject to the agreement of the Chair of the Committee acting according to such policy as the Commission may decide.

3. Further to paragraph 2 above the World Conservation Union (IUCN) shall have similar status in the Scientific Committee.

4. Non-member governments may be represented by observers at meetings of the Scientific Committee, subject to the arrangements given in Rule C.1(a) of the Commission's Rules of Procedure.

4.3 Non-Governmental Organisations

Based on recent requests, it is considered appropriate to extend, in an official manner, the Observer status also to representatives of scientific organisations not directly dealing with cetaceans (e.g. focusing on other marine mammals), and/or we modify the status of "local scientists" to include non-local ones (see section 4.5). In addition, Observer status should be also extended to representatives of industries relevant to the Scientific Committee's discussions in any specific meeting (e.g. technical experts from the oil and gas industry in the Sakhalin area:

5. Any non-governmental organisation accredited by the Comm-ission under its Rule of Procedure C.1(b), ***scientific organisations and representatives of relevant industries (e.g. technical representatives from 'Institutions', 'Enterprises' or 'commercial operations')*** [attention: see section 4.4. and 4.5 and modify accordingly] may nominate a scientifically qualified observer to be present at meetings of the Scientific Committee. Any such nomination should reach the Secretary 45 days before the start of the meeting in question and should specify the scientific qualifications and relevant experience of the nominee. The Chair of the Scientific Committee shall decide upon the acceptability of any nomination but may reject it only after consultation with the Chair and Vice Chair of the Commission. Observers admitted under this rule may submit documents in accordance with Rule E of the Scientific Committee, participate in discussions and have access to all meeting documents.

4.4 Invited Participants

Based on recent cases, some amendments to the SC RoPs are proposed as follow:

6. The Chair of the Committee, acting according to such policy as the Commission or the Scientific Committee may decide, may invite qualified scientists ***or experts in technical matters relevant to its Agenda*** not nominated by a Commissioner to participate by invitation ~~or otherwise~~ in committee meetings as non-voting contributors. They may present and discuss documents and papers for consideration by the Scientific Committee, participate on sub-committees ***and working groups***, and they shall receive all Committee documents and papers.

   W***here expenditure is proposed in support of invited participants, the following will apply:***

   (a) candidates will be selected through consultation among the Chair of the Scientific Committee, the Convenor of the appropriate sub-committee or working group and the Head of Science [footnote: Note that Convenors and Co-convenors are selected by the Chair and Vice-Chair of the Scientific Committee in consultation with the Head of Science];

   (b) all Contracting governments will be advised of all invitations. If, following this, some scientists are no longer an Invited Participant ~~but~~ and becomes a National Delegate or a self-funded IP, they lose the funding from the SC budget.

   (~~a~~***c***) Convenors will submit suggestions for Invited Participants (including the period of time they would like them to attend ***and a reference to the relevant group/s where they are expected to focus their expertise***) to the Chair (copied to the Secretariat) not less than four months before the meeting in question. The

[1]The term "Friends of the Chair" is an official technical term used in IGOs that generated within the UN. A 'friend of the chair' is '*a delegate who has been mandated by the presiding officer to undertake a task, usually that of finding consensus on a particular issue or body of issues*'. "Friends of the Chair" is '*a contact group convened by the presiding officer*'. Source: 'A Glossary of Terms for UN Delegates'. Published by the United Nations Institute for Training and Research (UNITAR). ISBN: 92-9182-036-8.

Convenors will base their suggestions on the priorities and initial agenda identified by the Committee and Commission at the previous meeting. The Chair may also consider offers from suitably qualified scientists to contribute to priority items on the Committee's agenda if they submit such an offer to the Secretariat not less than four months before the meeting in question, providing information on the contribution they believe that they can make. Within ~~two weeks of this~~ ***three and a half months before the relevant meeting***, the Chair, in consultation with the Convenors and Secretariat, will develop a list of invitees. ***This 'four months' provision may be waived by the Chair in special circumstances.***

(~~b~~***d***) The Secretary will then promptly issue a letter of invitation to those potential Invited Participants suggested by the Chair and Convenors. That letter will state that there may be financial support available, although invitees will be encouraged to find their own support. Invitees who wish to be considered for travel and subsistence will be asked to submit an estimated airfare (incl. travel to and from the airport) to the Secretariat, within 2 weeks ***of receiving an invitation letter***. ~~Under certain circumstances (e.g. the absence of a potential participant from their institute), the Secretariat will determine the likely airfare~~.

~~At the same time as (b), a letter will be sent to the governments of the country where the scientists is domiciled for the primary purpose of enquiring whether that Governments would be prepared to pay for the scientist's participation. If it is, the scientist is no longer an Invited Participant but becomes a national delegate~~.

(~~c~~***e***) At least three months before the meeting, the Secretariat will supply the Chair with a list of participants and the estimated expenditure for each, based on: (1) the estimated airfare; (2) the period of time the Chair has indicated the IP should be present and (3) a daily ~~subsistence rate~~ ***total cost*** based on the actual cost of the hotel deemed most suitable by the Secretary and Chair [as footnote: "Invited participants who choose to stay at a cheaper ~~hotel~~ ***accommodation*** will receive the actual rate for their ***accommodation*** ~~hotel plus the same daily allowance~~"], plus an appropriate daily allowance.

~~At the same time as (c), a provisional list of the proposed Invited Participants will be circulated to Commissioners, with a final list attached to the Report of the Scientific Committee.~~

~~(d)~~ The Chair will review the estimated total cost for all suggested participants against the money available in the Commission's budget. Should there be insufficient funds, the Chair, in consultation with the Secretariat and Convenors where necessary, will decide on the basis of the identified priorities, which participants should be offered financial support and the period of the meeting for which that support will be provided. Invited Participants ~~without IWC support, and those~~ not supported for the full period, may attend the remainder of the meeting at their own expense.

(~~e~~***f***) At least two months before the meeting, the Secretary will send out formal confirmation of the invitations to all the selected scientists, in accordance with the Commission's Guidelines, indicating where appropriate that financial support will be given and the nature of that support. ***The letter of invitation to Invited Participants will also include the following provisions:***

Under the Committee's Rules of Procedure, Invited Participants may present and discuss papers, and participate in meetings (including those of subgroups). They are entitled to access all Committee documents and papers. They may participate fully in discussions pertaining to their area of expertise. However, discussions of Scientific Committee procedures and policies are in principle limited to Committee members nominated by member governments. Such issues will be identified by the Chair of the Committee during discussions. Invited Participants are also urged to use their discretion as regards their involvement in the formulation of potentially controversial recommendations to the Commission; the Chair may at his/her discretion rule them out of order. [Note: This text is the full ex-paragraph (g) lifted up from below]

(f***g***) In exceptional circumstances, the Chair, in consultation with the Convenors and Secretariat, may waive the above time restrictions.

~~(g) The letter of invitation to Invited Participants will include the following ideas:~~

~~Under the Committee's Rules of Procedure, Invited Participants may present and discuss papers, and participate in meetings (including those of subgroups). They are entitled to receive all Committee documents and papers. They may participate fully in discussions pertaining to their area of expertise. However, discussions of Scientific Committee procedures and policies are in principle limited to Committee members nominated by member governments. Such issues will be identified by the Chair of the Committee during discussions. Invited Participants are also urged to use their discretion as regards their involvement in the formulation of potentially controversial recommendations to the Commission; the Chair may at his/her discretion rule them out of order.~~

~~(h) After an Invited Participant has his/her participation confirmed through the procedures set up above, a Contracting Government may grant this person national delegate status, thereby entitling him/her to full participation in Committee proceedings.~~

4.5 Local Scientists

See section 4.3 above for the reasoning of the potential the amendment proposed here:

7. A small number of interested ~~local~~ scientists may be permitted to observe at meetings of the Scientific Committee on application to, and at the discretion of, the Chair. Such scientists should be connected with the ~~local~~ Universities, other scientific institutions or organisations, and should provide the Chair with a note of their scientific qualifications and relevant experience at the time of their application. ***For logistical reasons, requests should be sent at least two weeks before the annual meeting.***

5. CONVENORS' GROUP *[TO BE USED TO UPDATE THE SC HANDBOOK]*

The 'Convenors' group' comprises the Chair, Vice-Chair, Head of Science, Secretary to the Commission, Secretariat computing manager, Convenors and Co-Convenors.

All Committee members are eligible to become Convenors or Co-convenors. This group is there to assist the Chair and Vice-Chair and part of the function is to act as 'Friends of the Chair' type of group (see footnote in section 3.2). They are directly identified by the Chair and Vice-Chair (with advice from the Head of Science), which usually consult with other members of the Scientific Committee (see below for more details on the appointment process). A Co-convenor may be appointed to assist the Convenor of a sub-group, gain experience in chairing and learn Committee procedures.

The role of the Committee's Chair and all Convenors is largely administrative and is to ensure that: (a) the Committee functions properly (in line with the Committee's Rules of Procedure and the Commission's instructions); (b) all matters on the Committee's Agenda are discussed and that the necessary expertise is available during meetings to do so; and (c) that clear scientific advice is delivered to the Commission. It is not their role to represent positions of Governments or others but rather to be sensitive to all different viewpoints. The composition of the group may change annually due to contingencies or rearrangement of the subcommittees and working groups (e.g. in 2017 there are 16 different subgroups, compared to 13 in 2016 and potentially in 2018).

Requirements to be appointed as Convenor/Co-convenor include appropriate scientific background and/or chairing experience, knowledge of Committee procedures and appropriate communication skills. Being perceived as balanced and fair SC member is also a desirable characteristic.

To emphasise the fact that the Convenors/Co-Convenors are the appointment of the Chair and Vice-Chair, it is suggested that in practical terms, the last day of the Scientific Committee meeting of the year of the appointment of a new Vice-Chair and the inception of the new chair, it shall be assumed that all Convenors/Co-Convenor have completed their terms. However, the new Chair and Vice-Chair retain the right to reconfirm Convenors/Co-Convenors for the following term, if they are available and willing. This will be usually done at the annual post-meeting of the Convenors. This will emphasise that the SC Chair and Vice-Chair retain discretion on the composition of the group that will work with them. It must be understood that SC Chair and Vice-Chair, in consultation with the Head of Science, can replace or invite Convenors/Co-Convenors whenever is necessary within each biennium.

The Convenor's responsibilities can be summarised as follows.

Intersessionally:

(1) to facilitate intersessional progress on identified tasks including providing advice to the Chair as appropriate;
(2) to identify potential invited participants for their sub-group (i.e. sub-committee and working group), in consultation with their sub-groups participants; and
(3) to assist the Secretariat during the intersessional editorial work for the publication of the final annexes and report.

At the annual meeting:

(1) to develop the draft agenda for the sub-group's work for discussion and agreement at an organisational meeting of the sub-group;
(2) when elected chair (as is normally the case, unless there is a formal objection from the floor) by the sub-group at its opening meeting, they are expected:
   (a) to meet daily in the Convenors' group to determine the business and timetable for the coming days;
   (b) to provide advice to the Chair on other meeting-related matters should they arise;
   (c) to chair the sub-groups meetings efficiently and fairly and if necessary establish small expert groups;
   (d) to authorise working papers should they be deemed necessary (see below);
(3) to recruit and appoint rapporteurs and ensure the sub-group's report follows the guidelines for reports, to present a summary of the sub-group report to the full Plenary and to provide an initial draft for the relevant sections of the Plenary report;
(4) to develop with other members of the Convenors' Group a prioritised list of workshops, studies, or other projects proposed for funding (that list needs to be made available to the full Committee at least by 6pm on the penultimate day of the Scientific Committee Annual Meeting);
(5) to ensure that the final version of the sub-group report is completed by the end of the day after the Scientific Committee meeting;
(6) to meet in the Convenors' group the day after the Scientific Committee meeting to finalise the draft workplan for the coming year(s) to be submitted to the Commission.

6. SOUTHERN OCEAN RESEARCH PARTNERSHIP (IWC-SORP)

A revised process for reviewing SORP projects proposals, endorsed by the Committee this year, is given in Appendix 1.

Appendix 1

IWC SOUTHERN OCEAN RESEARCH PARTNERSHIP RESEARCH FUND: NEW ASSESSMENT PANEL AND CRITERIA

This appendix contains agreed adjustments to the existing evaluation procedure to select for fund IWC-SORP project proposals (see Annex W; IWC, 2017). In particular, the agreed adjustments concern the composition of the Assessment Panel and criteria.

New assessment Panel

The new IWC-SORP Assessment Panel comprises the following Scientific Committee members:

(a) Chair of the Scientific Committee (leading the Assessment process);
(b) Vice-Chair of the Scientific Committee;
(c) IWC Head of Science (IWC Secretariat);
(d) current Convenor of the SH sub-committee;
(e) two to three ex-Convenors of the SH sub-committee;
(f) a representative from the IWC-SORP Secretariat;
(g) Chair and Vice-Chair of the IWC-SORP Scientific Steering Committee; and
(h) additional members deemed necessary by the SC Chair to facilitate the assessment of proposals. These assessors will be drawn from the Scientific Committee.

New assessment criteria

The text and criteria are explained below; these criteria will be included in guidelines to applicants that will be published when the new Call for Proposals is announced. Both the criteria and the text will be included in a wider document circulated to the Assessment Panel to help them complete an assessment of any proposals received, with which they have no Conflict of Interest.

Applications will be assessed and scored on scientific merit and relevance for the Scientific Committee priorities (a maximum of 35 points). Proposals will be ranked based on these scores and a threshold score for funding will be identified based on quality and available funds. Generally, only projects that score 3 or above for Criterion 1, will be considered for funding.

The applications are assessed for scientific merit against seven criteria, each of which is scored between 0 - 5 as shown in Table 1.

Assessing meeting/workshop/event proposals

If the application concerns a meeting, workshop or an event, consider whether the applicants have demonstrated the importance of the activity in facilitating the scientific work/progress of IWC/SC and IWC-SORP projects and priorities.

Table 1

Evaluation criteria and scoring.

Criteria	Weighting [Each criterion is scored to a maximum of 5 out of 35. Applicants must score 3 or above for Criterion 1 to be considered for funding.]
1. How well will the scientific outcomes of the project contribute to IWC-SORP and IWC/SC research priorities for Southern Ocean cetaceans?	• No contribution (0) • Poor contribution (1) • Reasonable contribution (2) • Good contribution (3) • Very good contribution (4) • Excellent contribution (5)
2. Will the project deliver novel studies or analyses facilitated by broad collaboration within the IWC-SORP Partnership and the IWC/SC?	• Existing, stand-alone project with no apparent need for broad collaboration (0) • Collaboration within the IWC/SC but less apparent need for collaboration within IWC-SORP (1-2) • Collaboration apparent between some IWC-SORP Partnership and IWC/SC members (3-4) • Highly collaborative project including many IWC-SORP Partnership and IWC/SC members (5)
3. Does the project have a wide geographic scope and/or applicability across multiple regions?	• Project has little applicability to Southern Ocean research (0) • Project focusses on a single, relatively restricted geographic region and has little applicability elsewhere (1) • Project focusses on two or more regions but has little applicability elsewhere (2) • Project captures two or more regions and is applicable across a wider geographic area (3) • Project captures multiple regions throughout the Southern Ocean and/or has demonstrated circumpolar relevance (4-5)
4. Does the proposal demonstrate that the proposed methodology and data analyses are suitable to deliver the stated objectives?	• Not demonstrated (0) • Poor methodology/data analyses (1) • Reasonable methodology/data analyses (2) • Good methodology/data analyses (3) • Very good methodology/data analyses (4) • Excellent methodology/data analyses (5)
5. Have the applicants demonstrated co-investment or the potential for the project to leverage co-investment/vessel time etc. if funded?	• Not demonstrated (0) • Little co-investment demonstrated (1) • Partial co-investment demonstrated (2) • Partial co-investment and potential for leverage (3) • Full co-investment but no potential for leverage (4) • Full co-investment1 demonstrated and potential for leverage (5)
6. Is the research proposed feasible, well budgeted, well organised and with a timeline allowing for the achievement of all objectives?	• Not demonstrated (0) • Feasibility, budget, organisation and timeline unrealistic (1) • Feasibility, budget, organisation and timeline not properly addressed (2) • Feasibility, budget, organisation and timeline may not allow all main objectives to be achieved (3) • Feasibility, budget, organisation and timeline indicate that most main objectives are likely to be achieved (4) • Feasibility, budget, organisation and timeline very likely to result in all objectives being achieved (5)
7. Do you consider the Chief Investigator and research team to have appropriate track record/s, including publishing in peer reviewed literature and/or delivery into the policy and management arena? *Please consider early career research scientists relative to their stage of career. Scores accommodate consideration of career maturity.*	• Not demonstrated (0) • Poor record (1) • Reasonable record (2) • Good record (3) • Very good record (4) • The CI and research team have excellent track record/s including publishing, management delivery and grant performance (5)
Overall total out of 35	

Assessing proposals for activities that provide ongoing contributions/support of projects

If the application concerns the support of ongoing efforts that contribute to existing projects but are not intrinsically innovative, collaborative or candidates for co-investment[2], *inter alia* matching of photographic-identifications or database development/management, consideration should be given to the overall importance of the activity in supporting and facilitating the scientific work/progress of IWC/SC and IWC-SORP projects and priorities.

[2]Full co-investment is defined as external contributions to the proposed project that approximately equal or exceed that requested from the IWC-SORP Research Fund. Partial co-investment is defined as external contributions that are cumulatively less than that requested. Co-investments can include both financial and/or in kind support, e.g. scientific equipment, personnel, vessel time/berths.

Assessing proposals for a new IWC-SORP Theme

If applicants propose a new IWC-SORP Theme, they need to show that:

(1) the project will make a substantial contribution to IWC-SORP and IWC/SC priorities;
(2) the project and PIs will strongly benefit from the multi-national collaborations that result from being part of IWC-SORP;
(3) the project will have sufficient support and longevity; and
(4) the project will have sufficient level of co-investment or potential for leveraging additional support/vessel time, etc., demonstrated.

REFERENCE

International Whaling Commission. 2017. Report of the Scientific Committee. Annex W. Update to the Funding Mechanism for Allocation of Funds from the IWC-SORP Research Fund. *J. Cetacean Res. Manage. (Suppl.)* 18: 455.

Annex W

Intersessional E-mail Groups

This list contains the intersessional groups identified at SC/67a. It has been divided into the following group types.

(1) **Steering Groups (SG):** these are groups that have been set up to ensure that particular meetings, workshops or identified pieces of work are completed by SC/67b. They have the authority to make decisions on behalf of the Committee within the context of their terms of reference (e.g. meeting budget spends, participants, agreements on parameters for analyses). Numbers are limited and members agreed at the meeting although the Convenor may request additional members or respond to late requests to be members. The expected outcomes will be either a workshop/meeting report or an analytical paper.

(2) **Intersessional Correspondence Groups (ICG):** these are groups that have been set up to ensure progress on particular topics within the intersessional period. Membership is more flexible and open. It is expected that a written report on progress will be submitted to the Committee at SC/67b.

(3) **Advisory Groups:** these are occasional groups established by the Committee to provide scientific and technical issues on specific issues if requested by a Contracting Government.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 3 and Item 22 SC	ICG-1	Progress Reports, IWC databases and National Progress Reports	(1) Review the information collected by IWC databases and National Progress Reports and make recommendations to the Scientific Committee to amend structure, content and workflows. (2) Work with the Secretariat to assist in development and testing of databases and encourage member nations to the submit information through Progress Reports and other data flows.	Double (Convenor), Allison, Bjørge, Brownell, de Almeida, De la Mare, Diallo, Donovan, Ferriss, Fonseca, Gallego, Haug, Helmens, Hielscher, Hrabovsky, Iñíguez, Jaramillo-Legorreta, Kitakado, Lauriano, Lundquist, Palka, Paniego, S. Reeves, Ridoux, Ritter, Santos, Sohn, S. Smith, Stachowitsch, Ulloa, Víkingsson, Witting, Zharikov. *progrep@dist.iwc.int*
Item 6.2 RMP	SG-1	WNP common minke whales	Hold preparatory meeting for WNP common minke whales.	Donovan (Convenor), Allison, Butterworth, de Moor, Kitakado, Pastene, Punt, Tiedemann. *wnpminke@dist.iwc.int*
Item 6.3 RMP	SG-2	WNP Bryde's whale *Implementation Review*	Guide the *Implementation Review* and plan for an intersessional Workshop in 2018.	Donovan (Convenor), Allison, Butterworth, de Moor, Kitakado, Pastene, Punt, Tiedemann. *wnpbrydes@dist.iwc.int*
Item 7.1.3 AWMP	SG-3	BCB	Prepare for 2018 *Implementation Review* of the *Bowhead SLA.*	Suydam (Convenor), Donovan, George. *bcb@dist.iwc.int*
Item 7.2 AWMP	ICG-2	AWS	Develop an updated draft AWS for consideration at SC/67b.	Givens (Convenor), Allison, Donovan, George, Scordino, Suydam. *aws@dist.iwc.int*
Item 7.1.2 AWMP	ICG-3	WGM	Finalise technical specifications to incorporate approaches to allow movement rates between regions to depend on relative local depletion levels for common minke whales off Greenland.	Allison, Brandão (co-Convenors), Butterworth, Donovan, Givens, Punt, Witting, de Moor *wgm@dist.iwc.int*
Item 9.2.6	SG-4	Right whale workshop	Prepare for right whale Workshop.	Brownell (Convenor), Corkeron, Donovan, Kraus, Suydam. *rightwhalewksp@iwc.int*
Item 12.1 ASI	ICG-4	Abundance process	(1) Develop a process to facilitate the review of abundance estimates in a timely fashion prior or during the annual meetings; (2) identify minimum requirements for presentation and review of abundance estimates for inclusion in the IWC consolidated table; (3) develop process to validate non-standard software, non-standard methods and how to consider estimates computed from population models; (4) consider how to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the SC; (5) amend the RMP Guidelines, particularly in regard to methods so far not included in the guidelines (e.g. spatial modelling and mark-recapture); and (6) develop a process to review national cruise reports with IWC oversight.	Zerbini (Convenor), Allison, Butterworth, Cañadas, Cooke, Donovan, Freitas, Gunnlaugsson, Herr, Kitakado, Matsuoka, McKinlay, Palka, Punt. *abunpro@dist.iwc.int*
Item 12 ASI (recommendations relevant to NH and SM)	ICG-5	Abundance reviews	Review estimates of abundance for North Atlantic humpback whales from Icelandic surveys and Asian coastal and river dolphins.	Palka (Convenor), Cañadas, Donovan, Freitas, Gunnlaugsson, Herr, D. Miller, Pike, Víkingsson, Wade, Weinrich, Zerbini. *abunrev@dist.iwc.int*

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SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 23.1 ASI	SG-5	IWC-POWER/ SOWER	To provide advice on forthcoming IWC-POWER cruises (including holding the Planning Meetings), on data analyses, storage and on requests for data/sample use of IWC-POWER/SOWER cruises.	Matsuoka (Convenor), An, Bannister, Bravington, Brownell, Clapham, Donovan, Ensor, Kato, Kelly, Kitakado, Miyashita, Murase, Pastene, Wade, Zerbini. *powsow@dist.iwc.int*
Item 23.1 IA	SG-6	IDCR/SOWER volume	Complete the IWC Special Issue on the IDCR/SOWER volume.	Bannister (Convenor), Brownell, Donovan, Ensor, Kato, Palka. *idcrsower@dist.iwc.int*
Item 22 SC	ICG-6	IMMA historical data	Work with IUCN MMPA TF intersessionally in order to provide advice on the most appropriate use of the IWC's (and other) historical datasets in the IMMA consideration process.	Mattila (Convenor), Allison, Barr, Donovan, Leaper, Notarbartolo di Sciara, Panigada, R. Reeves, Tetley. *imma@dist.iwc.int*
Item 14 HIM	SG-7	Ship strikes data review group	To continue to assist the ship strike co-ordinators in reviewing cases submitted to the IWC global database and to provide advice on how to reduce the backlog of cases.	Leaper (Convenor), Brownell, Cañadas, Donovan, Double, Ferguson, Fernandez, Herr, Holm, Mattila, Panigada, Ritter, Rowles, Weinrich. *ssredata@dist.iwc.int*
Item 13.4 HIM	ICG-7	Bycatch Expert Group	(1) Review the methodology (i.e. modelling the drift of carcasses) and bycatch estimates in Peltier *et al.* (2016) and compare with any comparable results in the area using observer methodology; (2) review any new data provided by the authors of Peltier *et al*. (2016) that are intended for consideration by the Committee in 2018; (3) review whether modelling drift of bycaught carcasses can help identify the fisheries involved; (4) in the light of (3), make recommendations for the design of new or existing observer programmes; and (5) provide advice to the Committee on general issues (e.g. beyond the specific case of Bay of Biscay) that need to be considered whenever estimates based on strandings are being evaluated.	Currey (Convenor), Bjørge, Cooke, Donovan, Herr, Fortuna, Lauriano, Leaper, Long, Northridge, S. Reeves, Slooten. *bycatch@dist.iwc.int*
Item 14.2 HIM	SG-8	Ships Routeing Group	(1) Consider how best to respond to requests for advice on routeing measures; (2) consider how to collate information regarding cetaceans in the Western Arctic and Bering Strait migratory routes; and (3) provide input into the IMMA process related to shipping.	Leaper (Convenor), Bjørge, Donovan, Ferriss, Fortuna, George, Hubbell, Mattila, Rojas-Bracho, Panigada, Thomas. *shiproute@dist.iwc.int*
Item 10.1.3 CMP	SG-9	Rangewide gray whale assessment	Continue to guide the rangewide assessment including organising the intersessional Workshop.	Donovan and Punt (co-Convenors), Bickham, Butterworth, Laake, Lang, J. Moore, R. Reeves, Scordino, Wade, Weller. *rangegrayass@dist.iwc.int*
Item 9.4 SH	SG-10	Standardisation of DNA profiles	Standardisation of DNA profiles between regions, in order to facilitate comparisons and consider sample depletion.	Torres-Florez (Convenor), Baker, Double, Jackson, Lang, M. Leslie, Rosenbaum, Steel. *standna@dist.iwc.int*
Item 9.4 SH	ICG-8	Evaluate DuFresne *et al*. (2014) sighting surveys	Use DuFresne *et al*. (2014) sighting surveys to determine best approach for future survey of HW1 BSD.	Weinrich (Convenor), Double, Bannister, Butterworth, Kelly. *dufresne@dist.iwc.int*
Item 9.2.3 SH/PH	SG-12	SH blue whale catalogue work	Continued work on photo-identification catalogue to progress towards population assessment. Particularly assess temporal and spatial progress on catalogue and preparation of Australian catalogue for quality coding.	Olson and Jackson (co-Convenors), Double, Galletti, Salgado Kent, Torres Florez. *shbluecat@dist.iwc.int*
Item 9.4.2 SH	ICG-9	Humpback mixed stock analyses	Continuation of previous group. Review mixed stock analysis approach, including: (1) sample sizes collected from breeding grounds and their influence on mixing; (2) population substructure in Oceania and the impact of combining versus using individual stocks on catch allocation; (3) some possible stratifications of the 'pure' breeding stock samples to test alternate composition of 'pure' stocks (particularly with respect to East Australia); and (4) developments of the likelihood model to account for unsampled haplotypes.	Jackson (Convenor), Baker, Butterworth, Donovan, Double, Kitakado, Pastene, Ross-Gillespie, Tiedemann, Waples, Weinrich. *humpstana@dist.iwc.int*
Item 9.2.2 SH	ICG-10	Chilean blue whale abundance	Apply habitat models developed for California Current and Eastern Tropical Pacific to construct habitat use analyses for Chilean blue whales and validate with sightings data.	Redfern (Convenor), Brownell, Galletti, Hucke-Gaete, Jackson, Palacios, Torres Florez, Zerbini. *cbwa@dist.iwc.int*

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SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 9.2 SH	ICG-11	Fin whale review of metadata	Review, collate and summarise available fin whale sightings, catch, acoustic, tracking and abundance information across Southern Hemisphere.	Herr (Convenor), Archer, E. Bell, Burkhardt, Butterworth, Dalla Rosa, Double, Elwen, Findlay, Friedlaender, Hevia, Iñíguez, Jackson, Kelly, Lauriano, Matsuoka, B. Miller, Mizroch, Olson, Panigada, Reyes Reyes, Rodriguez-Fonseca, Rosenbaum, Samaran, Sepulveda, Širović, Torres Florez, Weinrich, Williams, Zerbini. *finrevmet@dist.iwc.int*
Item 9.4.3 SH	ICG-12	Review available catch data	Review newly available pre-modern catch data pertaining to southern right whales.	Jackson (Convenor), Aguilar, Double, Findlay, R. Reeves, Smith, Vermeulen, Zerbini. *revcatchdata@dist.iwc.int*
Items 9.2.3, 9.2.4 SH, WW (recommendations relevant to ASI)	ICG-13	Abundance of Antarctic blue and fin whales	Inspect post-CPIII sightings data collected for Antarctic blue whales and fin whales, and Antarctic blue whale photo-IDs, with a view to providing updated abundance/ trend estimates.	Kelly (Convenor), Butterworth, Branch, Donovan, Fortuna, Olson, Zerbini. *abuntbluefin@dist.iwc.int*
Item 9.2.3 SH	ICG-14	Blue whale baleen plates	Match up Antarctic blue whale baleen plates at the Smithsonian Institution with the original catch data in Japan.	Brownell and Kato (co-Convenors), Kishiro, Ososky, Potter, Suydam. *bwbalpla@dist.iwc.int*
Item 9.2.2 SH	ICG-15	Blue whale population structure using acoustics	Reconcile different vocalisations for pygmy blue whales in order to develop a set of calls for comparative purposes and constructing hypotheses of population structure.	Širović (Convenor), Branch, Brownell, Buchan, Cerchio, Findlay, Lang, B. Miller, Olson, Rogers, Samaran, Suydam. *bluepop@dist.iwc.int*
Item 9.2.4 SH	ICG-16	Examination of fin whale stock structure	Examine fin whale stock structure in the Antarctic Peninsula region using relevant available data.	Jackson (Convenor), E. Bell, Butterworth, Donovan, Findlay, Herr, Lang, Olson, Reyes Reyes, Rogers, Samaran, Širović, Tiedemann, Torres-Florez, Zerbini. *exfinst@dist.iwc.int*
Item 22 PH	ICG-17	Data assessment for SHWBC Chile and Australia regions	Fill data gaps in Chile and Australia regional holdings of the SHBWC and assess data readiness for use in abundance estimates.	Olson and Jackson (co-Convenors), E. Bell, Double, Galletti, Torres-Florez, Salgado Kent. *shbwc@dist.iwc.int*
Item 22 PH	SG-13	Appendices for photo-ID guidelines	Begin compilation of technical appendices for photo-ID guidelines.	Olson (Convenor), Allen, Bell, E. Collins, Donovan, Double, Findlay, Galletti, Garrigue, Jackson, Kaufman, Mallette, Matsuoka, Minton, Stevick, Torres-Florez, Weinrich, Zerbini. *photoidguide@dist.iwc.int*
Item 9.2.1 NH (recommendations relevant to IA)	ICG-18	North Pacific blue whale assessment	Review available data needed for an assessment of North Pacific blue whales.	Branch (Convenor), Brownell, Donovan, Ivashchenko, Kato, Lang, Matsuoka, Rosenbaum, Širović, Suydam. *npbwass@dist.iwc.int*
Item 9.3.9 and Item 11.9.3.8 NH (recommendations relevant to IA)	ICG-19	Sperm whale assessment	Consider possible ways to provide 'broad brush' information on abundance and status of sperm whales with a possible focus on NP. Information includes: (1) population structure; (2) available abundance estimates from smaller areas; (3) revised catch histories for pelagic and land station operations; (4) potential datasets to improve understanding; and (5) identifying simple assessment approaches.	Brownell (Convenor), Baker, Bannister, Butterworth, Clapham, Cooke, Ivashchenko, Kato, Matsuoka, Mesnick, Miyashita, R. Reeves, Suydam. *spass@dist.iwc.int*
Item 9.1.3 IA	ICG-20	Antarctic minke whale assessment	Finalise a document synthesising the results of the in-depth assessment of Indo-Pacific Antarctic minke whale.	Murase (Convenor), Donovan, Kato, Kitakado, Matsuoka, Palka, Pastene, Punt, Suydam. *antminkeass@dist.iwc.int*
Item 9.1.2 IA	SG-14	NP sei whale assessment	Continue progress on developing the in-depth assessment including: (1) finalise and review the data inputs for the assessment (intersessional steering group); (2) conduct initial runs of the assessment using the assumptions proposed by the sub-committee (Punt); (3) review result of initial runs and specify alternative assumptions if required (intersessional steering group); and (4) report to next year's meeting on the final model inputs and the results.	Cooke (Convenor), Allison, Hakamada, Kitakato, Matsuoka, Mizroch, Palka, Punt, Yoshida. *npseiass@dist.iwc.int*
Item 9.1.1 IA	SG-15	NP humpback assessment	Further the preparation for the North Pacific humpback whale comprehensive assessment by: (1) consolidate and prioritise the stock structure hypotheses developed at the first Workshop from a modelling perspective and develop appropriate draft presence/absence and mixing matrices for consideration at the next Workshop; (2) facilitate the additional work on abundance estimates; and (3) finalise plans for the second Workshop in 2018.	Clapham (convenor) Baker, Calambokidis, Donovan, Kato, Kitakado, Ivashchenko, Matsuoka, Punt, Zerbini, Urban and Yoshida *npha@dist.iwc.int*

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SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 11.2.1 SDDNA	ICG-21	DNA guidelines	Review and update sections of the data quality guidelines that cover data, including SNPs, produced using next generation sequencing approaches.	Tiedemann (Convenor), Baird, Baker, Bickham, DeWoody, Goto, Hoelzel, Jackson, Lang, M. Leslie, Natoli, Palsbøll, Pampoulie, Rosel, Skaug, Taguchi, Waples. *dnaguide@dist.iwc.int*
Item 11.3.4 SDDNA	ICG-22	Simulation tools	(1) Review available software packages for conducting genetic and/or genomic simulations; and (2) evaluate the utility of these packages to address issues of interest to the SDDNA Working Group.	Lang (Convenor), Bickham, DeWoody, Hoelzel, Kitakado, Tiedemann. *simtoo@dist.iwc.int*
Item 15.1 E	ICG-23	Pollution 2020	To progress the IWC's Pollution 2020 programme, oil spills, and mercury synthesis project.	Hall (Convenor), Donovan, Ferriss, Greig, Herr, Holm, Jepson, Rowles, Ryeng, Schwacke, Simmonds, S. Smith, Stimmelmayr, Ylitalo. *pollution2020@dist.iwc.int*
Item 15.6 E	ICG-24	Cetacean Diseases of Concern (CDoC)	Finalise the IWC CDoC website redesign and content, determine best approach to maintain information in website and the consultation/discussion forum, work with Strandings Initiative.	Stimmelmayr and Simeone (co-Convenors), Ferriss, Gulland, Hall, K. Lee, Mattila, Rosa, Rowles, Ryeng, Smith, S., Suydam, Ylitalo. *codc@dist.iwc.int*
Item 15.7 E	SG-16	Strandings	Work with Secretariat and Chair of the SC to continue development and implementation of the International Strandings Initiative.	Simeone and Mazzariol (co-Convenors), Brownell, Deaville, Donovan, Gulland, Ferriss, Frey, Herr, Jepson, K. Lee, Marcondes, Oosthuizen, Rojas-Bracho, Rosa, Rowles, Seakamela, Simmonds, S. Smith, Stimmelmayr, Wimmer. *strandings@dist.iwc.int*
Item 15.8 E	ICG-25	Noise	Update on national and international noise strategies; Identify synergies between international noise strategies and develop priorities for future actions; Contribute to acoustic component of cumulative impacts workshop, as needed.	Cholewiak (Convenor), Buchan, Burkhardt, Cosentino, Donovan, Ferriss, Frey, Leaper, Moore, New, Parsons, R. Reeves, Reyes Reyes, Rowles, Simmonds, Smith, S., Suydam. *noise@dist.iwc.int*
Item 15.3	SG-17	Cumulative impacts	Planning and preparation for a cumulative impacts Workshop or focus sessions at SC/67b.	Hall (Convenor), Cholewiak, Cooke, Donovan, Gulland, Kitakado, Rowles, S. Smith, Ylitalo, Schwacke, L. Thomas. *cumulativeimpacts@distiwc.int*
Item 15.9 E	ICG-26	Climate change	Discussions of future work including refining planning for a Workshop.	Simmonds (Convenor), Bjørge, Donovan, Ferriss, Fortuna, Frey, Hall, Kitakado, Leaper, Parsons, Suydam, Williams, Smith, S. *climatechange@dist.iwc.int*
Item 15.5 E	ICG-27	Marine litter	Pre-planning for proposal for marine debris Workshop on marine litter and plastics to be presented at SC/67b and to be held at SC/68a.	Simmonds (Convenor), Baulch, Donovan, Ferriss, Fossi, Hall, Holm, Leaper, Long, Marcondes, Mattila, Rowles, S. Smith, Ylitalo. *marinedebris@dist.iwc.int*
Item 15.8 E, HIM	SG-18	Shipping Noise and IMO	Provide the Secretariat with a summary of the relevant material and discussions within the Committee on shipping noise (particularly from IWC, 2017) in the form of a paper that might be presented to MEPC 72 if requested.	Leaper (Convenor), Cholewiak, Donovan, Ferriss, Frey, Hubbell, B. Miller, Moore, Reyes, Rosenbaum, S. Smith. *noiseimo@dist.iwc.int*
Item 16.1 EM	SG-19	IWC-CCAMLR Workshop	Commence planning of a joint Workshop between IWC-SC and SC-CAMLR WG-EMM.	Kitakado (Convenor), Butterworth, De la Mare, Double, Donovan, Friedlaender, Palka, Watters. *iwcccamlr@dist.iwc.int*
Item 16.2 EM	SG-20	Species distribution models	Develop guidelines and recommendations for best practice in species distribution modelling.	Murase (Convenor), Friedlaender, Kelly, Kitakado, McKinlay, Palacios, Palka. *asmodels@dist.iwc.int*
Item 16.6.3 EM	ICG-28	Work focused on biological hypotheses relevant to IWC Resolution 2016-3	Develop proposals for a way forward in SC/67b, and how to best integrate this stream of work into the Scientific Committee.	Ritter (Convenor), Bjørge, Butterworth, Fortuna, Galletti, Iñíguez, Kitakado, New, Palka, Reyes, Simmonds, Suydam. *propsc@dist.iwc.int*
Item 17.1 SM	ICG-29	*Tursiops* taxonomy	Provide an overview of evaluation of *Tursiops* conducted in SC/66a, SC/66b and other relevant new information.	Natoli (Convenor), Archer, Brownell, Cipriano, Hoezel, Krutzen, Lang, Perrin, Rosel. *tursiopstax@dist.iwc.int*
Item 17.3 SM	SG-30	Amazon dolphin/ piracatinga Workshop/ wildmeat Workshop	Develop a draft 'toolbox' of investigative techniques to assist in documenting more clearly takes of small cetaceans; and organise a workshop comprising a multi-disciplinary group of biologists, social scientists, managers and NGOs with a global scope. Increase formal liaison with other MEA. Develop TOR, identify participants, organise and conduct a workshop focusing on the *Inia*/piracatinga fishery issue in South America.	Porter and Friet (co-Convenors), Almeida, Baker, Brownell, Collins, Cosentino, Coutinho, Donovan, Ferriss, Fortuna, Frey, Jiminez, LeGracie, A. Leslie, Luna, Parsons, S. Reeves, Scheidat, Simmonds, S. Smith, Thomas, Trujillo, Zerbini. *pirandwildmeatsg@dist.iwc.int*

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SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 17.4 SM	SG-22	Small Cetacean Task Team	Assist the Scientific Committee in providing timely and effective advice on situations where a population of cetaceans is or suspected to be in danger of a significant decline that may eventually lead to its extinction; the ultimate aim being to ensure that extinction does not occur.	Simmonds (Convenor), Bjørge, Donovan, Ferriss, Fortuna, Genov, Parsons, Porter, R. Reeves, Scheidat, S. Smith. *taskteamSG@dist.iwc.int*
Item 18.1.1 WW	SG-23	MAWI	Define specific research questions and hypotheses that will benefit understanding of the impact of whalewatching, identify those whalewatching locations that would be most suitable and amenable for targeted studies addressing these questions, and summarise the current modelling tools available to analyse the data that will be collected.	New (Convenor), Baldwin, Cook, Cosentino, Donovan, Ferriss, Fortuna, Frey, Jimenez-Assmus, Kaufman, Leaper, Minton, Parsons, Robbins, Rose, C. Smith, S. Smith, Suydam, Weinrich. *mawi@dist.iwc.int*
Item 18.4.1 WW	ICG-31	Swim-with-whale operations	Assess the extent and potential impact of swim-with-whale operations.	Rose (Convenor), Ferriss, Frey, Gero, Jimenez-Assmus, Kaufman, Minton, Parsons, Ritter, Rodriguez-Fonseca, Simmonds, Sironi, C. Smith, S. Smith, Urban, Weinrich. *swimwhale@dist.iwc.int*
Item 18.2 WW	SG-24	Draft Whalewatching Handbook	Provide advice when solicited by the contractor as she sources content for the online Whalewatching Handbook, and provide feedback on drafts as they become available.	Minton (Convenor), Ferriss, Kaufman, Parsons, Rendell, Rose, S. Smith, Suydam. *wwhandbook@dist.iwc.int*
Item 18.2 WW	SG-25	Review of Strategic Plan on Whalewatching	Review the Strategic Plan and provide advice to the Conservation Committee's SWG on Whalewatching.	Suydam and Rojas-Bracho (co-Convenors), Ferriss, Fortuna, Kaufman, Minton, Parsons, Rendell, Simmonds, S. Smith. *revplanww@dist.iwc.int*
Item 18.4.1 WW	ICG-32	IORA	Help provide advice to IORA when appropriate and facilitate communication between IORA and the sub-committee.	Ferriss (Convenor), Baldwin, Iñíguez, Kaufman, New, Parsons, Simmonds, C. Smith, S. Smith, Urbán, Weinrich. *iora@dist.iwc.int*
Item 18.1.3 WW	ICG-33	'Habituation' of cetaceans to whalewatching activities	Assess significance of cetacean 'habituation' and 'sensitisation' to the presence of whalewatching activities. Consider the definitions and initiate review of the topics 'habituation' and 'sensitisation'.	Simmonds (Convenor), Cosentino, Kaufman, Minton, Parsons. *habww@dist.iwc.int*
Item 18.2 WW	SG-26	Communication with the Conservation Committee	Discuss development of better methods for disseminating recommendations and advice on whalewatching to the Conservation Committee (joint with Conservation Committee).	Parsons and Rendell (co-Convenors), Ferriss, Cosentino, Minton, Ritter, Rojas-Bracho, Rose, Simmonds, S. Smith, Suydam, Weinrich. *comcc@dist.iwc.int*
Item 20 SC	SG-27	IWC-SORP	Provide advice on scientific and logistical matters related to the IWC-SORP (Southern Ocean Research Partnership) programme.	Double and Herr (co-Convenors), E. Bell, Burkhardt, Bjørge, Brownell, Charrassin, Donovan, Elwen, Fortuna, Fruet, Gallego, Galletti, Iñíguez, Lundquist, Lauriano, Luna, Olson, Oosthuizen, Reyes Reyes, Ridoux, Samaran, Suydam, Vermeulen, Zerbini. *iwcsorp@dist.iwc.int*
Item 26.3 SC	ICG-34	Annex P	To consider the need or otherwise to additionally modify Annex P in the light of the recommendations and suggestions made by previous Expert Panels and the discussions reflected in the Committee's considerations at SC/66b.	Fortuna (Convenor), De la Mare, Donovan, Double, Lundquist, Morishita, H. Morita, Y. Morita, Moronuki, Palka, Rendell, Suydam. *annexp@dist.iwc.int*
Item 26.5.1 SC	ICG-35	Succession plan for SC expertise	To identify a way or ways to address the issue of succession of key members of the Committee, particularly related to the *Implementation Review* and assessment processes (including modelling expertise). Should there be financial or HR implications, the Secretariat (Penfold) will be included in the group.	Fortuna (Convenor), Allison, Butterworth, De la Mare, de Moor, Donovan, Givens, Kitakado, Punt, Suydam, Walløe. *succession@dist.iwc.int*

REFERENCES

duFresne, S., Hodgson, A., Smith, J., Bennett, L., Burns, D., MacKenzie, D. and Steptoe, V. 2014. Final report: Breeding stock 'D' humpback whale pilot surveys - methods and location. Prepared for AMMC. 67pp.

International Whaling Commission. 2017. Report of the Workshop on Acoustic Masking and Whale Population Dynamics, 4-5 June 2016, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 18:615-27.

Peltier, H., Authier, M., Deaville, R., Dabin, W., Jepson, P.D., Van Canneyt, O., Daniel, P. and Ridoux, V. 2016. Small cetacean bycatch as estimated from stranding schemes: the common dolphin case in the northeast Atlantic. *Environ. Sci. Pol.* 63(2016): 7-18.

Report of the Expert Panel Workshop on the Proposed Research Plan for the New Scientific Whale Research Programme in the Western North Pacific (NEWREP-NP)

Report of the Expert Panel Workshop on the Proposed Research Plan for New Scientific Whale Research Programme in the Western North Pacific (NEWREP-NP)[1]

EXECUTIVE SUMMARY

The Panel's tasks were twofold: (1) review the JARPN II programme including analyses of data up to 2016; and (2) review the NEWREP-NP proposal in light of Annex P.

With respect to the JARPN II programme, although the additional data for the period were provided, only some analyses were available, primarily on the work carried out comparing lethal and non-lethal techniques. The Panel **agrees** that a full 'final' review of the JARPN II programme will be possible only when final analyses are completed, in line with the IWC Scientific Committee-agreed timeframe for analyses, and a full consolidated report made available. The Panel made several recommendations related to this item, including some directed at clarifying Annex P with respect to final reviews.

With respect to the review of NEWREP-NP, the Panel recognised the considerable work that had been undertaken by the proponents in developing the proposal and **commends** their efforts to: (a) follow Annex P and the Checklist; and (b) provide additional information during the Workshop itself (Annex D).

The Panel **agrees** that the Primary and most of the Secondary Objectives are important for conservation and management, although the level of the contribution varies. Despite the work undertaken by the proponents, the Panel **concludes** that, in its current version: (1) the Proposal does not adequately justify the need for lethal sampling and the proposed sample sizes, particularly with respect to quantifying the likely extent of management and conservation improvement in the context of the IWC; and (2) has basic design shortcomings. The Panel **recommends** that the lethal sampling components of the programme should not occur until the additional work identified in its report is undertaken and reviewed. The detailed rationale for this can be found in the full report. In short, the Panel's main concerns relate to:

(1) insufficient justification for the proposed sampling design and sample sizes for the lethal components;
(2) insufficient justification that *additional* age data will notably improve conservation and management; and
(3) the proponents' approach used to assess the potential effects of catches on common minke whales (and especially that even under the approach taken by the proponents, J-stock was shown to decline under some scenarios).

The Panel has provided **recommendations** on additional analyses that should be undertaken to limit some of these shortcomings (summarised in Table 3).

The Panel has also developed **recommendations** to improve the Annex P process, including the need to develop agreed frameworks to compare lethal and non-lethal approaches, to quantify 'improvements' in management in an IWC context and to evaluate the effects of catches on stocks.

1. INTRODUCTORY ITEMS

The Expert Panel Workshop of the Proposed Research Plan for New Scientific Whale Research Programme in the western North Pacific (NEWREP-NP) was held in the Toyomi Center Building, Tokyo from 30 January to 3 February 2017. The Panel also considered final data from the western North Pacific Japanese Special Permit programme (JARPN II).

1.1 Opening remarks

The Scientific Committee Chair, Fortuna, welcomed the Panel Members[2], Observers and Japanese Proponents to Tokyo and thanked the Fisheries Agency of Japan for hosting the Workshop. Morishita (IWC Commissioner for Japan) also welcomed the Panel and all participants.

The meeting was organised following the previous style of Expert Workshops. Mornings comprised open sessions with summary presentations by the proponents and the opportunity for questions and discussion (Panel members, proponents and observers present), followed by afternoon closed sessions for the Panel to discuss the morning topics and begin to outline relevant sections of its report and assign writing tasks. This year, live streaming of the open sessions was set up as a trial to allow remote participation: four observers (Baker, Bjørge, McKinlay and Weinrich) connected at least some of the time whilst four additional members of the Scientific Committee requested access but did not connect, perhaps due to the time difference with their respective countries. The list of participants is given as Annex A.

1.2 Appointment of chair and rapporteurs

Fortuna, as Chair of the IWC Scientific Committee, chaired the Workshop. Palka and Punt co-ordinated the report writing, which was finalised by Donovan. All members of the Panel contributed to the report. The report will be made public on 3rd April.

1.3 Available documents

The list of documents is given as Annex C. Four primary papers (SC/F17/JR01-04) were available, along with five 'For Information' papers, two Observer's Statements (SC/F17/O01-O02) and two responses by Japan to the Observer's statements (SC/F17/O03-O04). In addition, a number of 'morning papers' were provided by the proponents in response to questions during open sessions. These have been collated by subject as Annex D.

1.4 Adoption of the Agenda

The adopted Agenda is given as Annex B.

[1]Presented to the IWC Scientific Committee as SC/67a/Rep01.
[2]One member of the Panel (Donovan) participated remotely during all open and closed sessions. Another member (Gaichas) participated by e-mail.

2. OBJECTIVES OF THE WORKSHOP

2.1 Introduction to the Annex P process

The Scientific Committee Chair provided an introduction to the Annex P review process, which was revised in 2015 and endorsed by the Commission at its biennial meeting in 2016, focusing on aspects relevant to this review.

The primary objective of the Expert Panel Workshop was to review the proposal in the light of the stated objectives, with the help of the checklist outlined in Appendix 1 of Annex P.

The agreed three broad categories of objectives for Special Permits proposals are: (1) improve the conservation and management of whale stocks; (2) improve the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part; and (3) test hypotheses not directly related to the management of living marine resources. In this context, the Panel's tasks were to:

(1) 'comment briefly on the perceived importance of the stated primary objectives from a scientific perspective and for the purposes of conservation and management, noting particularly the relevance of each to the work of the Scientific Committee[3];
(2) evaluate whether the objectives of the research could be achieved by non-lethal methods or whether there are reasonably equivalent objectives that could be achieved non-lethally[4];
(3) for broad categories of objectives 1 and 2, evaluate whether the elements of the research that rely on lethally obtained data are likely to lead to improvements in the conservation and management of whales. This evaluation should include whether the proposal demonstrates the likely magnitude and relevance of improvements to conservation and management arising from the achievement of the programme objectives;
(4) evaluate whether the design and implementation of the programme are reasonable in relation to achieving the programme's stated research objectives[5], and in particular, evaluate whether sample sizes and the spatial and temporal scales[6] are reasonable in relation to the programme's stated research objectives and whether non-lethal alternatives are not feasible to either replace or reduce the size of the lethal sampling being proposed;
(5) assess the degree to which the programme coordinates its activities with related research projects[7];
(6) provide advice on the likely effects of the catches on the stock or stocks involved under various scenarios of length of the programme. This will include inter alia examination of abundance estimates provided and may involve a different analysis to that provided in the original proposal, including assumptions that short permit proposals may be projected further into the future;
(7) determine whether the programme has specified intermediate targets that would allow for an adequate review of progress relative to programme objectives; and
(8) consider any other relevant matters as decided by the Scientific Committee'.

In relation to the JARPN II programme, the Panel tasks were to consider: (1) updated analyses that included data obtained up to 2016; and (2) responses to recommendations made in IWC (2017a; 2017b).

2.2 Introduction to the Revised Management Procedure (RMP) process

Given that key aspects of the new proposal NEWREP-NP related to the RMP, Punt gave a short presentation on behalf of Donovan on the Revised Management Procedure (RMP) process and key parameters. Schematic representations of the RMP framework (Fig. 1) and its *Implementation Process* (Fig. 2) were presented.

Key requirements to implement the RMP are information on:

(a) stock identity (identify a range of plausible hypotheses in light of supporting data);
(b) absolute abundance (specified in light of stock hypotheses);
(c) MSYR; and
(d) removals (historical series in light of stock hypotheses, past and future estimates for ship strikes and bycatches).

It was stressed that within the *IST* framework, conditioning can be improved by using 'additional' data (e.g. age and marking data for North Atlantic fin whales, sex ratio data for North Atlantic common minke whales) to the types of data commonly used. Use of all data in conditioning must take into account uncertainty. In some cases, these additional data can be valuable to, but are not essential for, the process.

Where more detailed explanation of aspects of the process are required in light of specific components of NEWREP-NP, these are developed under the relevant agenda items below.

3. REVIEW OF THE JARPN II PROGRAMME

3.1 Overview of the 2016 Panel and Scientific Committee recommendations and the earlier JARPN II review

The Chair provided an overview of the 2016 Panel and Scientific Committee recommendations and the current status of progress (Table 1). In general, the 2016 Panel recognised the extensive field and laboratory components of the programme, but was concerned that this was not matched by analytical efforts. To this end, it made almost 40 recommendations for improved analyses, 15 of which could be achieved in the short-term (by the 2016, or at the latest the 2017 annual Scientific Committee meeting). The 2016 Panel did not make any recommendation that required or suggested the need for additional lethal sampling. Table 1 summarises the status of progress and comments made by the Panel on new received material (i.e. SC/J17/JR02rev1, Annex D and PowerPoint presentations by the Proponents).

[3]Include whether the programme objectives are sufficiently defined to enable an evaluation of the likely contribution of the different data sets to objectives.

[4]The comparison of lethal and non-lethal means should be based on their potential to meet the programme objectives (or their reasonable equivalents) based on power analyses and feasibility, including effort and time frames required to produce comparable results.

[5]For broad categories of objectives 1 and 2, and with respect to methods and sample size, 'reasonable' is determined by a demonstration that methods and sample sizes are necessary and sufficient.

[6]With respect to spatial and temporal scales, assess whether the timeframe, as well as the seasonal and spatial distribution of lethal or non-lethal sampling are appropriate.

[7]This will include assessment of whether the degree of coordination is sufficient to ensure that the field and analytical methods are appropriate and best practice to achieve the stated objectives and whether the degree of coordination is sufficient to avoid unnecessary duplication.

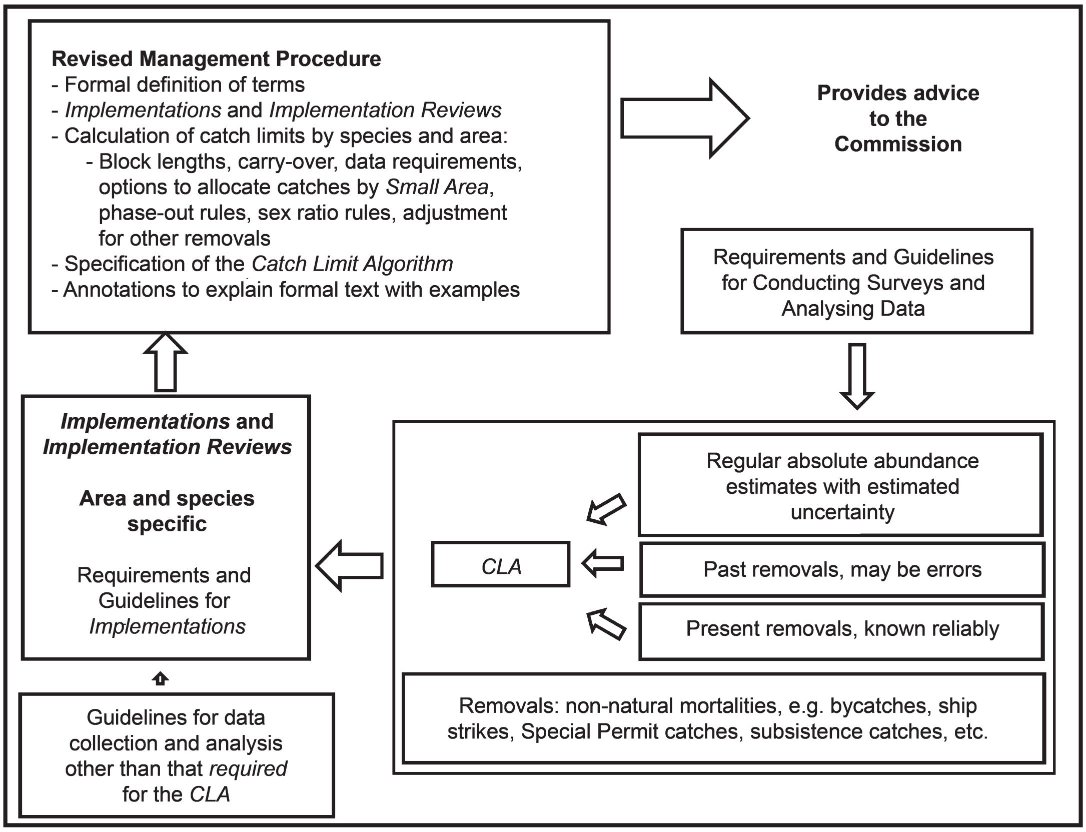


Fig.1. Schematic representation of the RMP.

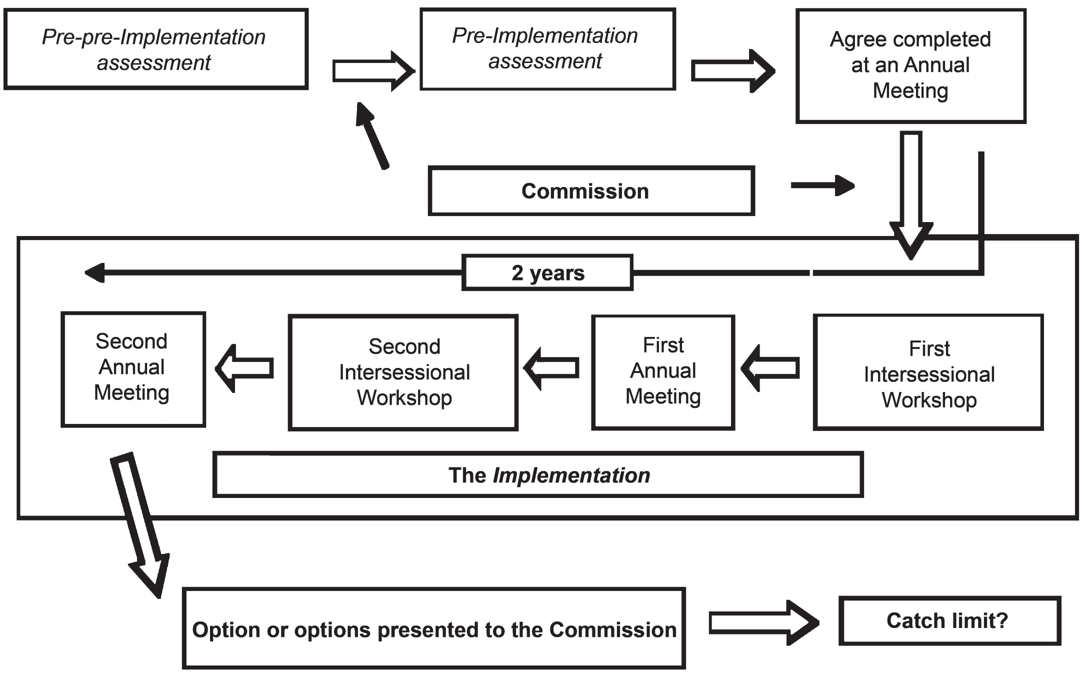


Fig.2. Schematic representation of the RMP *Implementation Simulation Trial* process.

Table 1

2016 Panel and Scientific Committee recommendations and the current status of progress.

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents presented to the Panel (SC/J17/JR02rev1)
Sampling design and areas (Item 3.4.2.1)			
(1)	A new paper that in addition to the information on sightings, it should document, for each year and season: (a) the predetermined tracklines for sampling and the rationale for those lines; and (b) the actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the rationale for any new lines developed. (c) It should also address the issue of whether the actual sampling that occurred can be said to be representative of: (a) the animals in the surveyed area; and (b) those in the biological population(s) and discuss the extent to which this may affect those objectives/parameters/ analyses for which this is or may be important.	By SC/2016: The proponents responded in Bando *et al.* (2016). The Committee discussed this at some length (see Item 18.2.3.1). Suggestions were made to improve the manuscript and to better evaluate the appropriateness of the pooling of data. This requires analyses that disaggregate the data collected according to the two different sampling strategies. This may allow pooling of data but the precision of estimated quantities, and hence required sample sizes, should also be examined. Issues related to the sample representativeness and the effect of this are partially addressed. **2017 Panel comment: Relevant to discussion under Item 4.2.**	No new information presented.
(2)	Papers using data from the inshore component must fully address the implications of the logistical rather than scientific sampling design.	By SC/2016: Partially addressed in Bando *et al.* (2016) but further analyses required to make allow-ance for non-random sampling. **2017 Panel comment: Relevant to discussion under Item 4.2.**	No new information presented.
Sample size (Item 3.4.2.2)			
(3)	A new paper should be developed that: (a) provides a clearer rationale for the changes in sample sizes initiated in 2014 and any implications for meeting the original objectives of the programme; and (b) provides the field and analytical protocols for the comparison of using lethal and non-lethal techniques for each key parameter taking into account the advice provided in 2009.	By SC/2016: (3a) The proponents provided some information in Tamura *et al.* (2016a). The Committee noted that this largely referred to information already available to the Panel and Committee and noted that further information, especially with respect to the implications for meeting the original objectives would be helpful. By SC/2016: (3b) The proponents presented the field and analytical protocols in Mogoe *et al.* (2016). Committee advice on presentation of results and analyses in a final report is given under Item 18.2.3.2 of SC/66b. **2017 Panel comment: Relevant to discussion under Item 3.**	No new information presented.
Stock structure (Item 4.4.3)			
(4)	All inferences regarding 'randomness' of observations (e.g. satellite tracks, mitochondrial DNA haplotypes and unassigned common minke whales) should be substantiated by a statistical assessment of the presumed randomness.	By SC/2016 (or 2017 at latest): Tamura *et al.* (2016a) indicates this will be addressed and proposes two approaches.	*These results will be submitted to the 2017 SC Annual Meeting. Progress at this stage is shown in Appendix 1 [of SC/J17/JR02rev1].*
(5)	The presence of multiple stocks within sample partitions should be assessed (employing, e.g. STRUCTURE and DAPC).	By SC/2016 (or 2017 at latest): In progress (see discussion in IWC, 2017c). **See Item 3.3.1 for 2017 Panel's full comments.**	*STRUCTURE analyses for Bryde's and sei whales were conducted and presented in Pastene et al. (2016, and Appendix 2.1 of SC/J17/JR02rev1). DAPC analysis is in progress (Appendix 2.2 of SC/J17/JR02rev1). The final results of DAPC for Bryde's whale will be submitted to the Bryde's whale Implementation Review Work-shop to be held in March 2017.*
(6)	More explicit information on quality checks be provided in each study as well as study-specific estimates or genotyping and DNA sequencing error rates.	By SC/2016 (or 2017 at latest): Goto *et al.* (2016) fully addresses this (see IWC, 2017d). **The 2017 Panel agreed that this recommendation has been completed.**	*See Appendix 3 of SC/J17/JR02rev1.*
(7)	To facilitate more definitive discrimination between single and multiple stock hypotheses, undertake work to determine the demographic dispersal rates among areas at which whales in different areas can be managed as a single stock. Identifying 'critical' dispersal rates by specific case and the corresponding levels of genetic divergence, should enable such discrimination. The approach of Van der Zee and Punt (2014) is commended. This will allow the development of a working definition of a 'stock'.	2-3 years after the 2016 Annual Meeting: The proponents noted that work had begun to address (7), (9) and (10). They propose use of kinship analyses to address (8). Progress is discussed further in IWC (2017c). **2017 Panel: No progress presented at the meeting.**	*This will be addressed after a discussion on direction of the analysis with panel members.*
(8)	Analytical approaches should be applied that do not assume mutation-drift-migration equilibrium (Hey, 2010).		*This may not be feasible for the cases of O stock common minke, Bryde's and sei whales where the effect sizes are low. Instead, kinship information will be used as a way to estimate migration rates, as this is an approach that does not depend on the assumption of genetic equilibrium.*

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents presented to the Panel (SC/J17/JR02rev1)
(9)	Serious consideration should be given to using genome-wide SNP genotyping approaches, such as RAD sequencing and GBS Elshire *et al.,* 2011; Miller *et al.*, 2007). This will increase the data per sample thereby improving the accuracy and precision of genetic parameter estimates and facilitate additional analyses Hey and Machado, 2003; Robinson *et al.*, 2014).		*Novel SNPs for minke whale species were developed under the collaborative research with Norway (Malde et al., in review) which will be used for the subsequent genetic analyses.*
(10)	A focused satellite tagging programme should be developed to greatly increase sample size to assess individual migration in the context of stock structure hypotheses more thoroughly.		*The proponents agree to make efforts to increase the number of satellite tagging experiments. In the case of the Bryde's and sei whales, this information should be examined in conjunction with the available information on mark-recapture from the period of commercial whaling. Effort to collect tagging data will be increased in the NEWREP-NP.*
Feeding ecology and ecosystem studies – Oceanography (Item 5.4.3.1)			
(11)	Chl-a concentration should be examined as a potential proxy for the food environment for whales.	2 years after the 2016 Panel review: Used in some analyses already and discussed in Tamura *et al.* (2016a).	
(12)	Oceanographic monitoring is required to compare with prey species distribution and abundance in the new 'decadal regime'.	Several years - The proponents agreed – this is long-term monitoring.	*Long-term monitoring.*
Feeding ecology and ecosystem studies – Distribution (Item 5.4.3.2)			
(13)	With respect to papers Murase *et al.* (2014; 2016), Matsuoka *et al.* (2016), Sasaki *et al.* (2013) and Tamura *et al.* (2016c), develop revised versions that: (a) include statistical summaries on model fit (R2 and % deviance explained) and model com-parison and spatial covariate selection (e.g. AIC, GCV scores); (b) avoid extrapolation of the regression models outside to data-poor areas or areas lacking coverage (especially when combining food consumption with sightings data); and (c) include variance plots of the fitted prediction surfaces in order to address precision and data sparseness.	By SC/2016: (13a) The proponents provided statistical summaries relating to model fits in papers Murase *et al.* (2014; 2016), Tamura *et al.* (2016c) and Tamura *et al.* (2016c), but not in Matsuoka *et al.* (2016). (13b, 13c) No information received. **2017 Panel: no progress presented at the meeting. See new details on plans in Annex D**.	*Improvement of analyses of Matsuoka et al. (2016) (spatial abundance estimation) and Tamura et al. (2016c) (spatial prey consumption estimation) is ongoing. Because they are companion papers, the improvement is conducted in parallel. Some of the results were presented to 2016 PICES annual meeting (Sasaki et al. (2016) to invite comments from regional experts. The improved version will be presented to 2017 PICES annual meeting for further consideration. Fully improved version would be submitted to IWC/SC after 2018. Revision of published papers (Murase et al., 2014; Sasaki et al., 2013) will not be conducted because they only used part of JARPN II data and full consideration can be achieved by improving Matsuoka et al. (2016) and Tamura et al. (2016c).*
(14)	Considerable effort be put into the methodological improvement of the spatial modelling in the various analysis related with the objectives on distribution of large whales and oceanography. A particular focus must be on the combination of survey data from the different years to make them more comparable in terms of distribution (and abundance) over time; use of data from other sources (e.g. the IWC POWER programme). This work is not only valuable in itself but is essential for a better parameterisation of ecosystem models.	2-3 years after the 2016 Annual Meeting: The proponents agreed and will undertake in light of guidelines to be developed by the Scientific Committee in 2017 (see Annex D). Will also include additional data. **2017 Panel: no new analyses presented at the meeting although the proponents suggested that a new paper will be presented at the 2018 Scientific Committee meeting.**	*See also comments to Recommendation 13.*
(15)	Additional effort be placed on fulfilling the 2009 recommendation with respect to the photo-identification data to contribute to the under-standing of large scale movements and whale distribution within and outside the JARPN II survey area for several species.	2-3 years after the 2016 Annual Meeting: The proponents agreed that consideration will be given to sharing photo-ID data. **2017 Panel: no progress presented at the meeting.**	*The database validations work started for several species.*
Feeding ecology and ecosystem studies – Distribution (Item 5.4.3.2)			
(16)	Explore methods to account for sampling differences between areas and years to obtain measures of short- and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models).	2-3 years after the 2016 Annual Meeting: The proponents agreed and expect to achieve this within the timeframe. **2017 Panel: no progress presented at the meeting.**	*The proponents will explore the method using models such as mixed effect model.*
(17)	Compare results from the design-based estimates of abundance with those of model-based estimates to potentially address problems of unequal sampling coverage between surveys and to potentially account for additional sources or causes of variability.	2-3 years after the 2016 Annual Meeting: The proponents agreed and expect to achieve this within the timeframe and in line with the IWC guidelines discussed under (14) above.	No new information presented.
Feeding ecology and ecosystem studies - Field and laboratory studies			
(18)	The sampling distribution for the parameters should be used in the assessment of the uncertainty associated with the estimation of consumption.	By SC/2016 (or 2017 at latest): Proponents agreed and will complete by 2017. **2017 Panel: see Item 3.3.2 for full comments.**	*Progress summarized in Appendix 4* [of SC/J17/JR02rev1].

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents presented to the Panel (SC/J17/JR02rev1)
(19)	Clarification should be provided on how density and diet consumption have been extrapolated outside the areas and months covered during the surveys and diet studies.	By SC/2016 (or 2017 at latest): Response provided in Bando *et al.* (2016) and discussed.	-
(20)	All sources of uncertainty should be quantified and an evaluation of which parameters contribute the most to uncertainty be conducted and taken into account in the analyses and modelling.	2-3 years after the 2016 Annual Meeting: The proponents agree. **2017 Panel: no progress presented at the meeting.**	*Analyses are ongoing.*
(21)	The studies on allometric relationships should be developed further to refine the range of suitable allometric-energy intake/consumption relationships.	2-3 years after the 2016 Annual Meeting: The pro-ponents will complete the work within the timeframe. **2017 Panel: no progress presented at the meeting.**	*Analyses are ongoing.*
(22)	The analyses of diet composition should consider the effect of seasonal changes in energy density of the various prey species.	2-3 years after the 2016 Annual Meeting: Proponents agreed and will complete by 2017. **2017 Panel: see Item 3.3.2 for 2017 Panel's full comments.**	*The proponents considered the effect of seasonal changes in energy density of the various prey species. Table 3 of Tamura et al. (2016b) indicated seasonal changes in energy density of the various prey species. Table 4 indicated prey composition (W%) of each whale sampled. Table 5 indicated the energy contents consumed by whales calculated based on their prey composition in research area based on Tables 3 and 4.*
(23)	Stable isotope analysis of whale tissues and their prey should be introduced not only into the assessment of diet, but also to statistically evaluate overlap in distribution and trophic niche between baleen whale species.	2-3 years after the 2016 Annual Meeting: With respect to (23) a study has begun with Hokkaido University. **2017 Panel: see Item 3.3.2 for 2017 Panel's full comments.**	*Preliminary result is shown in Appendix 6* [of SC/J17/JR02rev1].
Feeding ecology and ecosystem studies – Ecosystem modelling (Item 7.4.3)			
(24)	Generic recommendations identified by the 2009 Panel remain.	2-3 years after the 2016 Annual Meeting	
(25)	Generic recommendations identified by the 2009 Panel remain.	2-3 years after the 2016 Annual Meeting: The proponents agree.	
(26)	Establish clear objectives on the ultimate use of the models to make further progress (e.g. better understanding ecosystem linkages, delivering advice for fishery management) – ecosystem models are not suitable for tactical management.	2-3 years after the 2016 Annual Meeting: The proponents agree. **2017 Panel: no progress presented at the meeting.**	*Objective will be considered by a domestic group comprising scientists and managers in parallel with improvement of basic structures of models.*
(27)	Use models in concert e.g. use food web modelling to establish key predation linkages for extended single-species or multispecies models. In such a way the suite of available modelling tools can be used to integrate available knowledge.	2-3 years after the 2016 Annual Meeting: The proponents agree. **2017 Panel: no progress presented at the meeting.**	*The proponents have been undertaking some basic analysis especially on the effect of presence of ghost population etc. Construction of food web model at local scale (e.g. off Sanriku) will also be considered.*
(28)	Use stable isotopes to provide information on long term feeding patterns and inform models about trophic relationships between whales and their prey (see also Item 6.4).	2-3 years after the 2016 Annual Meeting: The proponents agree in broad terms but note the use in modelling may be limited. **2017 Panel: no progress presented at the meeting.**	*See also comments to Recommendation 23.*
(29)	With respect to the EwE modelling: (a) evaluate data quality for each input parameter (the 'pedigree': e.g. Gaichas *et al.*, 2015) to characterise uncertainty in model inputs; (b) further evaluate PREBAL and other diagnostics; (c) present more clearly and evaluate further the estimated vulnerabilities and other fit diagnostics (including sensitivity analysis using ranges of consumption estimates).	2 years after the 2016 Panel review: The proponents agree and will undertake analyses within the time frame but note some limitations with EE in the western North Pacific situation. **2017 Panel: no progress presented at the meeting.**	*Improved version of the model was presented to 'ICES/PICES: Drivers of dynamics of small pelagic fish resources' in March 2017 to invite comments from experts of small pelagic fish (Watari et al., 2017). Further improvement will be considered based on the comments if any. Fully improved version would be submitted to IWC/SC after 2018.*
(30)	With respect to extended single-species modelling: (a) ensure that the majority of predation mortality is captured; (b) carry out additional diagnostics: (1) examine the fits to: (i) fishery-independent survey data; (ii) proportion information; and (iii) trends in fishing mortality; (2) use posterior predictive checks to evaluate Bayesian model. (c) provide thorough justification for the current spatial boundaries of the model and the use of fishery CPUE as an index of abundance. (d) focus the model fitting on the fishery-independent survey if CPUE not considered likely to index abundance; (e) examine sensitivity to alternative plausible functional forms of the feeding relationship; and (f) explore the causes of the implausible pos-teriors, e.g. Kitakado *et al.* (2016) by changing the weights assigned to the data sources and fitting the model.	2-3 years after the 2016 Annual Meeting: The proponents broadly agree with all components of this recommendation, but identify some difficulties with lack of data for item (e). **2017 Panel: no progress presented at the meeting.**	*Some works have been undertaken such as standardisation of CPUE series and use of them in the model fitting. In addition to Bayesian methods, estimation with ML method has been revisited. All but (e) will be finalised in 2018.*

Topic (and agenda number from the 2016 Panel review)		2016 Panel suggested timeline, progress by 2017 Panel meeting and 2017 Panel comments and conclusions	Comments by the Proponents presented to the Panel (SC/J17/JR02rev1)
Monitoring environmental pollutants in cetaceans and marine ecosystem (Item 8.4.3)			
(31)	To improve the statistical analyses based on clear and well-formulated hypotheses.	By SC/2016 (or 2017 at latest): Addressed in Yasunaga *et al.* (2016a; 2016b), although additional consultation with statisticians would be beneficial.	-
(32)	Recalculate OC concentrations as values on a lipid weight basis, and Hg concentrations on a dry weight basis.	By SC/2016 (or 2017 at latest): The proponents elucidate some difficulties to address this recommend-ation due to e.g. loss of samples by tsunami in 2011.	-
(33)	Explore trends in pollutant concentrations using generalized additive models (GAMs) or other non-linear approaches, in addition to the linear models.	By SC/2016 (or 2017 at latest): Addressed in Yasunaga *et al.* (2016a; 2016b).	-
(34)	Evaluate the pollutant concentrations found in comparison with data from previous studies conducted in comparable species and available in the literature.	By SC/2016 (or 2017 at latest): More discussion on comparisons with previously published studies were included in Yasunaga *et al.* (2016a; 2016b).	-
(35)	Since body length is a poor proxy for age, particularly in sexually mature whales, incorporate age data into the multivariate analysis of pollutant concentrations as soon as they become available.	2-3 years after the 2016 Annual Meeting: The proponents agree and will undertake work. **2017 Panel: no progress presented at the meeting. However, in light of the proponents' comments, the Panel stresses that this recommendation can be implemented without collecting additional samples and the results can be presented within the suggested timeline.**	*This item will be addressed under Ancillary Objective I (i) of the research plan for NEWREP-NP.*
(36)	To include stable isotope values in the analyses to investigate the bioaccumulation process of pollutants through the food chain.	2-3 years after the 2016 Annual Meeting: The proponents agree and will undertake work. See comments in SC/J17/JR02.	*See progress on Recommendation 23. Proponents will integrate this result for investigating the bioaccumulation process of pollutants.*
(37)	To assess more widely the risk that these chemical pollutants present to the populations' abundance or distribution.	2-3 years after the 2016 Annual Meeting: The proponents agree but for long-term. They note no health risk from OCs or Hg thus far. **2017 Panel: no progress presented at the meeting. However, in light of the proponents' comments, the Panel stresses that this recommendation can be implemented without collecting additional samples and the results can be presented within the suggested timeline.**	*This item will be addressed under Ancillary Objective I (iii) of the research plan for NEWREP-NP.*
Ageing (Item 9.1.2)			
(38)	To investigate into whether there is any relationship between age or sex and readability that may affect the representativeness of the earplugs that can be read.	2 years after the 2016 Panel review: The proponents agree and work is underway. **2017 Panel: progress in this area was presented at the meeting (see Annex D). See Item 3.3.3 and 4.4.3.2 for 2017 Panel's full comments.**	*Some additional progress of ageing methods is provided under Item 3.2 in this Review Workshop.*
(39)	To age as many of the existing samples as possible and to incorporate age where appropriate in updated analyses (e.g. see the recommendations on pollutant studies).	2 years after the 2016 Panel Review: Work is underway. **2017 Panel: no progress presented at the meeting.**	*Analyses are ongoing. See also progress on Recommendation 38.*
Recommendations to the Scientific Committee on process (Item 11)			
(40)	The Panel recommends that the Scientific Committee considers: (a) including a guideline either relating to the minimum time after completion of a programme that a final review can take place or establishing a small review group to determine whether the materials available are for a review Workshop; (b) adopt guidelines for an integrated final report by the proponents. (c) to consider a mechanism for proponents to provide a short biennial update on progress with recommendations. (d) develop a mechanism to allow for the completion of expert panel reviews if a Panel states that its review is incomplete until further information/analyses is provided.	Some of these matters are under consideration by the Scientific Committee - see Item 26.3 in IWC (2017b). **The Panel reiterates recommendations 40a, 40c and 40d. See Item 3.3.5 and 5.1 for 2017 Panel's full comments.**	Proponent's representatives are fully involved in the intersessional work carried out by the Intersessional Correspondence Group on 'Annex P'.

3.2 Update analyses incorporating data up to 2016 and responding to recommendations made in IWC (2017a)

3.2.1 Proponents' overview

In concordance with the timeline agreed in the 2016 IWC SC Annual Meeting, SC/F17/JR02 presented the overall progress of the work and analyses implemented by the proponents since the IWC SC Annual Meeting in 2016 in response to the recommendations made in IWC (2017a). Responses to the recommendations are being implemented. Table 1 of SC/F17/JR02 presented a list of the data by JARPN II in the period 2014-16 related to the three objectives of JARPN II, obtained both in the field as well at the laboratory. The complete data set (2000-2016) is being used to implement some of the analytical recommendations in IWC (2017a). Table 2 of SC/F17/JR02 presented a summary of the work conducted by the proponents in response to each of the 38 recommendations in IWC (2017a). Appendices to this table were prepared when the progress made on a particular recommendation was considered substantial. For example, substantial progress has been made in responding to the recommendations on stock structure (Recommendations 4, 5, and 6). Final reports on some recommendations on stock structure will be reported to the upcoming Bryde's whale *Implementation Review* Workshop and the annual meetings of the IWC SC. Substantial progress was made on the treatment of uncertainty associated with the estimation of prey consumption by whales (Recommendation 18), on the investigation of the effects of seasonal changes in energy density of the various prey species on the analyses of diet composition (Recommendation 22), and on Recommendation 23, on the stable isotope analysis of whale tissues and their prey species.

Also substantial progress was made on the recommendation on ageing (Recommendation 38). At present, age is a key type of information for studies on life history, stocks and population dynamics of whales. The earplug is considered the most reliable source of absolute age determination in baleen whales. Under JARPN and JARPN II surveys, all earplugs were carefully collected and attempts were made to read growth layers in all earplugs collected. In 2007, a new sampling technique (Gelatinized Extraction Method) was developed to prevent damage of earplugs at the collection stage for common minke whales. As a result, age readability of North Pacific common minke whales could be improved from 8.7% in the past commercial whaling to 44.1% (45.2% for males, and 41.2% for females) in the JARPN and JARPN II surveys. In recent years, the Gelatinized Extraction Method was also applied to North Pacific sei whales. For earplugs collected in 2014 to 2016, laboratory work was carried out to read growth layers. New age data (96 earplugs for common minke whales, 118 earplugs for sei whales) were added to the data set, and further research on the relationship between body length/sex and readability, was made. Readability increased with body length class in both sexes.

SC/F17/JR03 presented results of the feasibility study on non-lethal techniques to address the main research objective of JARPN II (feeding ecology and ecosystem studies), based on data and samples obtained by JARPN II surveys during 2014-2016. Both field (biopsy and faecal sampling) and analytical techniques (stable isotope and fatty acids that potentially can be used based on biopsy samples and DNA analyses that potentially can be used to investigate prey in faecal samples), were investigated and evaluated. Evaluation of the techniques was conducted using a conceptual frame (protocol) developed by Mogoe *et al.* (2016), which includes four main questions: Q1: Can a tissue and other samples be obtained by a non-lethal method?; Q2: Can enough samples be obtained for statistical analyses?; Q3: Can the samples obtained by a non-lethal method produce scientific information comparable to that produced by a lethal sampling?; Q4: Is the cost for obtaining the sample and for producing scientific information reasonable? All of the four tests need to be satisfied to conclude that a particular non-lethal method is feasible and practicable to the extent that it can replace lethal sampling. Regarding biopsy sampling, response to Q1 was 'Possible' for the three species (common minke, sei and Bryde's whales); response to Q2 was 'Possible' for sei and Bryde's whales and 'Difficult' for common minke whale. Regarding faecal sampling, the response to Q1 was 'Possible' for sei whale and 'Very difficult' for common minke and Bryde's whales; response to Q2 was 'Very difficult' for the three species. Further analyses are required to respond to Q3 regarding isotope and fatty acid techniques using biopsy samples. Regarding the DNA analysis of faeces (intestine samples were used instead), response to Question 3 was 'Difficult' for the three species. In summary these results suggested that, given the main objective of JARPN II and available research resources, biopsy sampling is not feasible for common minke whale in the coastal area, and faecal sampling is not feasible for all three whale species at this stage. Further analyses on new non-lethal techniques will be conducted under the NEWREP-NP programme taking into account the results and progress made in JARPN II (see agenda item 4.2.2).

3.3 Panel conclusions and recommendations

The Panel noted that relatively few new analyses were presented but noted that field and laboratory data for the period 2014-16, as specified by objective, had become available; this is discussed by topic below. SC/J17/JR02rev1 contains some new information and results, and additional results were presented on ageing techniques at the review meeting, during open sessions (see Annex D). Recommendations for which substantial new information was available are discussed in the following paragraphs.

3.3.1 Stock structure

RECOMMENDATION 5

The Panel noted that analyses applying STRUCTURE to genotypes from Bryde's and sei whales were presented at SC/66b (Pastene *et al.*, 2016). The results of additional DAPC-based analyses of Bryde's whale genotypes were presented during the NEWREP-NP meeting (SC/J17/JR02rev1). None of the above analyses detected the presence of multiple clusters. Additional assessments of potential genetic structuring in North Pacific common minke whale presented thus far by the proponents have confirmed O and J stocks, but not detected further structure. However, the Panel noted the long-standing difficulties arising from the fact that an inability to reject the null-hypothesis of a single stock is not the equivalent of 'proof' that there is only one stock. That being said, the Panel **reiterates** the need for additional analyses of existing samples as outlined during the JARPN II report and considered further under Item 4.

3.3.2 JARPN II component on 'Feeding ecology and ecosystem studies - Field and laboratory studies'

RECOMMENDATION 18

The Panel noted that there appears to have been a misunderstanding in the interpretation of what was meant by the use of 'the sampling distribution of the parameters' in the recommendation. SC/J17/JR02rev1 shows the triangular distributions (and uniform distribution for assimilation efficiency) assumed in the Monte Carlo analysis, and calls this the 'data distribution'. As the actual data are not plotted, it is not possible to determine if they follow a triangular distribution, and any revised document should address this. More importantly, however, the intention of the recommendation was to investigate assumed parameter distributions other than the triangular distribution, because the 2016 Panel felt the triangular distribution put too much weight in the tails of the distribution and that a bootstrap approach (which would naturally follow the distribution of the actual data) would have been an improvement. The present Panel **agrees** that, in order to address this recommendation, the proponents should examine the actual sampled data distributions for body weight and caloric value of prey species and compare these to the triangular distributions used.

RECOMMENDATION 22

The Panel noted that the new table in SC/J17/JR02rev1 combines the previously presented energy content analysis with the diet compositions to examine overall energy content per unit weight of prey by season. However, it appears no additional sampling of prey energy density across seasons occurred in response to the recommendation. The Panel noted that the original recommendation was more towards addressing whether energy content of individual prey species changes seasonally, which may not be detectable with the original samples. With such small sample sizes of individual prey for energy density, differences between seasons are extremely difficult to detect, but this was not commented on, nor was the power to detect changes considered by the proponents. Given this, any differences between energy content for prey as a whole by season for each cetacean species may therefore be driven by changes in diet composition, changes in energy content, or both. Some discussion or conclusions in addition to the provided tables (e.g. on whether or not these differences are significant, and if additional sampling of prey energy content to resolve this matter had been or will be conducted) will help determine whether this recommendation has been sufficiently addressed by the proponents. In some ecosystems, prey energy content has changed over time as well as seasonally, so monitoring for this type of information would be useful to determine how ecological changes may affect cetacean productivity.

RECOMMENDATION 23

The Panel noted that the information in SC/J17/JR02rev1 represented a good start towards addressing the stable isotope recommendations. The comparison of the data from different sources and discussion of where and why isotopes agree with stomach data or not are interesting but there is a lack of detailed consideration of comparable data from other studies (e.g. Iceland) or a discussion of how the information from the various techniques relate to the ability to reach the broader objectives of JARPN II. In summary, the paper begins to address each of the components of the recommendation although did not answer them fully with this brief study. Further discussion is provided under Item 3.3.4.

OVERALL

The Panel **stresses** that for a final review, a synthesis document should be developed combining all of the parts of the uncertainty analysis to indicate the largest sources of uncertainty in consumption estimates - such a comprehensive overview has not yet been developed.

3.3.3 Ageing techniques

The Panel was pleased to learn that the work to improve ageing techniques for baleen whales is still ongoing. It re-iterated the 2016 commendation of the progress made in the development of the gelatinised extraction method. Further discussion can be found under Item 4.2.1.

3.3.4 Comparing lethal and non-lethal approaches

General, as well as specific discussions on lethal versus non-lethal approaches in whale research under Special Permits have occurred several times in the IWC Scientific Committee in the past (e.g. IWC, 1998; 2014b). The complexity of the issue was recognised along with the need for consideration of a number of disciplines, not all of which are scientific and/or require value judgements that may be considered subjective (e.g. economics, 'ethics', 'importance' of objectives). Scientific issues of concern include the practical aspects of collecting the data, which laboratory and analytical methods to use, quantification of comparable uncertainty and the interpretation of the results in the context of objectives.

The Panel **welcomes** SC/J17/JR03 presenting the results of the feasibility study on non-lethal techniques to address the key research objective of JARPN II, based on data and samples obtained during 2014-16. The objectives of JARPN II for those three years had been reprioritised in part to conduct a comparative study of lethal versus non-lethal techniques. A comparison of lethal and non-lethal techniques had been recommended by previous Panels. The Panel noted that several of the analyses are preliminary, perhaps not unexpected given that some of the data were collected less than a year ago. Comments on the various analyses presented are provided below.

CONCEPTUAL FRAMEWORK

Recognising that there is no single agreed approach to addressing the comparison of lethal and non-lethal techniques, the Panel **welcomes** the fact that the proponents have developed a conceptual framework to evaluate the feasibility and practicability of non-lethal techniques as one good way to structure data collection, analyses and reach conclusions (Mogoe *et al.*, 2016). Whilst the four general questions provide a suitable foundation for the framework, the Panel commented on the lack of quantifiable definitions of the terms used e.g. 'enough', 'comparable', 'reasonable', and 'costs'. The first three questions are primarily scientific, whereas the fourth - whether the cost for obtaining the sample/producing scientific information is 'reasonable' - while important, is vague upon how this will be evaluated either in terms of what would be considered as 'reasonable' or what will be included in the term 'cost'. For example, cost could include one, some or all of the following (this is an illustrative not an exhaustive list of possibilities), for both lethally and non-lethally obtained samples:

(a) the cost of collecting the sample alone;
(b) the cost of processing the sample in the laboratory;
(c) the cost of analysing the data as part of a broad analysis;
(d) the cost of individual components or an integration of all components in a multi-objective programme;
(e) the inclusion or exclusion of some or all costs associated with using existing material (e.g. vessels, equipment) and personnel (e.g. permanent staff versus contract staff, expertise and training); and
(f) the offset of costs against the sale of products (e.g. whale meat).

The Panel **agrees** that an expansion and clarification of the conceptual framework will help provide a way to evaluate Special Permit programmes that combine lethal and non-lethal sampling methods and optimise data collection methods in the light of objectives (and see Item 5.4.1).

BIOPSY SAMPLING

The Panel **agrees** with the proponents' conclusions that it is feasible to collect biopsy samples from all three species, minke, sei and Bryde's whales (question 1 of the framework) and that it is efficient to collect biopsy samples from at least sei (147 targeted) and Bryde's (117 targeted) whales (question 2). In that regard, it noted that the IWC-POWER cruises had already answered these questions for sei and Bryde's whales from a similar vessel to that used offshore by JARPN II.

The Panel also **agrees** that it is more difficult to biopsy sample common minke whales than the other species. However, the Panel **stresses** that insufficient effort (number of targeted animals and expertise) had been put into the feasibility study for common minke whales to allow a conclusion to be reached on the efficiency for that species based upon adequate data. Only 17 common minke whales had been targeted during 2014-16 although determining this efficiency had been a key component of the reprioritisation of JARPN II for those years. The additional information provided by the proponents in response to questions (Annex D) confirmed that:

(a) the advice from previous Panels that scientists with expertise in biopsy sampling common minke whales should be involved had not been followed;
(b) insufficient time had been allocated to the experiment for common minke whale biopsy sampling to determine if it was feasible; and
(c) the amount of effort dedicated to biopsy attempts for common minke whales was greatly exceeded by that effort used to catch common minke whales, making comparison of the two approaches infeasible.

These factors render any analysis of relative efficiency for this species from the existing data premature.

Given this, the Panel **recommends** that a properly designed experiment to assess the efficiency of biopsy sampling of common minke whales be undertaken (there is already sufficient detail on catch to render additional capture experiments unnecessary). This should incorporate at least:

(a) the use of the expected vessels in the programme (i.e. the small type whaling vessels);
(b) the use of vessels (that may be different) considered suitable by scientists already experienced with biopsy sampling this species;
(c) suitable levels of effort to allow a statistical comparison (effort for biopsy sampling should be measured or converted to the same effort used for examining catching efficiency);
(d) effort should be carried out in various environmental conditions (e.g. sea state, swell, visibility) up to the maximum conditions that would apply to whaling;
(e) advice and training from invited experienced minke whale biopsy samplers (e.g. Christian Ramp or Lars Kleivane); and
(f) analyses that provide a proper comparison of biopsy sampling and catching (including time to process samples under various variables such as experience of sampler, vessel, equipment, effort under similar conditions).

FAECAL SAMPLES

The Panel **agrees** that it is not feasible to use faecal samples to collect diet information for North Pacific minke, Bryde's and sei whales and further attempts are not worthwhile. In addition to the relatively low observations of faecal matter, another important reason for this decision is the issue that some parts of the faecal samples quickly sink and thus could easily be lost if not collected almost immediately; this will lead to bias of any resultant analyses.

STABLE ISOTOPES AND FATTY ACIDS

The Panel **welcomes** the analyses of the stable isotopes and fatty acids presented by the proponents. SC/J17/JR02rev1 provided a progress report on relevant recommendations from the JARPN II final review. Appendix 6 of that report addressed recommendation 23 and included a preliminary analysis of stable carbon and nitrogen isotopes ratios in the skin of sei and Bryde's whales and their prey. The Panel made several observations about the methods and results. Sample sizes of skin from sei and Bryde's whales were relatively large (n=180 and 50, respectively). However, sample sizes for prey were small (one prey item had a sample of 10 while the other seven prey items had samples sizes less than 5). There was considerable overlap in isotope ratios for most prey of sei whales, although copepods and krill appeared different from fish. There was no overlap in the ratios for prey of Bryde's whales. Although mixing models were used to estimate diet based on stable isotope ratios, a major flaw was that the results did not include estimates of uncertainty. This was especially problematic for sei whales for which stable isotopes suggested the diet was substantially different than analysis of stomach contents. As well-known and referred to in several previous Expert Panel reports (including that for the Icelandic Special Permit final reviews), stable isotopes and stomach contents provide information on diet at different time (and geographical) scales; comparisons must thus be undertaken carefully. Stable isotopes likely represent diet over the previous several months while stomach contents represent recent feeding bouts. Thus, one must include a careful consideration of uncertainty in any analyses before formal conclusions on differences in diet can be made. The Panel noted that the results from the mixing model of stable isotopes from whale skin suggest a much greater precision in diet than is justified given the overlap in the stable isotope ratios of many of the prey items.

The Panel **recommends** the proponents to review and apply the approach used by Iceland for analysis and comparisons of stable isotopes, fatty acids and stomach contents (IWC, 2014a). Icelandic researchers presented detailed results of prey species found in whale stomachs and acknowledged the biases associated with that type of study. For stable isotopes, they did not try to estimate the prey species, but rather compared the estimated trophic levels as measured in the whale's skin with prey found in the stomach. For fatty acids, they used a qualitative approach and analysed three different tissues, including inner and outer blubber. They concluded that the inner layer of blubber best represents diet, but there was considerable spatial and temporal variation in fatty acids.

The Expert Panel for the review of the Icelandic programme strongly recommended that 'integrated analyses including comparison of the information from each approach [i.e., stomach contents, stable isotopes, and fatty acids] (including consideration of uncertainty) be developed and submitted to the Scientific Committee.' The Panel **recommends** this approach also be used for the JARPN II investigation of foraging ecology.

NEXT-GENERATION-SEQUENCING (NGS)

The Panel **acknowledges** the attempt to use Next-Generation-Sequencing (NGS) techniques for prey determination in stomach/intestine and faecal samples. It however notes that the sensitivity of such an approach critically depends on the experimental setup prior to sequencing. Specifically, the proponents used universal primers developed for DNA barcoding, targeting amplicons of >500bp. This approach is suited for DNA of high quality. However, both in stomach/intestine and faeces, DNA of prey species can be expected to be highly degraded, such that the application of universal primers constitutes a strong filter, likely to detect only a limited fraction of the DNA of prey species that was present. The Panel therefore **recommends** that if additional studies with faecal samples are undertaken, application of techniques tailored to degraded DNA, i.e. amplification of small amplicons or hybrid capture, both methods well established in faecal, environmental and ancient DNA research. Further, if the prey species to be expected are known beforehand, amplification/hybrid capture can be designed to specifically target these species, enhancing both specificity and sensitivity.

3.3.5 Overall conclusion and the Annex P process

The Panel noted that a full 'final' review of the JARPN II programme will be possible only when final analyses are completed, in line with the IWC SC-agreed timeframe for analyses, and a full consolidated report made available. Given the recurring difficulties with finalising reviews, in terms of Annex P process, the Panel **reiterates** some of the 2016 Panel recommendations, in particular that the Scientific Committee considers:

(a) including in Annex P a guideline relating to the minimum time after the field programme/the programme itself is completed that a final review can take place. This time must allow the completion of all analyses related to the programme's objectives. The Panel **agrees** that a full description of the fieldwork, collected samples and data and preliminary results are not to be considered sufficient to call a final review.

(b) to consider a mechanism for proponents to provide a short biennial update on progress with recommendations. Given the biennial cycle of the Commission, the Scientific Committee needs to be informed about progress only in years when the Commission meet.

(c) develop a mechanism to allow for the completion of Expert Panel reviews if a Panel states that its review is incomplete until full further information/analyses is provided/concluded.

4. REVIEW OF THE RESEARCH PROGRAMME PROPOSAL

4.1 Objectives of the proposal

This section evaluates the various primary, secondary and ancillary objectives of the proposal in terms of their 'in principle' contribution to the conservation and management of whale stocks and of other living resources. It does not consider whether the proposed research is feasible, whether the sample sizes are sufficient to address the objectives, and the relative benefits of the additional samples proposed to be collected during NEWREP-NP. These aspects are discussed under Item 4.2. Most of the discussion focussed on the Secondary Objectives - the Panel **agrees** that the broad primary objectives are important to the conservation and management of whales.

4.1.1 Proponents overview

The NEWREP-NP has the following Primary and Secondary Objectives (details in sections 2.1 and 2.2 of SC/J17/JR01):

Primary Objective I: Contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan.

Secondary Objectives

I (i): Investigate the spatial and temporal occurrence of J stock minke whales around Japan, by sex, age and reproductive status.

I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan.

I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan.

I (iv): Improve RMP trials by incorporating age data in their conditioning.

I (v): Investigation of the influence of regime shift on whale stocks.

The proponents consider that it is difficult to reconcile the results of the 2013 RMP *Implementation Review* for western North Pacific common minke whales with the empirical observations from the field. For example, the average catch under the New Management Procedure (NMP) in 1978-1987 was 340 animals but no sign of decreasing CPUE under this level of catches was observed. On the other hand, no drop in the J stock bycatch under constant effort in Japan has been observed and the J/O stock proportion has increased over the past 30 years on the Pacific side of Japan. The wide discrepancy between the empirical evidence from the field and the results of the 2013 *Implementation Reviews* suggests problems with the interpretation of data and key assumptions used in the population assessment under the RMP *Implementation Review*. Some of the questions which research needs to address are the following: (a) Is the J stock heavily depleted? (b) Is there an Ow stock on the Pacific side of Japan? (c) Were the abundance estimates of O and J stocks sufficient and reliable? (d) Was sufficient use made of biological (e.g. age) data during the conditioning? (e) What is the effect of the major environmental change (e.g. regime shift) on the distribution/abundance of common minke whale?

NEWREP-NP will attempt to respond to these questions under the five Secondary Objectives listed above. Response to the questions above will assist and improve the next RMP *Implementation Review* to be conducted by the IWC SC starting probably in 2018 or 2019, particularly for its work of developing and conditioning of trials.

The key information requiring lethal sampling is the age of the animals, which is essential for Secondary Objective I (iv). The intent under this objective is to determine whether and how well, using the SCAA methodology to analyse the future age data generated, it is possible to detect changes in recruitment (strictly in the number of recruits per adult female) and other biological parameters.

Primary Objective II: Contribution to the RMP/*IST* for North Pacific sei whale.

Secondary Objectives

II (i): Abundnace estimates for North Pacific sei whale taking account of additional variance.

II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*.

II (iii): Additional anayses on stock structure in North Pacfici sei whale for RMP *Implementation*.

II (iv): Specification of RMP *IST*s for North Pacific sei whale.

II (v): Investigation of the influence of regime shift on whale stocks.

No RMP *Implementation* has been conducted previously for North Pacific sei whale by the IWC SC. Considerable information on stock structure and abundance has been accumulated in recent years from JARPN II surveys as well as from IWC POWER. The idea under this primary objective is that the data collected so far, in addition to biological (e.g. age data) to be collected under the NEWREP-NP, will be used as input information for the current in-depth assessment, as well as for future RMP *Implementation* to be conducted by the IWC SC, including the *pre-Implementation assessment*. In particular, the use of age data in the conditioning of trials has the potential to improve the *Implementation*.

The research needs under this primary objective are the following: (a) Confirm the existence of a single pelagic stock; (b) Get new series of abundance estimate and its precision; (c) Estimate biological parameters such as natural mortality; (d) Use of biological data (e.g. age) during the conditioning of trials; and (e) Investigate the regime shift, and its implication for management.

NEWREP-NP will address these research needs under the five Secondary Objectives listed above. By doing this, NEWREP-NP will assist and improve the current in-depth assessment, future pre-implementation assessment and RMP *Implementation*.

The key information requiring lethal sampling is the age of the animals, which is essential for Secondary Objective II (ii). As in the case of common minke whale, the intent under this objective is to determine whether and how well, using the SCAA methodology to analyse the future age data generated, it is possible to detect changes in recruitment (strictly in the number of recruits per adult female) and other biological parameters such as natural mortality.

Ancillary Objective I: Examination of the effects of pollutants on whale stocks.

In 1980, the Special Scientific Committee Working Group on Management Procedures identified that 'Management measures should take into account the effect on whale stocks of environmental changes due either to natural causes or to human activities' as one of the principles for whale management.

In response to this suggestion, the JARPN II conducted environmental studies under one of its objectives ('Monitoring environmental pollutants in cetaceans and the marine ecosystem'). It was observed that PCB levels in common minke whales and total mercury (Hg) levels in common minke, Bryde's and sei whales, did not change during the research period, and were sufficiently under their thresholds in other whale species. It was suggested that the adverse effects of pollutants such as PCB and total Hg to whale health could be low in the area. On the other hand, some areas for further research were identified: (i) examination of possible adverse effects of pollutants with adjustment for confounding factors such as nutritional condition and age; (ii) species differences in sensitivity and response to pollutants; and (iii) investigate adverse effects of novel compounds. Research under these items will be conducted under this ancillary objective.

Ancillary Objective II: Study of distribution, movement and stock structure of large whales with particular emphasis on blue and North Pacific right whales.

JARPN and JARPN II were useful platforms for the collection of biopsy and photo-id data from large whales, included the depleted North Pacific right whale. NEWREP-NP also will be a platform for further collection of those kinds of data, particularly for blue and right whales. For blue whales the IWC SC recommended the analysis of biopsy samples from the central and western North Pacific for comparison with genetic data from the eastern North Pacific population. NEWREP-NP will contribute with additional biopsy and photo-id data for such purpose.

The IWC SC has welcomed the research on distribution, movement and stock structure of North Pacific right whales. The only genetic study on stock structure was based on samples collected in the eastern North Pacific. The available biopsy samples from JARPN II and those to be obtained by NEWREP-NP will allow the genetic comparison between eastern and western North Pacific right whales.

In conclusion, the proponents consider that Primary, Secondary and Ancillary Objectives above are important for the improvement of the conservation and management of whale stocks for the following reasons (see details in section 2.5 of SC/J17/JR01):

(a) Collection and analyses (following guidelines and recommendations from the IWC SC) of relevant data and samples (abundance, stock structure, and biological parameters) will improve the application of the RMP to the western North Pacific common minke and North Pacific sei whales.
(b) Those data, samples and analyses will contribute to the next *Implementation Review* in the case of the western North Pacific common minke whale, and the completion of an in-depth assessment and the carrying out of the pre-implementation assessment and RMP *Implementation* in the case of sei whale.
(c) Information on stock structure (biopsy) and abundance trends (sighting surveys) in large baleen whales, including the North Pacific right and blue whales, will contribute to understanding of the patterns of recovery of those whales after past commercial whaling. These works have been encouraged and recommended by the IWC SC.
(d) Research on the health of whales is directly related to whale conservation purposes, and studies in this field have been recommended by the IWC SC.

The proponents consider that Primary, Secondary and Ancillary Objectives above are important for the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part for the following reasons (see details in section 2.5 of SC/J17/JR01):

(a) under the Secondary Objective on regime shift, NEWREP-NP will contribute to the understanding of the interaction between whales and several components of the ecosystem, of which they are part;
(b) research on regime shifts will contribute to better understanding of the dynamics of fish resources and in turn improve their management; and
(c) new ecological data from NEWREP-NP will contribute to the effort to develop ecosystem models by JARPN II researchers and other organizations.

The proponents consider that Primary, Secondary and Ancillary Objectives above are important *for testing of hypotheses not directly related to the management of living resources* for the following reasons (see details in section 2.5 of SC/J17/JR01):

(a) information will be provided to characterize the oceanographic structure and dynamics of the research area;
(b) long-term oceanographic data will provide insight into whether or not environmental changes are occurring in the research area, particularly in the context of global warming.

NEWREP-NP will contribute information about the effects of marine debris on cetaceans.

4.1.2 Importance of stated objectives from a scientific perspective and for the purposes of conservation and management of whale stocks

4.1.2.1 CONTRIBUTION TO PAST RECOMMENDATIONS OF THE SCIENTIFIC COMMITTEE

Recent recommendations and research needs identified by the IWC Scientific Committee relevant to Secondary Objectives of the NEWREP-NP were summarised by the Proponents below.

Secondary Objective I (i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status.

(a) 'There is still a lack of information on stock structure in sub-areas 10 and 11. This is very important to the in-depth assessment' (IWC, 2008b, p.198).
(b) Several recommendations listed in IWC (2010b) are relevant to this objective.
(c) 'In light of continued uncertainty about the best way to deal with purging of samples that do not demonstrate strong assignment to either the O or the J stock of common minke whales, the Committee suggests to the proponents that:
(d) including the results of analyses conducted on both purged (at various levels) and non-purged samples would be valuable in the future; and
(e) further exploration of the relationship between departures from Hardy-Weinberg equilibrium and FST values for individual microsatellite loci be conducted with the expanded dataset, given that this method may be informative in evaluating hypotheses of mixing' (IWC, 2017b, p.47).

Secondary Objective I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan.

(a) 'The Committee therefore recommends that variance-covariance matrices be computed for the entire time-series of abundance estimates for sub-areas 7CS, 7CN, 8, and 9' (IWC, 2013b, p.10).

(b) 'The Committee strongly recommends that the Government of the Russian Federation give permission for the survey to take place in its EEZ in the Sea of Okhotsk throughout sub-area 12, given the importance of abundance estimates for sub-area 12 to the understanding of the status of common minke whales in the western North Pacific' (IWC, 2013b, p.15).
(c) 'The Committee recommends continued development of appropriate confidence intervals for g(0) be developed (e.g. using resampling approaches). This information will be of value in the expected 2018 *Implementation Review* of western North Pacific common minke whales, particularly in the context of also estimating additional variance' (IWC, 2017b, p.13).
(d) 'Compare results from the design-based estimates of abundance with those of model-based estimates to potentially address problems of unequal sampling coverage between surveys and to potentially account for additional sources or causes of variability' (IWC, 2017b, p.87).
(e) 'Explore methods to account for sampling differences between areas and years to obtain measures of short-and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models)' (IWC, 2017b, p.87).

Secondary Objective I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan.

(a) Several recommendations listed in IWC (2010b) are relevant to this objective.
(b) 'In order to be able to evaluate the preliminary analysis presented, the Committee recommends that a paper to examine the spatial distribution of close kin in North Pacific minke whales be submitted by the proponents for review at next year's meeting. In the interest of providing advice to the proponents that might be useful as this analysis moves forward, the Committee:
(c) emphasises the importance of evaluating the potential for false positive and false negative detections of parent offspring pairs (Tiedemann *et al.*, 2014);
(d) encourages the authors to explore different approaches (e.g., software) to conduct kinship-based analyses; and
(e) recommends that the samples be genotyped at additional loci (microsatellites or SNPs) to validate the putative parent offspring pairs that were identified' (IWC, 2017b, p.47).

Secondary Objective I (iv): Improve RMP trials by incorporating age data in their conditioning.

(a) 'Thus, if the *Implementation Simulation Trials* for the western North Pacific minke whales are to be revised in the future, the age data should be included in the conditioning process' (IWC, 2017a, p.542; 2017b).

Secondary Objective I (v): Investigation of the influence of regime shifts on whale stocks.

(a) 'Oceanographic monitoring is required to compare with prey species distribution and abundance in the new 'decadal regime'' (IWC, 2017b, p.87).
(b) 'Explore methods to account for sampling differences between areas and years to obtain measures of short-and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models)' (IWC, 2017b, p.87).
(c) 'In the medium-term, the Panel recommends further oceanographic monitoring to compare with prey species distribution and abundance in the new regime' (IWC, 2017a, p.548).

Secondary Objective II (i): Abundance estimates for North Pacific sei whale taking account of additional variance.

(a) 'The Committee looks forward to receiving consolidated analyses of results from a number of recent and past surveys on North Pacific sei whales at next year's meeting' (IWC, 2017b, p.36).
(b) 'Explore methods to account for sampling differences between areas and years to obtain measures of short-and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models)' (IWC, 2017b, p.87).
(c) 'Compare results from the design-based estimates of abundance with those of model-based estimates to potentially address problems of unequal sampling coverage between surveys and to potentially account for additional sources or causes of variability' (IWC, 2017b, p.87).

Secondary Objective II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*.

(a) 'The Committee recommends the work plan in Appendix 5, Annex G….' which stated that 'Historical age and reproductive data from commercial whaling in the eastern and western North Pacific should be recompiled and presented, so that comparisons with results from modern catches can be made when the latter are available' (IWC, 2008a, p.50).

Secondary Objective II (iii): Additional analyses on stock structure in North Pacific sei whale for RMP *Implementation*.

(a) 'In the case of North Pacific common minke, Bryde's and sei whales, as with several other baleen whale populations assessed by the Committee, the lack of samples from breeding areas makes discriminating between stock structure hypotheses difficult. All of the analysed samples were collected in areas used by feeding and/or migrating whales, and thus could represent a mixture of animals from different breeding stocks. Thus, in addition to longstanding advice to try to locate breeding grounds, the Committee emphasises the importance of using methods that do not require a priori stratification of samples (e.g. DAPC, PCA) when analysing these datasets, while noting that the power of such methods to detect weak levels of differentiation needs to be assessed' (IWC, 2017b, p.46).
(b) 'The Panel has developed a number of recommendations….' 'The presence of multiple stocks within sample partition should be assessed (employing, e.g. STRUCTURE and DAPC) for Bryde's and sei whales' (IWC, 2017a, p.543; 2017b).

Secondary Objective II (iv): Specification of RMP *IST*s for North Pacific sei whale.

(a) 'Thus, if the *Implementation Simulation Trials* for the western North Pacific minke whales are to be revised in the future, the age data should be included in the conditioning process' (IWC, 2017a, p.542; 2017b) (also relevant for sei whales).

Secondary Objective II (v): Investigation of the influence of regime shift on whale stocks.

(a) Same as I (v) above.

The Panel noted these recommendations and **agrees** that the objectives of the proposal are relevant to many Scientific Committee recommendations. In doing so, it notes that a number of the JARPN II final review recommendations concerned improved or new analyses of existing data rather than the collection of new data.

4.1.2.2 CONTRIBUTION TO THE COMPLETION OF THE COMPREHENSIVE ASSESSMENT OR IN PROGRESS OR FUTURE IN-DEPTH ASSESSMENTS

The Panel noted that as written, Primary Objective II relates to providing a 'Contribution to the RMP/*IST*' for North

Pacific sei whales and thus should be discussed under Item 4.1.2.3. However, to date there has been no request for the Scientific Committee to undertake an *Implementation* for this species/region, which in any event could only occur after the completion of a *pre-Implementation assessment* and would require approval by the Commission (see Fig. 2). Rather, the Scientific Committee is currently undertaking an in-depth assessment of North Pacific sei whales. Once the in-depth assessment is completed it could form the basis for a *pre-Implementation assessment* and ultimately an *Implementation*. Therefore, the Panel's views of Primary Objective II are provided under this Agenda Item and references as to any possible future *Implementation* for North Pacific sei whales in this report are phrased in terms of 'should one occur' rather than 'when one occurs'.

An in-depth assessment involves developing models that reflect hypotheses regarding stock structure, parameterized using biological parameters such as MSY rate, natural mortality rate, pregnancy rates, and the age-at-maturity and fitted to available data, such as estimates of abundance, mark-recapture data and age-composition information.

Secondary Objective II(i) – Abundance estimates taking account of additional variance. NEWREP-NP will provide two estimates of abundance for sei whales west of 170°E over the 12-year duration of the programme. These estimates, in conjunction with estimates for other parts of the North Pacific (e.g. from IWC-POWER surveys), will provide important information for estimating parameters of population models for North Pacific sei whales. Information on abundance is always important for conservation and management, but the contribution to the present in-depth assessment will depend on how long it takes to complete. Should an *Implementation* occur, then abundance is a key parameter and more abundance estimates are always better (the RMP is a feedback procedure). The additional contribution of new surveys depends on their precision (which will include sampling error as well as additional variation) and the current number and quality of abundance estimates.

Secondary Objective II(ii) – Estimation of biological and ecological parameters. The data currently available could allow parameters such as natural mortality and fishery selectivity to be estimated; the potential value of information from additional samples is discussed under Item 4.2. Issues related to the time scale above (with respect to the completion of the in-depth assessment and the potential for a future *Implementation*) for abundance estimates are also relevant for this Secondary Objective. Estimation of these parameters would improve understanding of the population dynamics of North Pacific sei whales, but it is currently unclear how precise and with what bias the estimates of these biological parameters will have. However, the key 'biological' parameter is the MSY rate, which the proponents do not plan to estimate. The proponents aim to address this Secondary Objective using biological data (related to age, sex and reproductive class) collected using lethal means as well data such as survey estimates of abundance.

Secondary Objective II(iii) – Additional analyses on stock structure. Stock structure is integral to any in-depth assessment. The Panel noted that NEWREP-NP is focused on the pelagic region of the North Pacific, which the Scientific Committee has agreed probably contains only a single stock (IWC, 2016b) based upon the existing data and analyses. Thus, the Panel **agrees** that the additional value new information might provide to the in-depth assessment (or any potential future *Implementation*) is unclear (and see Item 4.2). The proponents aim to address this objective using a range of approaches, in part using data collected using lethal sampling.

Secondary II(iv) – Specification of ISTs. Should an *Implementation* to be conducted in the future, then formally specification (and coding) of *IST*s is the responsibility of the Scientific Committee. However, the Panel **agrees** that a 'strawman' set of specifications could assist the work of the Scientific Committee.

Secondary Objective II(v) – influence of regime shift. The Panel noted that the objective lacked a practical definition of 'regime shift' (and see Item 4.2 for feasibility discussions). In fact, the objective appears to relate to the impacts of environmental variability, and the Panel **agrees** that this terminology is more appropriate. The Panel **agrees** that analysis of cetacean biological/physiological responses (e.g. blubber lipids, body condition, etc.) to 'environmental variability' is worthy of investigation. Such analyses would contribute to the basic understanding of responses of cetaceans to environmental factors (George *et al*., 2015; Harwood *et al*., 2015; Schick *et al*., 2013). However, the Panel also **agrees** that this sub-objective would be better treated as an ancillary objective in that it is unlikely to make a direct contribution to the in-depth assessment or even an *Implementation* within a reasonable timeframe. This is partially due to enormous difficulties identifying more than one regime shift during NEWREP-NP, as well as because simulation trials have been conducted to examine the robustness of the *Catch Limit Algorithm* to regime shifts. The Panel notes that analysis of cetacean biological/physiological responses (e.g. blubber lipids, body condition, etc.) to 'environmental variability' as an ancillary objective would contribute to the basic understanding of responses of cetaceans to environmental factors (George *et al*., 2015; Harwood *et al*., 2015; Schick *et al*., 2013).

In conclusion, the Panel **agrees** that:

(a) Secondary Objective II(i) could contribute substantially to the in-depth assessment (but note the time-scale issue) and a possible future RMP *Implementation,* should one occur;
(b) Secondary Objective II(ii) could contribute to the in-depth assessment (but note the time-scale issue) and a possible future RMP *Implementation,* should one occur - however, the parameters that are the focus of this Secondary Objective are not the most important in terms of management;
(c) Secondary Objective II(iii) could contribute to a possible future RMP *Implementation,* should one occur but whilst stock structure is an extremely important issue, the extent of the contribution of the expected new information is unclear;
(d) Secondary Objective II(iv) could contribute to a possible future RMP *Implementation* should one occur; and
(e) Secondary Objective II(v) should be considered an ancillary objective.

4.1.2.3 CONTRIBUTION TO *IMPLEMENTATIONS* OR *IMPLEMENTATION REVIEWS* OF THE RMP OR AWMP

The Panel noted that the *Implementation Review* for common minke whales in the western North Pacific completed in 2013 was based on 23 sub-areas, three primary stock structure hypotheses and explored the performance of 11 RMP variants (IWC, 2014c). The next *Implementation Review* is due to start in 2018 and will incorporate data and analyses from the JARPN II programme. Priority should be given to completion of all of the recommendations from the Review Panel and the Scientific Committee. However, the Panel **agrees** that any outcomes of NEWREP-NP are most likely to feed into the *Implementation Review* that is scheduled to start in 2024 and that this implies that sufficient priority and resources must be put into completed analyses being ready by the proposed mid-term review. The results of the 2013 *Implementation Review* indicated that the two key components influencing the results were: (a) stock structure; and (b) abundance estimates. Stock structure was a key determinant of which RMP variants were considered to be 'acceptable without research', 'potentially acceptable with research' and 'unacceptable'. Abundance estimates also affect this as well as influencing acceptable removal levels. Thus, the Panel **agrees** that the objective to refine stock structure hypotheses, if achieved, can have an important and substantial impact on the conservation and management of common minke whales in the western North Pacific – the extent to which this requires additional samples rather than improved analyses of existing samples and data for the Secondary Objectives is discussed elsewhere in this report (e.g. see Item 4.1.5.2).

Secondary Objective I(i) – Investigate the spatial and temporal occurrence of J-stock common minke whales around Japan by sex, age and reproductive status. The results of trials depend on the mixing proportions for J-stock minke whales. Increasing knowledge of mixing proportions for some sub-areas (e.g. sub-area 11) and months could substantially reduce uncertainty and also potentially help to assign probabilities to stock structure hypotheses. The proponents aim to address this objective using a range of approaches, including data collected using lethal sampling.

Secondary Objective I(ii) – Estimate the abundance of the J- and O-stock stocks in the coastal waters of Japan. The availability of estimates of abundance by stock would enhance the ability to condition the operating models on which trials are based. The proponents aim to address this objective using a range of approaches, including data collected using lethal sampling.

Secondary Objective I(iii) – Verify that there is no structure in the O-stock common minke whales off the east coast of Japan. Refining stock structure hypotheses and particularly whether or not there are two 'O-stocks' is the most influential factor in terms of which RMP variants are 'acceptable without research' and thus extremely valuable. The Panel **advises** that this Secondary Objective be reworded as 'Investigate whether there is structure in the O-stock common minke whales off the east coast of Japan', as that better reflects the work to be conducted under this Secondary Objective and does not imply a pre-determined outcome. The proponents aim to address this objective using a range of approaches, including data collected using lethal sampling.

Secondary Objective I(iv) – Improve RMP trials by incorporating age data in their conditioning. There is no requirement within the RMP process to include age data (or any biological data) when conditioning trials, but doing so could improve estimates of selectivity and biological parameters such as natural mortality rate. In principle, inclusion of age-composition data in the conditioning could indicate that some stock structure hypotheses are implausible. Reduction of the number of stock structure hypotheses could reduce the disagreements over which RMP variants can be implemented for the western North Pacific common minke whales. Inclusion of age data in the conditioning is unlikely to reduce uncertainty regarding MSYR, to which trial results are very sensitive. The proponents aim to address this objective using age data collected using lethal sampling.

Secondary Objective I(v) – influence of regime shift. For the reasons provided above for sei whales, the Panel **agrees** that this sub-objective as stated would be better treated as an ancillary objective - it is unlikely to make a direct contribution to future *Implementation Reviews* within a reasonable timeframe, if at all.

In conclusion, whilst noting the proponents' additional information presented in Annex D, the Panel **agrees** that:

(a) Secondary Objectives I(i), I(ii) and I(iii) all address important aspects related to stock structure of common minke whales in the western North Pacific and would be of importance in future *Implementation Reviews*. The extent to which this requires additional samples rather than improved analyses of existing data for the Secondary Objectives is discussed elsewhere in this report (see Item 4.2);
(b) Secondary Objective I(iv) would enhance the way trials are conditioned, but would not likely have the same magnitude of impact as Secondary Objectives I(i), I(ii), and I(iii); and
(c) Secondary Objective I(v) should be considered ancillary as it is unlikely to make a direct contribution to future *Implementation Reviews* within a reasonable timeframe, if at all.

4.1.2.4 CONTRIBUTION TO IMPROVED UNDERSTANDING OF OTHER PRIORITY ISSUES AS IDENTIFIED IN THE SCIENTIFIC RULES OF PROCEDURE OR IN ITS REPORTS.

The Proponents stated that Ancillary Objective I (Examination of the effects of pollutants on whale stocks) will contribute to improved understanding of the 'Effect of environmental change on cetaceans' that is identified as one of the 'specific topics of current concern' in the Scientific Committee Rules of Procedure.

The Panel **agrees** that this is the case.

The Panel **welcomes** the proposed studies of other large whales with particular focus on blue and North Pacific right whales under Ancillary Objective II and **agrees** that this is a contribution to the conservation and management of these species, even though this is considered an ancillary objective of the NEWREP-NP programme. The two focus species are considered a high priority to the Scientific Committee (IWC, 2011).

4.1.2.5 CONTRIBUTION TO RECOMMENDATIONS OF OTHER INTERGOVERNMENTAL ORGANISATIONS

The Proponents stated that NEWREP-NP is designed mainly to contribute to conservation and management of whale stocks by the IWC. The Panel **concludes** that while the proposal does not necessarily refer to recommendations of other intergovernmental organisations, NEWREP-NP establishes provision and protocols to facilitate research collaboration with external scientists and organisations (and see Item 4.5).

4.1.3 Improvement in the conservation and management of other living resources or the ecosystem of which the whale stocks are an integral part

Some of the data that will be analysed as part of NEWREP-NP such as oceanographic data and data on prey species abundance may provide information pertinent to the conservation and management of species other than whales. However, the Panel **concludes** that none of the Primary and Secondary Objectives of NEWREP-NP pertain in a direct way to living resources other than whales or to the ecosystem, although in principle the data could be used by other researchers addressing such matters if the data were made available.

4.1.4 Hypothesis testing not directly related to the management of living marine resources

The Panel **concludes** that all of the activities in NEWREP-NP are related to hypothesis testing directly linked to the management of living marine resources.

4.1.5 Evaluation of options in terms of lethal vs non-lethal methods in relation to the objectives

4.1.5.1 PROPONENTS' OVERVIEW

Lethal sampling is required mainly for Secondary Objectives I (i), I (iv) and II (ii) (sample/data for age determination, body length and sexual maturity); I (v) and II (v) (sample/data on prey composition/consumption and on nutritional condition indices such as blubber thickness, girth, fat weight and body weight). Lethal sampling is also required for Ancillary Objective I (sample/data on blubber, liver, muscle and plasma) (see details in section 3.1.1 of SC/J17/JR01). A detailed evaluation of the available information on feasibility of lethal and non-lethal techniques led the proponents to a conclusion that the sample/data listed above can only be obtained through lethal methods at this stage (see details in section 3.1.1 of SC/J17/JR01).

4.1.5.2 PANEL CONCLUSIONS

The discussion on the complexities and need for a proper evaluation of options for lethal and non-lethal techniques has already been discussed under Item 3.3.4. All recommendations and conclusions of that section are also relevant here. The proponents presented their evaluation of the use of non-lethal methods to address their objectives and concluded that certain data could only be obtained using lethal techniques (see Item 4.1.4.1). The Panel **agrees** that certain data types (e.g. age and body measurements) require lethal sampling and may in principle provide improved conservation and management but **also recommends** that a more thorough *quantitative* review of the contribution of those data types to the ability of the proponents to meet their primary objectives is warranted (and see Item 4.2 for a fuller evaluation of options in terms of lethal *vs* non-lethal methods in relation to the objectives). Government of Japan (2016) provide initial work to show modifying the *CLA* to use age data could improve the performance of the IWC's whale management procedure and similar work could be conducted for common minke whales in the western North Pacific. However, modification of the *CLA*, as it is applied to common minke whales in the western North Pacific is not proposed under NEWREP-NP.

Given the focus in Annex P in several places (e.g. sample sizes) on comparing lethal and non-lethal methods (and the general contribution this can make to many scientific studies related to the conservation and management of whale stocks), the Panel **recommend**s that any future Special Permit programme should include a specific Primary Objective to continually review new techniques as these become available in order to facilitate discussions of methods and samples sizes at milestones such as the mid-term reviews.

If available data do not allow for a full comparison of relevant lethal and non-lethal techniques of a proposal, a focussed pilot study to enable a full and proper evaluation of lethal *vs* present non-lethal methods integrated across objectives should be undertaken, prior to a full programme starting; where such data already exist then the desktop-study evaluation should be undertaken before the permit programme begins. Such evaluations could be undertaken in light of an expanded framework as recommended under Item 3.3.4 and must be properly designed to enable more effective reviews of sample sizes/methods during mid-term reviews.

Informative evaluations must include using analyses and/or simulations to evaluate the influence of the same or similar data obtained lethally and non-lethally on the objectives related to the management/conservation of the whale stock, and recognise that the data obtained using different methods, may be slightly different, and may have slightly different interpretations or provide different levels of precision.

4.2 Field and analytical methods to address stated objectives

This section evaluates the various primary, secondary and ancillary objectives in terms of their feasibility, whether the sample sizes are sufficient to address the objectives, and the benefits of the additional samples proposed to be collected during NEWREP-NP.

For Primary Objective I, the western North Pacific common minke whale will be the target species and the study areas will be: (i) the Sea of Japan side of Japan; (ii) north of Hokkaido (sub-area 11) and Pacific side of Japan (sub-areas 7-9). The Sea of Japan will be the main target area for dedicated sighting surveys for abundance estimate purposes. North of Hokkaido (sub-area 11) and Pacific side of Japan (sub-area 7-9) will be the main target area for non-lethal and lethal sampling. The research area will be surveyed between April and October, which is the migratory season of common minke whale around Japan.

For Primary Objective II, the North Pacific sei whale will be the target species. The study area will be the pelagic region of the North Pacific delimited approximately by the Japanese DNA survey (30°N-50°N; 143°E-140°W), which is occupied by a single stock of sei whale. Lethal sampling of sei whale will be conducted mainly in the western part. This research area will be surveyed between April and October.

4.2.1 Secondary Objective I(i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status (Annex 7 of SC/J17/JR01)

Age: The proponents intend to determine the age of captured whales using two methods: (1) counting growth layer groups (GLGs) accumulated in the earplugs; and (2) racemization of aspartic acid (AAR) in the eye lens. The former will be the primary ageing method and the Panel **reiterates** that the gelatinized extraction technique (Maeda *et al.*, 2013) is a substantial improvement on past methods (see discussion under Item 3.3.3). Both methods are well established in the literature (Masters *et al.*, 1977; Rosa *et al.*, 2013) and the Panel **agrees** that they are acceptable.

Sexual maturity: The proponents intend to determine the sexual maturity of females by the presence of *corpora* in the ovaries (for both species). This is a well-known and developed technique and the Panel **agrees** that it is appropriate and accurate technique. Both ovaries need to be examined in case ovulations favour one ovary. Additionally, the presence of *corpora lutea* suggests a pregnancy (even if an embryo/foetus is not found) and should be recorded. The Panel **recommends** that levels of progesterone in blubber and serum should be compared with sexual maturity and reproductive status of examined females. This comparison is valuable for assessing the efficacy of biopsy sampling for assessing reproductive status.

The proponents propose to determine the sexual maturity of males '*preliminarily on the research vessel, based on testis weight*'. The Panel **highlights** that this approach is only suitable if there is a clear distinction in testis mass between immature and mature males. Histological examination of testes of pubertal males is needed to confirm maturity, e.g. by microscopically determining if there is sperm in the epididymis or if the seminiferous tubules exceed 100µm in diameter (Kato, 1986; O'Hara *et al.*, 2002).

Sightings surveys: The Panel notes that abundance estimates are important for several of the Secondary Objectives for both primary objectives. The comments in this section are usually generally applicable, but include some specific comments by objective. The Panel **agrees** that line-transect surveys are an appropriate and well-established method of obtaining estimates of abundance provided that the correct design and implementation is undertaken. The proposal provided relatively few details on line transect survey design and data collection protocols as they proposed to use standard data collection and analysis methods in accordance with the Scientific Committee requirements and guidelines (IWC, 2012). As such, the details will be discussed and approved by the Scientific Committee before the survey is conducted and IWC oversight will be assigned. In the light of this, the Panel **concludes** that appropriate methods will be applied by the proponents.

However, the Panel noted that there are several issues unique to this proposed programme for which it either requested additional information or highlighted that would need to be addressed before the programme starts. For example, the Panel requested (and received – see Annex D) details on the survey strategy of how to cover this vast area in multiple years using multiple platforms and potentially multiple data collection methods. The Panel was informed that sub-Areas 6E, 10E, 11, 7CS and 7CN were proposed to be covered twice in each half of the programme (each half is six years long), and that offshore sub-Areas (7WR, 7E, 8, and 9) will only be covered once in each half of the programme. The Panel **welcomes** the idea of covering all areas at least twice. It notes that for common minke whales, the proponents suggest addressing additional variance following the approach of Kitakado *et al.* (2012). Design- and model-based estimators will be considered. A similar approach is suggested with respect to North Pacific sei whales (see Annex 14 of SC/F17/JR01).

The Panel also highlighted several other issues that must be considered when designing line transect surveys that are expected to provide abundance information to address multiple objectives (overall stock abundance estimate, the spatial-temporal abundance patterns within each sub-area, the influence of 'regime shifts). The Panel **recommends** that these issues related to survey design, data collection protocols and priorities, data analyses and coordination are included in the plans to be submitted to the Scientific Committee for approval before the surveys start. The main additional issues that should be covered in the proposals for surveys submitted to the Scientific Committee are summarised below.

(a) **Evaluation of past surveys' analytical difficulties**. These new surveys provide an important opportunity to evaluate and potentially add/modify the variables or values of variables that are collected. Evaluating the shortcomings of previous surveys (for example, sample size issues and the amount of effort expended, problems that arose in analyses of past data) could suggest ways to supplement the future surveys. For example, during the spatial abundance pre-meeting in Bled in May 2017, issues may become apparent that indicate that small modifications to the data collection scheme could greatly increase the ease of analysing future data.

(b) **Appropriate temporal stratification** of the surveys (e.g. comparability with past surveys, which months are the most appropriate to survey in each sub-area to document potential shifts, account for the fact that these waters include a known common minke whale migratory path).

(c) **Appropriate direction of travel** for the survey vessel(s) and direction of tracklines to account for the fact that the animals are migrating.

(d) **Use of independent observer (IO) mode,** especially in the offshore waters where the weather and sea state conditions are poorer, which means the estimate of $g(0)$ will be lower and thus the IO mode will be most important to avoid negatively biased abundance estimates.

(e) **Use of passive independent observer mode** with abeam closing to get the benefits of estimating $g(0)$ and also improving the precision of the group sizes.

(f) **Development of protocols/priorities for biopsy-related activities** since both activities will be competing for survey time.

(g) **Evaluation of additional variance analysis and spatial model methods** to determine which is preferred or whether both methods are investigated.

(h) **'Regime shift'-related aspects**, also a Secondary Objective, require that consideration should be given to whether sampling of prey is possible during the line transect surveys - obtaining simultaneously collected prey and whale data seems ideal, however logistically challenging. Possible approaches include running an EK60 at the same time the visual sighting surveys are conducted from the sighting vessel, net sampling from the sighting vessels during non-visual survey times (such as during the night or poor weather), or coordinating the line transect surveys (Annexes 7 and 14 of SC/F17/JR01) with the trawling and acoustic surveys conducted on other vessels (Annex 11 of SC/F17/JR01).

These survey-related conclusions and recommendations also apply to Secondary Objective II(i): Abundance estimates for North Pacific sei whales taking account of the additional variance (Annex 14 of SC/J17/JR01).

4.2.2 Secondary Objective I(ii) Estimate the abundance of the J and O stocks in coastal waters of Japan (Annex 8 of SC/J17/JR01)

Comments on line-transect sighting surveys are provided under Item 4.2.1. However, assigning individuals to 'stock' with abundance estimates is a key, but difficult part of the *Implementation Review* exercise (see the mixing matrix discussions of previous *Implementation Reviews*). The proponents refer to undertaking further biopsy sampling experiments for common minke whales; this is especially important in terms of mixing of stocks during surveys; the Panel refers to its discussion under Items 3.3.4 and 4.1.4.

In addition, the proponents are suggesting trying to generate an additional estimate of abundance employing so-called 'gametic' mark-recapture of males that sired the foetus in sampled mother-foetus pairs. Gametic mark-recapture has been applied to large whales before, such as Caledonian and North Atlantic humpback whales (Garrigue *et al.*, 2004; Nielsen *et al.*, 2001). The Panel **welcomes** consideration of new techniques but in this case it **cautions** that while it is in principle possible to estimate the abundance of males by this approach, the precision of such estimates is generally low even with large sample sizes (Nielsen *et al.*, 2001; Palsboll *et al.*, 2005). The approach is also sensitive to migration in and out of the target population (Palsboll *et al.*, 2005).

4.2.3 Secondary Objective I(iii) Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan (Annex 9 of SC/J17/JR01)

As noted above, the Panel **recommends** that this specific objective is rephrased in a manner that does not assume the result is already known.

The Panel notes that the proponents are intending to follow the kinship analysis approach used by Tiedemann *et al.* (2014) for common minke whales in the North Atlantic. Kinship analyses can detect genetic cohesion and is hence informative about stock structure. Conceptually, dispersal rates could be inferred from such data, but there has been so far no specific threshold dispersal rate defined above which a single stock hypothesis is adopted.

The Panel **welcomes** the proposal to implement SNP genotyping, which has multiple benefits in terms of number of loci and data sharing.

Whichever genetic approach is used, the Panel **concludes** that the additional samples NEWREP-NP intends to collect will add relatively little to the existing genetic data for common minke whale in the O-stock area. The main effort is planned to be directed towards sub-area 7 and is relatively low compared to the existing data. Consequently, the impact of the samples to be collected during NEWREP-NP is likely limited in terms of resolving current stock structure hypotheses compared to conducting additional work on existing samples (see Items 5.3.1 and 5.10).

As the Scientific Committee has previously noted, telemetry data can provide valuable information on movements and stock structure (especially with respect to the location of breeding grounds) although sample size issues can be a limiting factor. The Panel **welcomes** the information that the proponents are intending to undertake a feasibility study in conjunction with outside experts on common minke whales (and see Item 4.4.3.2).

4.2.4 Secondary Objective I(iv): Improve RMP trials by incorporating age data in their conditioning (Annex 10 of SC/J17/JR01)

Annexes 10 and 12 of SC/J17/JR01 outline the proponents proposed approach to address this Secondary Objective with a focus on a Statistical Catch-at-age (SCAA) method. The Panel **agrees** that SCAA is an appropriate basis for developing RMP trials and for including age data in conditioning (the JARPN II review had concluded that if age data are to be included *Implementation Simulation Trials*, this should be achieved through the conditioning process). Age data were considered in the recent North Atlantic fin whale *Implementation Review* (IWC, 2016a) and can be one source of information used to refine stock structure hypotheses. However, the Panel **reiterates** (as noted under Item 4.1.2.3) that few data from NEWREP-NP are likely to be available for the 2018 *Implementation Review*, although the existing age data could be used as part of the conditioning process if made available in time. The current (and likely future) trials will be multi-stock, which will mean that the trial specifications in Annex 12 of SC/F17/JR01 will need to be modified to include multi-stock and multi-area components and also modified to fit the other sources of data included in the current *Implementation Simulation Trials* such as J-O mixing rates.

4.2.5 Secondary Objective I(v): Investigation of the influence of regime shift on whale stocks (Annex 11 of SC/J17/JR01)

Under this Secondary Objective, the proponents aim to assess the effects of 'regime shifts' on the distribution and prey consumption of western North Pacific common minke whales through the analysis of the stomach contents of whales and changes in the environment encountered by whales. The Panel refers to its recommendation under Item 4.1.2.2 to replace the term 'regime shift' with 'major environmental change' and also the suggestion that this should become an ancillary objective.

Secondary Objective II(v) is the same, but for sei whales and proposes the same field and analytical methods. Therefore, the Panel discusses both species together in this section.

'Regime shifts' can be considered 'a relatively rapid change from one decadal-scale period of a persistent state to another decadal-scale period of persistent state' (King, 2005). It is unclear whether 12 years will be sufficiently long to document such a shift using the methods and effort levels proposed. The detection of a 'regime shift' requires several years to pass after the shift to allow differentiation of a 'regime shift' from interannual variation. One might expect one or at most two major environmental changes during the NEWREP-NP period and perhaps none. The Panel **concludes** that it would be more productive for the proponents to focus on the impacts of shorter-term (inter-annual) environmental variability on the distribution and prey consumption of the whales which may in the future allow examination of major environmental changes should they occur.

The proponents propose to address this Secondary Objective by monitoring changes in distribution of whales and their prey species and state that the objective under NEWREP-NP is not to detect a regime shift directly. The proponents do not, however, provide information or analysis of the power of the methods they propose to detect changes in either prey use or oceanographic conditions given present knowledge (including data collected during JARPN and JARPN II). However, these data may be of future use to others conducting retrospective analyses of prey habits or oceanographic conditions. In addition, it is not clear how the proponents or other future users of the data will be able to associate the responses of the whales regarding distribution and prey use to environmental change without documenting and quantifying both major environmental changes, and the responses of whales. To achieve their objective, the proponents will need to identify and quantify the timing and nature of the environmental change, and the responses of the whales, such that they can compare the environmental conditions before and after the environmental change as well as the distributions and prey habits of the whales before and after the change.

The *field methods* described for stomach sampling are standard and appropriate. Fixation of prey in 10% formalin and freezing is appropriate. It should be noted that freezing is increasingly the method of choice as an array of analyses can be conducted with archived samples (e.g. screening for HABS, microbiome analyses) if deemed necessary and as new techniques are derived.

Considering the total stomach volume of a sei whale can reach 1,000kg, the question of proper sub-sampling arises, particularly with mixed prey types. Care is required during sub-sampling to assure that the sample is representative when stomach volumes are large and prey diverse, the Panel **recommends** that the proponents specify how this is to be achieved in the field protocols.

The methods for collecting samples/data for condition indices are appropriate and include blubber weight blubber thickness, girth, body weight, and the (%) lipid content of blubber. The Panel **recognises** the considerable work required to gather these data. The addition of '% lipid' measurements of the blubber reflects responsiveness to past recommendations (IWC, 2010a).

The Panel **agrees** that, while the basic field sampling of the captured whales appears standard and appropriate, the sensitivity of the biological metrics for detecting effects of an environmental 'regime shift' on the two species is not specified. Whether changes in metrics such as blubber volume, body weight, and % lipid (blubber) can be statistically detected depends on the degree of natural variation in these parameters and the strength/persistence of the putative ecosystem shift. However, the Panel acknowledges that such data can contribute to a better understanding of how whales respond to environmental change and of cetacean ecology generally (Lockyer, 1987).

Calculation of '*feeding period estimation*' and '*feeding habits, estimation of daily and seasonal prey consumption*' (Annex 7 of SC/F17/JR01, p.104) requires many assumptions such as estimates of standard metabolic rate as a function of body mass. Therefore, estimates of prey consumption for instance must be accompanied with appropriate variance estimates, as uncertainty is typically quite high in these kinds of estimates which require large extrapolations from individuals to population.

The Panel **agrees** that proponents clearly specify the *types* of data that they will use to document the responses of the whales to a major environmental change, but do not demonstrate that they will have adequate information to *detect* environmental changes in the various study regions. The plans for obtaining data on oceanographic conditions, by which we assume is meant climate data and physical oceanographic data, are not well specified. For example, Annex 11 of SC/F17/JR01 provides detailed methods for sampling fish prey in the Sanriku region, but there is apparently no sampling of fish prey planned for the Kushiro, Okhotsk and offshore regions. Additionally, there is apparently no plan to sample krill or copepods, even though these are potentially important prey.

The Panel **concludes** that, as stated this objective is unrealistic within the given timeframe. In any event, the present proposal does not provide sufficient information to demonstrate that the proponents will be able to meet this Secondary Objective. To demonstrate this feasibility, the Panel **recommends** that the proponents must specify more fully:

(a) quantitative criteria with respect to identifying [major] environmental change and potential responses by whales;
(b) the adequacy of the methods and effort to specify the distribution, seasonality, and precision of the environmental data, for the regions in which the whales being studied are feeding; and
(c) taking into account uncertainty, conduct a power analysis to determine the sample sizes/effort for the characterisation of the environment and whales (including distribution and prey use) needed to determine if there are changes before and after a major environmental change occurred, should one occur during the programme.

4.2.6 Secondary Objective II(i): Abundance estimates for North Pacific sei whales taking account of the additional variance (Annex 14 of SC/J17/JR01)

The Panel refers to its comments under Item 4.2.1 with respect to sightings surveys.

4.2.7 Secondary Objective II(ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP Implementation (Annex 15 of SC/J17/JR01)

The field and laboratory methods proposed for obtaining information on age, sexual maturity and reproductive status discussed elsewhere in this report (e.g. see Items 3.3.3, 4.2.1). The Panel **agrees** that these are adequate.

The proponents aim to estimate natural mortality and selectivity using an SCAA approach (Annexes 15 and 17 of SC/F17/JR01). However, the SCAA is based on the assumption of a single stock and time-invariant selectivity. However, unless the 5-stock hypothesis for the North Pacific as a whole (IWC, 2017b) is rejected as part of the in-depth assessment, any future *IST*s, will need to be based on a multi-stock, multi-area model, (including a single 'pelagic' stock) which will complicate the analysis. The Panel notes that there are considerable age-composition data already available for North Pacific sei whales (Fig. 2 of Annex 17 of SC/F17/JR01), which already provide some information on natural mortality and all the information on commercial selectivity. The results in Annex 17 of SC/F17/JR01 suggest that additional sampling will reduce the RMSE of the estimates of mortality, with the extent of improvement proportion to the number of years of sample (Fig. 5 of Annex 17 of SC/F17/JR01) but bias will remain. The estimation of natural mortality is related to the value assumed for MSYR, a key parameter, but the proponents are not planning to estimate MSYR thus any estimates of natural mortality will need to be consistent with the assumed value(s) for MSYR. The Panel **reiterates** that a primary determinant of the performance of RMP variants is MSYR rather than natural mortality.

4.2.8 Secondary Objective II(iii) Additional analyses on stock structure in North Pacific sei whale for RMP Implementation (Annex 16 of SC/J17/JR01)

The planned sampling effort is directed towards a single area which is already assumed in the ongoing in-depth assessment to comprise a single pelagic stock (notwithstanding discussions about whether or not there are a number of coastal stocks – the '5-stock' hypothesis referred to under Item 4.2.7). Thus, while the addition of new genetic samples may be valuable, the Panel **agrees** that it is unlikely to have a substantial impact on the outcome of the analysis of past samples with regards to stock structure in this area. The Panel noted the lack of a sampling effort in other putative North Pacific sei whale stocks where the stock structure remains unresolved. Accordingly, the Panel **agrees** that the proposed samples and genetic analyses will not add to further resolve current stock structure hypotheses *per se* for the entire North Pacific, but will naturally provide data which later may be employed towards the ocean-wide stock structure in the North Pacific.

The proponents also propose to undertake satellite tagging in collaboration with outside experts and the Panel **welcomes** this and refers to its comments under Item 4.4.3.2.

4.2.9 Secondary Objective II(iv): Specification of RMP ISTs for North Pacific sei whales

The proponents aim to base *Implementation Simulation Trials* on the SCAA approach. The Panel's comments regarding the timing and process with respect to any future *Implementation* are given under Item 4.1.2 and on the SCAA approach under Item 4.2.7.

4.2.10 Secondary Objective II(v): Investigation of the influence of regime shift on whale stocks (Annex 15 of SC/J17/JR01)

The Panel refers to its discussion under Item 4.2.5.

4.2.11 Ancillary Objective I: Examination of the effects of pollutants on whale stocks (Annex 18 of SC/J17/JR01)

This objective has three components, to examine: (i) the possible adverse effects of pollutants with adjustments for cofounding factors such as nutritional condition and age; (ii) species differences in sensitivity and response to pollutants; and (iii) the adverse effects of novel compounds. The aim is in line with several IWC Resolutions such as 2012-1 (IWC, 2013a), which 'requests the Scientific Committee to remain engaged in the evaluation of the available data on organic contaminants and heavy metals in some cetaceans as well as the effect of such contamination on the health of cetaceans and their reproduction'. The Panel **welcomes** the inclusion of pollution work as an ancillary objective and agrees that it is well specified – however, the three approaches do not address the effect of pollutants on whale *stocks* as the original proposal stated. They are aimed at identifying pollutant effects at the molecular, cellular and individual level. To tackle the objective, as currently stated, the proponents need to assess the effects at the population or stock level, for example using the approach developed under the IWC's Pollution 2000 initiative (Hall and Williams, 2015). This could be carried out for the major pollutant classes, PCBs and mercury, and using currently available data (as indicated by the Resolution) because studying the effects of pollutants was also an aim of the JARPN II research programme. However, during the Workshop the proponents clarified (see Annex D) that the objective is to monitor effects at the individual rather than the stock level.

The Panel **agrees** that the broad methods outlined in the research plan appear to be appropriate to address each of the research items, but there was a lack of detail about the specific methods.

The aim of research item (i) is to investigate relationships between pollutants and immune function, which has been addressed in many studies on marine mammals. The reference given in the proposal regarding the immune function assays to be used (Wayland *et al.*, 2002) relates to studies on birds, which are not relevant to mammalian systems. Mammalian immunotoxicologists have established the most sensitive assays to use, a combination of which is recommended due to the complexity of the immune system and the potential for compensatory effects of different arms (innate and acquired). The Panel **recommends** that any immune function assays used should be those already established for cetaceans (Schwacke *et al.*, 2012) so that the results are comparable to published studies. However, the main concern regarding this item is that the results of the JARPN II studies demonstrated that PCBs and mercury were at very low levels in these stocks, well below established no observable effect levels (NOELs). Thus, the likelihood that this study will result in any positive relationships between exposure and immune response is small, particularly as the existing data suggests very little variability in exposure levels, resulting in, at best, a negligible exposure gradient and thus no variation in pollutant concentration and immune response. In addition, following previous Expert Panel recommendations, the Panel **strongly reiterates** that all lipophilic compounds being measured must be reported on a lipid weight and not a wet weight basis.

Research item (ii) relates to the investigating the link between intracellular receptor signalling and pollutant exposure. The method referenced (Hirakawa *et al.*, 2011) uses a microarray to investigate the induction of various cytochrome P450 enzymes (e.g. CYP1A1 and CYP1A2), which is mediated through the aryl hydrocarbon receptor. However, this microarray was developed for seals rather than cetaceans so sequence differences in these enzymes (Teramitsu *et al.*, 2000) will almost certainly affect the accuracy of the results and the ability of the proponents to fulfil their goal. Given that the gene sequences for the CYP1A family for minke whales have been available for a long time (Niimi *et al.*, 2005; Teramitsu *et al.*, 2000) and that the genome for this species has been published (Yim *et al.*, 2014), the Panel **agrees** that other approaches, such as RNA-seq (i.e. a transcriptomic method), are more appropriate than the use of heterologous microarrays. The proponents clarified that it is in fact the hepatic oligo array available for minke whales (Niimi *et al.*, 2014) and used in the JARPN II studies that would again be used (along with additional 'omic approaches being developed by collaborators) in pursuit of this objective.

Research item (iii) relates to novel compound exposure and indicates that the levels of polybrominated diphenyl ethers (PBDEs) and other flame retardants would be quantified in blubber, prey and marine debris (presumably micro- and macro-plastics found in whale stomachs). In addition, the contaminant content of any plastic material collected would be conducted using a Fourier transform infrared spectroscopy (FTIRS) technique that identifies the presence of organic, polymeric, and in some cases, inorganic materials in samples. However, there is no indication of how these results would be related to 'adverse effects' as stated in the objective. The Panel, therefore, **recommends** an integration and combined analysis of the results obtained by all three research items (i.e. relating exposure to polychlorinated biphenyls, flame retardants and novel compounds from plastics to responses such as immune function and enzyme induction, including controlling for any effects of age (emphasizing the need to use the age estimates obtained from the earplugs rather than body length) and nutritional condition. This would require samples from the same individuals to be included in each of the three research items.

4.2.12 Ancillary objective II: Study of distribution, movement and stock structure of large whales with particular emphasis on blue and North Pacific right whales

The Panel **welcomes** the proposed studies of other large whales with particular focus on blue and North Pacific right whales. The two focus species are considered a high priority to the Scientific Committee (IWC, 2011). The Panel **agrees** that sightings, biopsy and photo-identification methods are appropriate. Biopsies of blue whales in the NEWREP-North Pacific study area (central and western North Pacific) are of particular importance so that the genetics of these animals can be compared to existing samples from the eastern North Pacific animals. This may assist in the North Pacific blue whale in-depth assessment. Biopsy and photo-identification studies of North Pacific right whales found in the NEWREP-NP study area will be very informative to assist in discovering more about this rare species.

The Panel **concludes** that the methods proposed are appropriate and **recommends** continued coordination with IWC-POWER to ensure consistent data collection and processing, as appropriate. The Panel also **recommends** information on these species are included in annual reports to the Scientific Committee to encourage collaboration with scientists involved with research on these two species.

4.3 Sampling design (coastal component in Annex 6; offshore component in Annexes 6 and 13 of SC/J17/JR01)

4.3.1 Lethal sampling

The Panel notes that the sampling designs for the inshore and offshore components of NEWREP-NP differ quite markedly, with the inshore component involving day trips for catcher boats from land stations in Kushiro (sub-area 7CN), Ayukawa (sub-area 7CS) and Abashiri (sub-area 11). Annex 6 of SC/J17/JR01 outlines the general procedure for sampling in the inshore areas, which is similar to that for JARPN II and for which the JARPN II Review Panel made a number of recommendations for clarification and analyses (and see Table 1). The Panel **agrees** that there are several aspects of this procedure that make the design unusual for a scientific survey and will complicate and possibly compromise data analyses. In particular, the Panel **concludes** that:

(a) the design would lead to oversampling of the areas close to ports (the Panel was informed that an additional land-based station may be established in the northern Sanriku to better cover sub-areas 7CS and 7CN);
(b) the boats can search freely once they reach 30 n.miles from port if no whales have been encountered *en route* from port, which means the design is not fully specified in terms of the catches by the port-based boats; and
(c) the *Nisshin Maru* will conduct sampling if the number of common minke whales caught does not reach the target number, but no sampling plan for this contingency is provided.

The Panel **agrees** that the impact of non-random sampling of the inshore areas has different consequences for each Secondary Objective under primary objective I. In particular, the Panel **concludes** that it will substantially complicate achievement of Secondary Objective I(i), which investigates the spatial and temporal occurrence of J-stock animals around Japan by sex, age and reproductive state for which random sampling is ideal if not essential. In addition, the power to achieve Secondary Objective I(iii) depends on sample size in the inshore and offshore areas (see Item 4.2.4), but also how samples are collected within sub-areas 7CS (n=50), 7CN (50) and 11 (47). In terms of resolving stock structure from genetic analyses (traditional population genetic as well as kinship-based inference methods), the key issue is to obtain and include representative samples from all areas to be included in the assessment of stock structure. Whilst random sampling is not essential to include age data in an SCAA analysis, lack of random sampling will reduce statistical power to detect stock structure as well as it will necessitate estimation of selectivity parameters and hence to increased overdispersion of any resulting age data relative to the case of uniform (or near uniform) sampling by sex and age. Estimation of additional parameters and larger overdispersion will further reduce the power of the age data to detect trends in recruitment (which is already poor over the short- to medium-term; see Item 4.2.4). The Panel **recommends** that analyses be conducted, before the start of the programme, to assess the extent of loss in statistical power and precision due to the sampling strategy for the objectives related to common minke whales and the implications for meeting Secondary Objectives. The Panel also **recommends** that the experience/data gained from JARPN II should be used by the proponents to investigate (a)-(c) above.

The Panel noted that the offshore sampling design matches that on which JARPN II was based. The Panel **concludes** that the given sampling lines will not achieve uniform coverage of the research area and do not cover the whole distribution range of each whale species (Bando *et al.*, 2016). The unbalanced sample sizes in the offshore (27) and inshore (100) areas will complicate the estimation of the selectivity pattern for offshore common minke whales (if there is a single O-stock). It may lead to a dome-shaped selectivity, which will need to be accounted for in any SCAA analysis, at the cost of additional parameters and lower precision. The survey plan allows for the possibility of taking multiple animals from a school, which could impact the power of analyses related to diet and genetic structure owing to the possibility of pseudo-replication. Additionally, the rather small sample size offshore may reduce the likelihood of detecting the effects of a major environmental shift on both the diets and the distributions of common minke whales. The Panel **concludes** that Proponents must thoroughly consider these issues and provide further justification/modification to their current data collection plan.

During the Workshop, the proponents provided the Panel with the sampling strategy (samples by month, year, and sub-area). The Panel **welcomes** this information and **recommends** that it be included in the version of the proposal that is provided to the Scientific Committee. The Panel also **recommends** that tables of past samples in the same format as the new samples should be included in a revised proposal to place the new samples in a spatio-temporal context. In itself, this does not negate the need for a further justification/modification to their current plan as discussed above.

4.3.2 Survey tracklines

The Panel's views on issues relating to abundance estimates are given under Item 4.2.1. In response to a request, the proponents provided the Panel with example survey tracklines (see Annex D). This assisted an understanding of both the survey strategy and also how the direction of the surveys relates to the expected direction of whale movement. It confirms that the survey component of NEWREP-NP should provide estimates of abundance comparable with those from earlier surveys. The Panel **reiterates** the importance of submitting detailed plans in accord with the RMP requirements and guidelines.

4.4 Sample size of the lethal component of the programme

4.4.1 Common minke whales (Section 3.1.3 and Appendix 12 and addendum of proposal)

4.4.1.1 PROPONENTS' SUMMARY

For the Pacific side of Japan (sub-areas 7-9), the sample size was estimated in the context of Secondary Objective I (iv) 'Improve RMP trials by incorporating age data in their conditioning'. The approach followed is founded on the SCAA methodology applied to the O-stock of the common minke whale by Kitakado and Maeda (2016), which is used to generate future data in a simulation testing context. The intent is to determine how well, using the SCAA methodology to analyse the future data generated, it is possible to detect changes in recruitment. Data such as historical catch, catch-at-age, life history parameters (e.g. age-depended natural mortality, 50% age-at-maturity etc.), which were used in the RMP/*IST*s for this species (IWC, 2014b), were used. Stock hypothesis A (i.e. a single O-stock distributed from the Japanese coast until approximately 170°E) was assumed, given that preliminary results from close-kin genetics are not compatible with the existence of an Ow stock as in Hypothesis C. The estimation process assumed that carrying capacity K could change every 10 years. The scenario of a 30% drop in recruitment after 10 years with MSYR (mature)=1% was the base case scenario. For sensitivity, two scenarios for recruitment with a step function change, and two for recruitment based on the recruitment variability evident for two Antarctic minke whale stocks, were considered. Annex 12 of SC/J17/JR01 provided results labelled in terms of annual catches n of 0, 40, 80 and 120. These numbers n do, however, refer to an 'effective' sample size which justifies analysis under the assumption of no over-dispersion in the ageing data. The actual sample sizes have to take that over-dispersion into account, which increase them to 0, 53, 107 and 160 respectively. In the baseline scenario, results showed that drop in recruitment was detected sooner and much better when n=80 than when n=0. It was evident that the drop in recruitment would not be predicted well without age data. Regarding precision, total numbers is predicted much more precisely when n=80 than n=0 with future changes in K. Results of sensitivity analyses were similar to the baseline scenario although estimation performance deteriorated somewhat when this trend is increasing. From the results, the annual sample size of 80 whales (corresponding to the actual sample size of 107 after taking into account of over-dispersion) from the O-stock was also found to be the most appropriate sample size. 75% of the sample size would be taken in coastal sub-areas (7CS and 7CN) and 25% in offshore sub-areas (7WR, 7E, 8 and 9) (Annex 12 of SC/J17/JR01). Therefore 80 animals will be sampled in coastal sub-areas and 27 in offshore sub-areas. Because around 20% of the animals in sub-areas 7CS and 7CN are from the J-stock (Annex 7 of SC/J17/JR01), the sample size of O-stock in coastal sub-areas should be adjusted to 100 animals. Therefore, the total sample size in the Pacific side of Japan is 127 animals.

For Hokkaido (sub-area 11), sample size was preliminarily estimated so that standard error of mixing proportion of the J stock in sub-area 11 is less than 0.1. This is related to the assumptions of an over-dispersion parameter of 1.689 and a proportion of unassigned samples (0.09) based on an estimate from JARPN II data. Sample size was estimated using the formula for the standard derivation of a binomial distribution and given the assumptions above, the resultant sample size was estimated as 47 (see details in section 3.1.3 and Annex 12 of SC/J17/JR01). This estimate applies for the first six years of NEWREP-NP only. More detailed estimates of sample size for the objective of studying temporal changes and trend for the J-stock mixing proportion will be made once data have accumulated from the first six surveys. The survey in the first six years can be considered as a feasibility study.

4.4.1.2 PANEL CONCLUSIONS

The sample size (127) for common minke whales in sub-areas 7-9 is based on the ability to estimate recruitment when there is a 30% reduction in recruits-per-female 10 years after the start of NEWREP-NP and when carrying capacity changes (as for the P-stock of Antarctic minke whales – Punt *et al.* (2014)). However, the proponents did not provide a strong link between a reduction in recruits-per-female and the primary or any of the Secondary Objectives, in particular evaluation of potential methods for setting sustainable catch limits for coastal areas east of Japan using the RMP (Primary Objective I). The analyses do show some value in including age data in assessments of common minke whales based on SCAA, and allowing for variation in recruitment will improve the realism of the *Implementation Simulation Trials* for the western North Pacific common minke whales. Nevertheless, the Panel **agrees** that even if the power to detect a change in recruitment was high, the analyses in Annex 12 of SC/F17/JR01 do **not** provide a defensible basis for the currently assigned sample size (i.e. 50 from 7CS, 50 from 7CN and 27 from 7E-8-9). The Addendum to Annex 12 (SC/J17/JR04) shows improved estimation performance for a step-function reduction in recruitment ten years into the programme compared to Annex 12 where the proposed SCAA approach is not able to detect a change in recruitment even after 50 years, i.e. well beyond the project timeframe of 12 years. The Panel **notes** that the SCAA was able to provide unbiased estimates of total numbers even without age data. However, as the proponents note in Annex D, the analyses show how the conditioning can be improved in the future (if a substantial reduction in recruitment occurred) but no analyses are provided to qualify the improvement in RMP performance. They also state in Annex D that a 'detailed calculation for this would need to be based on the planned updated conditioned (including with the age data available at that time) set of NP minke *IST*s, and consequently must await completion of that exercise which is the responsibility of the IWC Scientific Committee'.

The Panel had several technical concerns with the analyses presented which could be addressed in further analyses. However, the Panel **stresses** that these would **not** remove the fundamental problem that the planned sample size is not fully justified for the primary objective or any of the Secondary Objectives. While Annex D does refer to the use of age data for Objective I (iv), the Panel believes that the link with conditioning is rather weak and the number chosen not well justified in terms of management performance. These concerns are summarised below.

(a) The analysis assumes that there is single O-stock, when in fact testing the hypothesis whether there is one O-stock is one of the Secondary Objectives. In principle, the analysis of sample size should have been conducted for both the one-O-stock and the two-O-stock hypotheses, to avoid potential issues of circularity and prejudging the results of other Secondary Objectives.

(b) The estimator is provided with the true values for several (unknown) key parameters including natural mortality, MSYL, and, in particular, MSYR, which would increase (overestimate) the power to detect changes in recruitment.

(c) Selectivity post-1988 equals selectivity pre-1998, but with female selectivity multiplied by an estimated constant. The rationale for this is not provided, but the SCAA estimator knows that this is the parameterization of selectivity, which would increase (overestimate) the ability to estimate trends in recruitment.

(d) The abundance data are provided as estimates of mature female numbers, but in actuality the estimates of abundance would be estimates of 1+ numbers.

The Panel noted that the total sample size is split between sub-areas 7 and 8+9 based on historical catches, adjusting the sample sizes to account for age-readability and the proportion of the catch that is likely to be J-stock. The overall sample size would be lower if more animals were taken in sub-areas 8+9, because the J-stock proportion is lower offshore. The Panel **agrees** that the impact of the split of the total sample size between sub-areas 7 and 8+9 will impact the ability to achieve Secondary Objective I(iii). Uneven sampling efforts also impact some genetic analyses, such as the identification of clusters (usually assumed to represent populations) using programme STRUCTURE (Landguth and Schwartz, 2014). Disproportional sample sizes from different populations reduce the probability of detecting dyads of close relatives where each member is sampled in different populations, which constitutes the basic data points to infer dispersal rates from identification of close kin.

The Panel noted that concentrating sampling over short periods increases the probability of detecting dyads of close kin. This has potential consequences in terms of detecting dyads of close kin across sub-areas assumed to contain common minke whales from different stocks (e.g. stock structure hypothesis III) where the large historical datasets will decrease in utility due to natural and whaling mortalities that eventually remove related individuals, which, in turn, effectively will reduce the probability that new samples are close kin to older samples.

Finally, the Panel **agrees** that the small sample size of common minke whales in the offshore area (sub-areas 8+9) will reduce the ability to detect a change in whale diets in response to major environmental changes.

In conclusion, the Panel **agrees** that the proponents have not justified the sample size proposed for sub-areas 7-9.

For the area north of Hokkaido (sub-area 11), the sample size (47) was selected to estimate the J-O mixing proportion in this sub-area annually with a standard error of no more than 0.1 irrespective of the true proportion[8]. The Panel **agrees** that the technical approach adopted to compute the sample size is justified and accounts for both overdispersion and the probability of not assigning animals to J- or O-stock for the period from May to September. The proposed sampling scheme will allow J-O mixing proportions to be estimated for May-September. The months with low current sample sizes are April and September-November and thus the Panel **concludes** additional samples will not inform mixing proportions for the most data-poor months. The sample sizes are computed under the assumption that each annual estimate has a standard deviation of 0.1 or less. However, lower sample sizes would be needed if data were pooled over multiple years.

4.4.2 North Pacific sei whales (Section 3.2.3 and Appendix 17 of proposal)

4.4.2.1 PROPONENTS SUMMARY

The sample size was assessed by focusing on the acquisition of biological information. More specifically, it was calculated based on the number of earplugs for age-information on sei whales for Secondary Objective II (ii), which is 'Estimation of biological and ecological parameters in North Pacific sei whales for RMP Implementation'. The analyses are based on the hypothesis of a single stock in the pelagic region of the North Pacific to which the catches to be made will be restricted. Abundance estimates taking account of additional variance in future surveys were used with the aim of estimating sample size. Based on the conditioned models, projections were made to generate future abundance estimates and catch-at-age data. In a 12-year research period, it was assumed that abundance estimates are available twice, though not for the whole area of the North Pacific instead only for the survey area in the NEWREP-NP. These abundance estimates are subject to process error due to inter-annual variation in spatial distributions, and therefore it was assumed that the abundance estimates inflated to the whole area have larger CV (30%) than CV=21.4% for the actual survey, to take additional variance into consideration. In the projection and generation of future data, log-normal deviations were accounted for when generating recruitment. The projection starts from 2014 because the model was conditioned on data up to 2013. In the three-year gap, the actual catch was allocated to age composition using estimated selectivity and numbers-at-age. For future catch-at-age data, multinomial distributions were used without assuming any overdispersion or age-reading error. Age-readability was taken to be 70% across all the ages. The parameter of interest is natural mortality (M). Two measures, root mean square error and relative bias, were used for evaluation of estimation performance by sample size. Although there are Monte Carlo errors and non-convergence issues in the iterations, the estimation performance is, as expected, improved when the sample size increases. Simulations conducted suggest that the preferred sample size is 200 if M=0.05yr^{-1}, and 140 if M=0.07yr^{-1} since the variability of the estimate asymptoted at a sample size of 140. Both M=0.05 yr^{-1}and M=0.07 yr^{-1} were considered to be realistic assumptions for the natural mortality rate for the North Pacific sei whale. The annual sample size of 140 was found to be consistent with the policy to limit the sample size to the extent necessary to achieve the research objectives. The annual sample size of 140 was also found to be a feasible sample size in terms of the capacity of the research vessels. Taking account of these factors, it was concluded that the sample size of 140 per annum is the appropriate size for this research plan. The levels of the CV for abundance and unaccounted overdispersion and age-reading error may drive the levels of performance measures, but the relative difference over candidate sample sizes is likely to be similar to the results shown here.

4.4.2.2 PANEL CONCLUSIONS

As noted earlier, the Panel did not see a clear link between the ability to estimate natural mortality and improvements in the conservation and management of sei whales. For example, if there was a relationship between natural mortality and MSYR, improvements in the estimate of natural mortality would lead to a reduction in the range for MSYR that needs to be considered in the in-depth assessment and subsequently in *Implementation Simulation Trials*. However, no such relationship is suggested by the analyses in Annex 17 of SC/F17/JR01.

The Panel notes that even with the proponents' assumptions, the calculated sample size was underestimated because the analyses ignored the effects of age-reading error and age-readability, both of which will reduce the information content of the age data; such analyses must be updated to account for both of these sources of uncertainty. In addition, it appears that the SCAA was provided with information about MSYR and MSYL, which would not be available in reality. It is likely that attempting to estimate MSYR simultaneously with natural mortality would lead to imprecise estimates of both quantities, while setting MSYR to an incorrect value will lead to biased estimates for natural mortality. However, this needs verification.

The Panel notes that estimates of natural mortality are biased even at large annual sample size. This is probably due to the historical age-composition data (for which sample sizes are high) not being consistent with the values for natural mortality applied during the period of NEWREP-NP. Downweighting the historical age-composition data might reduce the conflict between the historical and simulated future data, but could also lead to less precise estimates of model outputs, including natural mortality. The Panel **recommends** conducting analyses in which the historical age-composition data are downweighted by various levels.

In conclusion, the Panel **agrees** that the proponents have **not** justified the sample size for sei whales.

4.4.3 Feasibility of non-lethal alternatives to either replace or reduce the size of proposed lethal sampling

4.4.3.1 PROPONENTS' OVERVIEW

During the implementation of the NEWREP-NP research, the proponents will conduct further study on the feasibility and practicability of a variety of new non-lethal methods including biopsy sampling, satellite tagging and their associated analytical methodologies which potentially could be used to address the objectives: DNA-Methylation for age determination, examination of hormone in blubber for determination of sexual maturity, stable isotope and fatty acids for studies on feeding ecology. Potentially all these techniques could be used based on tissues collected by biopsy sampling. The design of the feasibility studies in NEWREP-NP will take into account the results already obtained in JARPN II and NEWREP-A (see section 3.1.1 and Figure 2 of SC/J17/JR01). Further details of the feasibility studies to be conducted were presented during oral presentations at the Workshop. A final assessment of the feasibility of non-lethal techniques will be carried out during

[8]The proponents intend to review this estimate once data are accumulated to refine the estimate of the mixing proportion.

the mid-term review, including an evaluation of possible modification of sample size of the lethal component of the programme, on a whole-programme basis. The results of the feasibility study on age determination based on DNA-M will be relevant here because sample size calculation in NEWREP-NP bases on the necessity of age data. A final assessment of possibility to replace/reduce the size of lethal sampling will be conducted based on four questions provided by Mogoe *et al.* (2016). Even when all of the four questions are not satisfied at once, there could be a possibility to reduce the lethal sample size if non-lethal techniques can produce the same quality of age information. In this case, a part of sample numbers for lethal method will be transferred to biopsy sampling as long as research resources (time, funding, etc) allows. However, the effect of reduced lethal sample size on other data that can be obtained only lethally (e.g. sexual maturity, stomach contents), will be evaluated during the final review.

4.4.3.2 PANEL CONCLUSIONS

BIOPSY SAMPLING

Skin biopsies can be used to contribute to issues such as, stock structure, aging by DNA methylation, maturation state by hormone assays and feeding ecology from analyses of stable isotopes and fatty acids. The Panel **agrees** with the proponents that it is possible to collect large numbers of samples of sei whales. The proponents do not believe that this is possible yet for common minke whales. Their current skin biopsy system uses the Larsen gun and short light biopsy bolts.

The proponents concluded that in addition to the size and behaviour of the animals, the main technical cause of failure was the current barbed steel biopsy tip, which often failed to retrieve a skin biopsy at a successful hit; the Panel suggests that too short barbs could be the cause. The Panel **reiterates its recommendation** under Item 3.3.4 that the proponents undertake a fully resourced experiment to assess the efficacy of undertaking biopsy sampling of common minke whales as soon as possible, co-operating with outside experts and with clear milestones and quantitative criteria to ensure a timely completion of the feasibility study. The Panel **recommends** the implementation of biopsy sampling to reduce the lethal sample size as soon as it is deemed feasible rather than wait until the mid-term review.

SATELLITE TELEMETRY

Satellite telemetry, particularly in combination with genetic analysis, can be a powerful tool to address questions such as stock identity, migratory routes, feeding and wintering areas particularly for highly migratory whale species (Citta *et al.*, 2012; Heide-Jørgensen *et al.*, 2006). Satellite tag technology is rapidly evolving; hence, the Panel **commends** the proponents for collaborating with outside experts (e.g. Lars Kleivane and Restech Norway A/S) on their proposed satellite tag development (SC/J17/JR01, Annex 9) and notes the particular success rates now being achieved for large baleen whales. The Panel **recommends** that the proponents attend the IWC-ONR joint Workshop on Tag Development, Follow-Up Studies and Best Practices to be held in September 2017 in Silver Spring, MD (USA) to become acquainted with the most current tagging technologies and deployment methods.

Rather than set an arbitrary number of tags, the Panel **recommends** that the number, location and timing of tag deployments should reflect the questions being addressed. For example, tagging during the autumn migration could help delineate wintering and possibly breeding areas. Tagging during spring migration, or tags that last a year or more, can help elucidate migratory routes and possible sub-structuring on the summer feeding grounds (e.g. Oe- *vs* Ow-stocks).

Once a suitable tag is developed, the Panel **recommends** tagging North Pacific common minke whales within the study area to address stock structuring within the NEWREP-NP study region. Again, tag deployment location and tag design should be tailored to the question being addressed.

The possible health effects of tags on whales is an area of ongoing research by whale biologists and veterinarians (Robbins *et al.*, In Prep.). In the remote chance that a tagged whale is recaptured by lethal sampling, a thorough veterinary health assessment of the attachment site and general health of the animal would contribute greatly to the literature on this subject.

AGE DETERMINATION FROM ASSESSMENT OF DNA METHYLATION

The Panel **welcomes** the planned work aimed at assessing DNA methylation as a proxy for age.

DNA methylation has been thoroughly studied in several model animal and plant species (Mazzio and Soliman, 2014; Trucchi *et al.*, 2016; Xiong and Laird, 1997; Yang *et al.*, 2004). The nature of epigenetic changes across mammals are identical where only CpG sites are methylated (Nakao, 2001).

Changes in methylation at CpG sites can arise within a single generation due to a variety of processes, such as aging, physiological processes as well as environmental effects (Jarman *et al.*, 2015). The rate of methylation also varies across tissue types (Horvath, 2013). Epigenetic variation may also be transmitted across generations, either via germ-cell exposure or 'inheritance' (Daxinger and Whitelaw, 2012; Jablonka and Raz, 2009; Weyrich *et al.*, 2015).

The rate of change in methylation at a large number of CpG sites correlates closely with age in model species. In the case of humans, thousands of CpG sites have been identified where the degree of methylation correlates with chronological age (Florath *et al.*, 2014; Jung and Pfeifer, 2015). A total of eight such candidate loci, containing 37 CpG sites, was tested and optimized to assess age-related methylation in humpback whales by Polanowski *et al.* (2014). Among the 37 CpG sites assayed, the level of methylation at seven CpG sites correlated significantly with age (R^2=0.79, p <3.0E-14) in a sample of 63 humpback whale DNA samples collected from individuals of known ages. The study by Polanowski *et al.* (2014) also revealed (as expected) species-specific differences in which CpG sites level of methylation correlate with age. Although, unknown at this time, con-specific populations may also differ in methylation dynamics at homologue CpG sites.

Preliminary work under NEWREP-A focused on the seven CpG sites (across three loci), which correlated with age in North Atlantic humpback whales. Data were presented for one CpG locus, which revealed a statistically significant correlation between degree of methylation and age inferred from ear plugs in Antarctic minke whales. However, the correlation was low (R^2 = ~0.06) suggestive of a much lower precision compared to that observed in humpback whales. No results were presented that combined the correlation between the age inferred from earplugs with the combined change in methylation in all seven CpG islands.

Age data have been put forward as a key reason for the lethal sampling under NEWREP-NP. The Panel **recognises** the in principle value of reasonably precise age determination methodology for conservation and management (although see the discussion above concerning quantifying 'improved' management and sample sizes). The Panel **concludes** that an ability to reduce or eliminate the lethal sampling component of the programme will depend crucially upon approaches that enable age determination from skin biopsies, such as methylation of CpG sites. However, the few CpG sites targeted so far, along with the comparatively poor level of correlation between inferred age and DNA methylation warrants further development to achieve a better precision. The Panel **recommends** using the extensive amount of data in age-related methylation in mammal model species (e.g. humans) where thousands of CpG sites have been identified in which the level of methylation correlates with age, similar to the approach taken by Polanowski *et al.* (2014) who assessed 37 CpG sites originally identified in humans. Once putative aging CpG sites have been identified among the candidate CpG sites observed in humans, a more targeted approach may be developed by identifying the homologous loci in the minke whale genome, thereby presumably increasing the precision of methylation-based aging in North Pacific minke whales. Existing tissue samples from animals aged using the earplug method should be used for this study.

The Panel **reiterates** that the key 'performance' parameter to assess in terms of the suitability in methylation-based ageing may not be whether methylation-based ageing achieves a comparable level of precision to earplug-based ageing, but rather whether or not the observed level of precision in ages inferred from methylation is sufficient for meeting conservation and management objectives requiring age data. Initial analyses to compare the estimation performance of an SCAA approach that uses age data was conducted in Government of Japan (2016). That analysis showed that the CV of recruitment was appreciably higher when ages were determined using the methylation approach compared to reading of ear plugs. To date, those analyses have not considered how such imprecision impacts management performance (e.g. how much poorer a *CLA* that uses age data would perform given age data from earplug readings compared to the methylation approach).

The above discussion does not negate the need to properly quantify the level of improvement that might be expected in RMP performance if age data (from any source) are incorporated (see Item 5.2).

BLUBBER PROGESTERONE

The feasibility of determining pregnancy status from concentrations of progesterone (P4) in the blubber of minke whales was demonstrated by Mansour *et al.* (2002) in which levels were significantly higher in females carrying a foetus and those with *corpora lutea* (CL) in the ovaries. Trego *et al.* (2013) carried out a similar study in various species of stranded delphinids, also finding significantly higher P4 blubber concentrations in pregnant females. Further studies have shown that this approach is feasible for pregnancy determination in samples from humpback whales (Mello *et al.*, 2017) and in remote biopsy samples of pantropical spotted dolphins (Kellar *et al.*, 2013). The study by Trego *et al.* (2013) concluded that although an embryo in the early stage of pregnancy might not be detected by visual inspection, all animals with a corpus luteum also had a corresponding foetus. In determining the feasibility of using P4 as an indicator of pregnancy in the North Pacific common minke whale, the Panel **stresses** the value of determining the presence of corpora (CL and *corpora albacantia*) in the study animals in addition to determining the presence or absence of a foetus to minimise misclassification errors. Resting and immature cetaceans have significantly lower levels of circulating and blubber P4 (Mansour *et al.*, 2002; Yoshioka and Fujise, 1992) than pregnant or ovulating females so it is important to evaluate samples from animals at all life history stages.

FATTY ACIDS AND STABLE ISOTOPES

The proponents discussed plans for improving knowledge about foraging ecology of common minke and sei whales through the analyses of fatty acids and stable isotopes. Non-lethal sampling will obtain skin and outer blubber samples through the biopsy programme. The blubber will be analysed for fatty acids and skin will be analysed for stable carbon and nitrogen isotopes. Other samples, including stomach contents, will also be obtained from whales taken lethally.

The proponents provided preliminary information about the analysis of fatty acids in prey items of Bryde's whales in the North Pacific. General prey type (i.e. krill, copepods, or fish) could be classified using analysis of fatty acids but individual fish species could not. Another concern was expressed by the Panel about the efficacy of using fatty acids to quantitatively assess diet of whales. Using fatty acids to estimate which species of prey are being consumed requires specific conversion factors of how fatty acids are converted from prey to blubber. Another confounding factor is that biopsy samples collect only the outermost blubber. Fatty acids are layered in blubber and the inner layer is most metabolically active and likely best represents diet. Thus, biopsy samples do not provide the appropriate tissues for fatty acid analysis if the other difficulties mentioned above could not be overcome. These limitations reduce the value of using fatty acids to estimate specific prey items. The proponents replied that they did not expect to use fatty acids alone but would instead use a combination of fatty acids, stable isotopes (from several tissues that represent diet over differing time periods), and stomach contents to improve understanding of foraging ecology.

NEWREP-NP will analyse more skin, muscle, liver, baleen, and prey samples for stable isotopes, blubber and prey for fatty acids, and collect stomach contents. The Panel **agrees** that combining these approaches will improve the knowledge of diet of North Pacific common minke and sei whales.

OVERALL CONSIDERATIONS

The Panel considers the four question criteria (Mogoe *et al.*, 2016) an appropriate general framework to evaluate the feasibility of using non-lethal methods as a replacement or in addition to lethal samples, though more quantification and clarification is needed to fully implement the framework (see Item 3.3.4 for further Panel comments on this framework).

The Panel **welcomes** the proponents' proposals to collect samples non-lethally, conduct the associated laboratory and analysis work, and report the results from the comparison of lethal and non-lethal methods. However, it **reiterates** that this should be seen as a priority and that the proponents provide the Scientific Committee with an estimate of the number of additional non-lethal samples required to complete the assessment so that a full analysis is available at least by the mid-term reviews. It also **recommends** that the similar data/results from the Icelandic sampling programme are incorporated in the analyses. Finally, the Panel **reiterates** that non-lethal techniques should be incorporated into the programme as soon as they are deemed plausible.

An important component of determining appropriateness is determination of sample size – as non-lethal techniques become appropriate, non-lethal and lethal sample sizes will need to be recalculated to ensure that objectives are met. The Panel noted there was no discussion in the proposal as to what the strategy would be to determine sample sizes or how the current methods that determine sample sizes might be modified to determine the new sample sizes. The Panel **recommends** that this issue is considered by the proponents and a strategy to be included in the project proposal before the start of the fieldwork.

The Panel **stresses** that the extensive number of samples and genetic data already available should be used to the fullest extent to guide the sampling design as well as genetic data and analyses in order to address the NEWREP-NP objectives in an efficient manner. The current genetic data could serve as a basis [by limiting the 'parameter space' to be explored] for conducting simulations aimed at evaluating the possible benefits of genotyping additional microsatellite loci and/or large number of SNP loci and different analytical approaches (see Hoban *et al.*, 2012 for a comprehensive review). Such an assessment will reveal the extent of the potential of additional genetic analyses of existing samples. This kind of assessment will also provide insights into how many more samples are required and from which areas. It is possible that the additional sampling in the current plans only will add marginally to the current available data/ samples, hence alleviating the need for additional lethal sampling in terms of the genetic analyses. Consequently, the Panel **strongly recommends** that the Proponents take full advantage of existing materials and data to assess the necessity of the planned efforts (in terms of numbers, timing and geographical areas) under NEWREP-NP to further resolve the current stock structure hypotheses in the targeted species before collecting additional samples.

4.5 Assessment of potential effect of catches

4.5.1 Common minke whales

4.5.1.1 PROPONENTS SUMMARY

The effect on the O-stock common minke whale of annual catch 107 and 160 was examined for 100 years using simulation based on SCAA) (see details in section 4.1 and Annex 12 of SC/F17/JR01). It was assumed that a single O stock distributed from the Japanese coast till approximately 170°E (i.e. stock structure hypothesis A). Abundance estimates in the sub-areas, historical catches and biological parameters were as in the 2013 RMP *Implementation*. A $g(0)=0.8$ was used, which was assigned high plausibility during the RMP *Implementation*. Results for the baseline scenario, which assumed the standard stock recruitment relationship of Annex 12 of SC/J17/JR01 for 100 years, indicated that the impact of an annual catch of 107 and 160 whales was very small. This was particularly clear when the ratio of projections with and without catches was considered. For the sensitivity scenario assuming a 30% drop in recruitment in 10 years, the ratio of projection indicated a relatively small impact of catches for MSYR=4%. For MSYR=1%, the impact of the catches was larger, but this needs to be considered in the context that this MSYR refers to MSYR (mature) as used for the IWC trials on which these analyses were based, and that the IWC SC has subsequently increased this lower bound to the larger MSYR (1+).

The effect on the J-stock of the proposed catch in sub-area 11 (14) and those in sub-areas 7CS and 7CN (20) was examined for 50 years (see details in section 4.1). Hitter runs with MSYR (1+)=1% and 4%, were conducted. A single J-stock was assumed (i.e. stock structure hypothesis A). It was assumed that g(0) was 0.856 (CV=0.120) for surveys with IO mode and 0.798 (CV=0.168) for surveys without IO mode (Okamura *et al.*, 2010). The abundance in sub-areas 5, 6 and 10 of 16,162 (CV=0.277) based on sighting surveys in 2005, was used (Kitakado *et al.*, 2010). Historical catches and biological parameters were as in the 2013 RMP Implementation. For MSYR (1+)=1%, the figure suggested that the population decrease from 1930 even in absence of catches. It can be considered that the decrease is due mainly to the level of bycatches. The ratio of the projections with and without the proposed catches was examined. The ratio becomes 0.8 after 50 years, which suggest that the effect on the stock of the proposed catches is not substantial. For MSYR (1+)=4%, population increases. The population trajectory with and without proposed catches were very similar to each other, suggesting that there is no negative effect of the catches on the J-stock for MSYR(1+)=4%. As a sensitivity test, trajectories were investigated assuming a mixing proportion of J-stock of 10% for commercial catches in sub-areas 7CS and 7CN. Results were similar to the base case scenario.

4.5.1.2 PANEL CONCLUSION

The Panel has two major concerns with the approach used to assess the potential effects of catches for common minke whales as summarised below.

(1) The approaches taken are based on projecting an SCAA model forward (O-stock) and an age- and sex-structure HITTER model (J-stock). However, the Scientific Committee and past Expert Panels have recommended that the impact of catches on stocks be based on trial framework (not the *CLA*) developed for RMP *Implementations* when these are available (IWC, 2010a). The projections should be based on the anticipated Scientific Permit catches as well as any projected other human-caused removals (e.g. by-catches). In the case of common minke whales, use of the trials structure on which the 2013 *Implementation* was based would account for uncertainty regarding future by-catch and also assume that the amount of by-catch is related to population size rather than being assumed to be constant.

(2) The results are based on the assumption that there is a single J-stock and a single O-stock (Stock Hypothesis A). However, the 2013 *Implementation* considered scenarios in which there is a Y-stock in the Yellow Sea (Stock Hypothesis Y) and in which there are two J-stocks and two O-stocks (Stock Hypothesis C). The proponents consider Stock Hypothesis C to be implausible, but nevertheless Secondary Objective I(iii) involves investigating the likelihood of two O-stocks, which suggests that the proponents consider the possibility of there being two O-stocks is not fully resolved.

The Panel notes that stock size is projected to decline even under the optimistic situation of a single J-stock when $MSYR_{mat}=1\%$ - due primarily to bycatch. Population size is projected to be reduced further (by 20% in approximately 2030 if catches of 47 continue to be taken). While this reduction is probably overestimated owing to assuming $MSYR_{mat}=1\%$ rather than $MSYR_{1+}=1\%$ and assuming that bycatch will remain at current levels, any further reduction of J-stock is of **concern**.

The Panel **recommends** that the assessment of the effects of catches on stocks be based on a subset of the trials on which the 2013 *Implementation* was based (including two levels for MSYR and all three stock hypotheses) as this will better account for uncertainty regarding current abundance and future bycatch, as well as time-variation in the J-O mixing proportion. The trials will also be able to account for the location (sub-area) and timing (month) of future catches. However, the trials on which the 2013 *Implementation* was based consider $MSYR_{mat}=1\%$, whereas the Scientific Committee has agreed that the lower bound for MSYR should be $MSYR_{1+}=1\%$ (IWC, 2014b). Furthermore, those trials did not use the most recent estimates of abundance. Thus, before a full consideration of the effects of the catches can be concluded, the Panel **recommends** that the proponents update the trials so that trials are conducted for $MSYR_{1+}=1\%$ and $MSYR_{mat}=4\%$ are fit to the most recent estimates of abundance. The Panel **recognises** that modifying trials is a substantial undertaking (and must be accompanied by evidence of satisfactory conditioning) and it may not be possible to update even a subset of the trials prior to the 2017 Annual Meeting. However, the Panel **stresses** the importance of this being completed before the programme commences.

4.5.2 North Pacific sei whales

4.5.2.1 PROPONENTS' SUMMARY

To evaluate effect of proposed annual catches of 140 upon the stocks, population trajectory was projected based on conditioned SCAA models using the latest information on stock structure, abundance and biological parameters (see details in section 4.2 of SC/J17/JR01). The calculation was conducted based on conditioned age-/sex-structured models. Regardless of parameters assumed, there is no serious difference in the median trajectory between the two catch scenarios (0 and 140 per year) over the 12-year sresearch period, and therefore it is evident that the impact of an annual catch of 140 whales is very small.

4.5.2.2 PANEL CONCLUSION

The Panel **agrees** that approach on which the evaluation of the effects of catches for North Pacific sei whales was based was largely appropriate. However, the analysis is based on the (single) best estimate of abundance and $MSYR_{1+}$ values of 1% and 4%. The Panel **recommends** that the proponents consider additional analyses in which current abundance is assumed to equal to the lower 95% confidence bound for the current estimate of abundance and present results for $MSYR_{1+}$=1% and $MSYR_{mat}$=4%, as these are the values selected by the Scientific Committee (IWC, 2014b).

4.6 Logistics and project management

4.6.1 Proponents' summary

To facilitate review by the IWC SC, the proponents will present progress under NEWREP-NP to annual meetings of the IWC SC. Furthermore, results for each Secondary Objective will be presented and evaluated during the mid-term review. Such scientific review will assist the direction of the analyses in the second period of the NEWREP-NP (see timeline of research activities in Figure 3 of SC/J17/JR01). The Fisheries Agency of Japan is responsible for providing financial support for personnel and logistic resources. Regarding personnel resources, the Institute of Cetacean Research will play the leading role in order to pursue the research activities and achieve the research objectives in collaboration with scientists from other domestic and/or foreign organizations. At least nine leading research institutes and universities including over 50 scientists will participate in the research under the NEWREP-NP. Five small type whaling catcher vessels will be employed for sampling of common minke whales in sub-area 11 and sub-areas 7CS and 7CN. One research base and two sampling/sighting vessels will be employed for sampling common minke whales and sei whales in offshore waters (sub-areas 7-9). NEWREP-NP establishes a backup plan for contingencies such as bad weather in order to respond to the contingency and secure the scientific value of data. The backup plan addresses three aspects; (i) adjustments of research protocols at the scene of bad weather, (ii) adjustment of research plans including research period, sample size, and research areas after the year of disruption, and (iii) consideration of analysis methods to compensate the effects of disruptions (see details in section 5 of SC/J17/JR01).

4.6.2 Panel conclusion

The Panel received a summary of: (1) the review process; (2) personnel and logistics; and (3) contingency plans for NEWREP-NP. A mid-term review to be held in 2023 will evaluate the results pertaining to the secondary and ancillary objectives, including an assessment of the success of non-lethal methods. Data collection for the second half of the programme and analyses will be modified, as necessary. The research activities will be led by staff at the Institute of Cetacean Research (ICR). ICR has 11 scientists and two technicians available to implement the research under NEWREP-NP. Additionally, approximately 40 scientists from eight other leading research institutes and universities in Japan will participate in the programme.

The Panel **welcomes** the logistical information provided by the proponents but has a number of comments as summarised below.

(1) The Panel **reiterates** its comments that the proponents must: (a) ensure that data are promptly analysed to ensure a meaningful mid-term review; and (b) it also refers to its comments about providing adequate resources into work on common minke whale biopsy sampling as soon as possible to facilitate the prompt use of non-lethal techniques.

(2) For the environmental chemistry laboratory, the proponents indicated that they have one experienced scientist and one recent graduate. They propose to carry out the immune function assays in this laboratory although they do not appear to have any immunotoxicologists working with them. The Panel **recommends** that the proponents collaborate with wildlife immunologists and immuntoxicologists to assist them as optimising, validating and interpreting the results from any immune assays requires specialist skill and knowledge; it is **not** a trivial undertaking.

(3) While on the surface, the number of researchers may seem adequate to conduct the research, the Panel **recognises** that the ICR scientists are also involved in other programmes, such as NEWREP-A and the completion of analyses from JARPN II. Although a new graduate analyst has been appointed, the Panel **remains concerned**, that, as has been the case for all previous Special Permit programmes undertaken by Japan, field and laboratory work and laboratory analyses have been allocated much higher priority than quantitative analyses and modelling. This has been reflected in the sometimes long times taken to complete analyses (some of which remain incomplete). The Panel **strongly recommends** the recruitment of sufficient highly trained and qualified analyst/modellers to improve NEWREP-NP study design, data analysis and review.

(4) Additional information on sample and data archiving, relational database(s) and multiple sampling on the same whales, as noted by previous Expert Panels would be welcome.

(5) The proponents recognised the need for a backup contingency plan in the event of disruption of the programme. The primary contingency is for the cruise leader to adjust sampling efforts and locations, if necessary, for example due to bad weather preventing the collection of data in a certain location. The Panel **agrees** that contingency plans are needed, but noted that the proponents have not yet developed a more detailed plan/protocol, *a priori*, for how research will be modified in the event of disruption.

4.7 Co-operative research

4.7.1 Proponents' summary

Scientists from the ICR will play the leading role in order to conduct the research activities and achieve the research objectives of NEWREP-NP. They will collaborate with scientists from other domestic and/or foreign organizations. At least nine leading research institutes and universities including over 50 scientists will participate in the research. Participation of foreign scientists in the field surveys of NEWREP-NP will be welcomed, so long as they meet the qualifications established by the Government of Japan. Protocol for collaboration in field activities was developed. Data obtained by NEWREP-NP will be available to members of the IWC SC in accordance with the IWC SC Data Availability Agreement (DAA). Protocol for collaboration in analytical studies was also developed (see details in section 6 and Annexes 20 and 22 of SC/J17/JR01).

4.7.2 Panel conclusion

The Panel **welcomes** the information provided and **encourages** further collaboration with international researchers. It notes the proponents should separate out collaborators who have agreed to share expertise and data to assist in meeting NEWREP-NP objectives from research groups or programmes that are simply working independently in the same area, even if their data and analyses are relevant to the NEWREP-NP programme (such the IWC/POWER programme that was mistakenly included).

The NEWREP-NP programme is ambitious with many varied research objectives. As such, the Panel **encourages** the proponents to reach out to cutting edge researchers in many of the scientific fields associated with the objectives. Involvement of additional researchers will improve the quality of data, analysis, results and reporting, as is the case for any other large research programme.

5. PANEL CONCLUSIONS

Table 2 consolidates the Panel's views on the items assigned to it under Annex P with respect to NEWREP-NP. Summary text is provided under Items 5.2-5.6. Table 3 summarises all of the recommendations made by the Panel. The overall conclusion (which is also the Executive Summary) is given as Item 5.10.

5.1 Completion of the review of the JARPN II programme (see Item 3)

The Panel noted that the original expectation had been that it would receive a final integrated report of the completed programme (i.e. all data up to 2016). The proponents, however, explained (Annex D) that compiling such an integrated report at this time was inconsistent with the timeframe for completion of recommendations agreed at the 2016 Scientific Committee meeting (IWC, 2017b). They believed that producing such a report after finishing these recommendations would be more constructive.

The proponents had produced some additional material on stock structure, feeding ecology, ageing techniques and, in particular, progress with the comparison of lethal and non-lethal techniques that had been the focus of the 2014-16 programme. While welcoming the new information and recognising that some of the 2016 Panel's recommendations required one or two years more to be completed, the Panel **concludes** that it was not able to complete the full review of the JARPN II programme completed in 2016. This will be possible only when final analyses are completed following the timeframe agreed at the Scientific Committee in 2016 and a full consolidated report following the template outlined in Annex P is made available that addresses the recommendations made by the 2016 Expert Panel, this Panel and the Scientific Committee.

Given these recurring difficulties in terms of Annex P process, the Panel **reiterates** some of 2016 Panel recommendations that remain relevant. In particular, the Panel **requests** that the Scientific Committee considers the three items below.

(a) The inclusion in Annex P of a guideline relating to the minimum time after the field programme/ the programme itself is completed that a final review can take place. This time must allow the completion of all planned analyses related to the programme's objectives. The Panel **agrees** that a full description of the fieldwork, collected samples and data and preliminary results are not to be considered sufficient to call a final review;

(b) The development of a mechanism for proponents to provide a short biennial update on progress with recommendations. Given the biennial cycle of the Commission, the Scientific Committee needs to be informed about progress only in years when the Commission meets.

(c) The development of a mechanism to allow for the completion of Expert Panel reviews if a Panel states that its review is incomplete until full further information/analyses is provided/concluded.

5.2 General comments on process and Annex P

The Panel was pleased to verify that the use of the checklist helped the Proponents to produce a proposal covering all main areas relevant to the Annex P evaluation and for which the Panel and the Scientific Committee are required to provide their advice to the Commission.

However, the Panel wishes the Scientific Committee to clarify the purpose of the Expert Panel review process to avoid any misunderstandings. During the course of the Workshop, the Panel received the (perhaps mistaken) impression that the Proponents perceived the Expert Panel review as an intermediate step before a final evaluation by the Scientific Committee. Whether the impression was incorrect or not, the Panel **stresses** that it believes it's role is to review a *final* proposal (or final documents for a periodic or final review). Indeed, this is the reason for the Panel's report to be transmitted to the Commission untouched. This is not to say that the Proponents should not take into account Panel recommendations and respond to them by the Scientific Committee meeting – as indeed is envisaged in Annex P – but that the Proponents should be submitting to the Panel what they believe to be the final, fully justified proposal (or reports that contain full analyses of all data).

Whilst the Panel is pleased that Governments are prepared to revise their proposals where problems are detected, it does not believe that it is appropriate for a Panel to receive, as has sometimes happened, responses to questions along the lines that there had not been time for particular information to be prepared for the Panel, but that it would be provided for the next meeting of the Scientific Committee.

In short, the Panel **reiterates** its view that Expert Workshops are meant to undertake a thorough review of a **final** proposal (or a mid-term or final report). The Panel **recommends** that the Scientific Committee considers revising Annex P to provide the necessary clarity on this, in order to help future reviews.

In addition to the recommendations on final reviews provided under Item 5.1, the Panel also **recommends** that the Scientific Committee develops general guidelines/ frameworks, which could be appended to Annex P for the following:

(1) quantifying any likely improvements in conservation and management postulated for particular special permit objectives in an IWC/RMP context (e.g. using the RMP simulation trial framework under different data assumptions and scenarios to examine different catch performance statistics for the same conservation performance);

(2) assessing the impact of the effects of special permit catches upon stocks, for situations for which there has or has not been an RMP *Implementation* (and see Item 4.5); and
(3) evaluating the feasibility and practicability of non-lethal techniques (and see Item 5.4).

5.3 Importance of objectives in the NEWREP-NP proposal

Annex P requires that the review comments briefly on the perceived importance of the stated primary objectives from a scientific perspective and for the purposes of conservation and management, noting particularly the relevance to the work of the Scientific Committee. A summary of the Panel's views by Objective and Secondary Objective can be found in Table 2.

5.3.1 Primary Objective I

Primary Objective I is that the permit programme provides a 'Contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan'.

In conclusion, the Panel **agrees** that this overall broad objective is important for the purposes of conservation and management. With respect to the Secondary Objectives, the Panel **agrees** that:

(a) Secondary Objectives I(i), I(ii) and I(iii) all address important aspects related to the abundance and stock structure of common minke whales in the western North Pacific and would be of importance in future *Implementation Reviews*. The extent to which this requires additional biological samples rather than improved analyses of existing data to achieve the Secondary Objectives is discussed elsewhere in this report;
(b) Secondary Objective I(iv) relates to RMP trials – it will enhance the way RMP *Implementation Simulation Trials* are conditioned, but would not probably provide as great an impact as Secondary Objectives I(i), I(ii), and I(iii) – see discussion elsewhere in the report on the need to quantify postulated improvements; and
(c) Secondary Objective I(v) related to 'regime shifts' should be considered ancillary as it is unlikely to make a direct contribution to future *Implementation Reviews* within a reasonable timeframe, if at all.

5.3.2 Primary Objective II

Primary Objective I is that the permit programme provides a 'Contribution to the RMP/*IST* for North Pacific sei whales'.

In conclusion, the Panel **agrees** that this overall broad objective is important for the purposes of conservation and management, but that, as phrased, it is somewhat premature until the in-depth assessment and an RMP *pre-Implementation assessment* have been satisfactorily completed and the Commission approved moving to an *Implementation*. At present, the Scientific Committee is involved in an in-depth assessment of North Pacific sei whales and not an RMP *Implementation*, as explained under Item 4.1.2.2. With respect to the Secondary Objectives, the Panel **agrees** that:

(a) Secondary Objective II(i) relating to abundance will contribute substantially to the in-depth assessment (but note the time-scale issue) and a possible future RMP *Implementation,* should one occur;
(b) Secondary Objective II(ii) relating to improved estimates of biological parameters may contribute to the in-depth assessment (but note the time-scale issue) and a possible future RMP *Implementation,* should one occur - however, the parameters that are the focus of this Secondary Objective are not the most important in terms of management;
(c) Secondary Objective II(iii) relating to stock structure will contribute to a possible future RMP *Implementation,* should one occur but whilst stock structure is an extremely important issue, the extent of the contribution of the expected new information is unclear;
(d) Secondary Objective II(iv) relating to RMP trial specifications will contribute to a possible future RMP *Implementation* should one occur; and
(e) Secondary Objective II(v) related to regime shift should be considered an ancillary objective for the same reasons as for Secondary Objective I(v).

The Panel also **agrees** that the Secondary Objectives of both primary objectives of the proposal are relevant to many Scientific Committee recommendations. However, the Panel **reiterates** that several these recommendations concerned improved or new analyses of existing data, rather than the collection of new data.

5.4 Ability of objectives to be met by non-lethal methods

Annex P requires that the review evaluates whether the objectives of the research could be achieved using non-lethal methods or whether there are reasonably equivalent objectives that could be achieved non-lethally.

This Panel, as have previous Expert Panels, has noted the complexities of this issue overall and the need for a proper evaluation of options for lethal and non-lethal techniques (see discussion under Item 3.3.4, aspects of Item 4.2 and Item 4.4.3). The Panel **agrees** that certain data types (e.g. age and body measurements), specified to meet the objectives as stated, require lethal sampling, at least at present. However, it **recommends** that a more thorough quantitative review of the relative contribution of those data types to the ability of the proponents to meet their primary and Secondary Objectives is required before a formal conclusion can be drawn on the ability or otherwise of non-lethal methods to meet some specific sub-objectives.

Given the focus in Annex P on comparing lethal and non-lethal methods, the Panel **recommends:**

(a) that any Special Permit programme should include as a specific primary objective, the constant review of new techniques as these become available to facilitate discussions of methods and samples sizes at milestones such as the mid-term reviews;
(b) if present data do not allow for a full evaluation, a focussed pilot study to enable a full and proper evaluation of lethal vs present non-lethal methods integrated across objectives should be undertaken, prior to the start of a full programme - where such data already exist, then a desktop-study evaluation should be undertaken before the permit programme begins;
(c) such evaluations could be undertaken in light of an expanded framework as recommended under Item 3.3.4 and must be properly designed to enable more effective reviews of sample sizes/methods during mid-term reviews; and
(d) informative evaluations must include using analyses and/or simulations to evaluate the influence of the same or similar data obtained lethally and non-lethally on the objectives related to the management/

conservation of whale stocks, and recognise that the data obtained using different methods, may be slightly different, and may have slightly different interpretations or provide different levels of precision.

The Panel **agrees** that whilst the proponents have begun such work, it is not yet complete.

The Panel **recognises** that the responsibility for developing a suitable evaluation framework (see point (c) above) is not a trivial task given the complexities of the subject (see past Expert Panel reports and Items 3.3.4 and 4.4.3). It believes that the responsibility should not fall solely on the proponents and **recommends** that the Scientific Committee develops a mechanism to provide consolidated advice on this.

5.4.1 Primary Objective I and Secondary Objectives

The Panel **agrees** that at present, non-lethal methods are not suitable to meet those Secondary Objectives that require age data. See the discussion under Item 3.3.4 about the future feasibility of biopsy sampling for this species. Additional work is required to determine whether the present age data are sufficient to meet the objectives of the programme. The Panel also expresses **reservations** on the value additional age data would bring to improved conservation and management (see Item 5.6.1).

5.4.2 Primary Objective II and Secondary Objectives

As for Primary Objective I, the Panel **agrees** that at present, non-lethal methods are not suitable to meet those Secondary Objectives that require age data. Additional work is required to determine whether the present age data are sufficient to meet the objectives of the programme. The Panel also expresses **reservations** on the value additional age data would bring to improved conservation and management (see Item 5.6.2).

5.5 Are lethal methods likely to improve conservation and management?

Annex P asks that the review evaluate 'whether the elements of the research that rely on lethally obtained data are likely to lead to improvements in the conservation and management of whales. This evaluation should include whether the proposal demonstrates the likely magnitude and relevance of improvements to conservation and management arising from the achievement of the programme objectives'.

The Panel refers to its earlier general discussion of the complexities of issue related to the discussion of lethal and non-lethal techniques (and see Item 5.4 above) and the need to quantify any postulated improvements in conservation and management for both lethal, non-lethal and combined approaches (and see Item 5.2).

5.5.1 Primary Objective I and Secondary Objectives

With respect to Secondary Objective 1(i) on the spatial and temporal occurrence of J-stock, the Panel **recognises** that improving understanding of J-stock is useful for conservation and management. However, it notes that the lethal component contribution is not likely to be as substantial for overall management as addressing stock structure uncertainty (much of which may be able to be done using existing samples) and by improving estimates of abundance.

With respect to Secondary Objective I (iii) on resolving stock structure issues with O-stock(s), the Panel **agrees** that resolving this will have a substantial impact. The performances of some of the RMP variants, especially those that lead to higher catch limits for the *Small Areas* near Japan, depend critically on whether there are one or two O-stocks.

With respect to Secondary Objective I (iv) on incorporating age data into eventual RMP trials, the Panel **agrees** that whilst this may be of value, it is not clear to what extent additional samples will improve the conservation and management – this must be quantified (see Item 5.2).

5.5.2 Primary Objective II and Secondary Objectives

The Panel refers to earlier comments (Item 4.2.9) that it is not clear to what extent additional age data will improve the situation with respect to the estimation of biological parameters or the effect of this on conservation and management; this should be quantified by the proponents (and see Item 5.2).

5.6 Design and implementation

Annex P asks that the Review Panel to evaluate 'whether the design and implementation of the programme are reasonable in relation to achieving the programme's stated research objectives, and in particular, evaluate whether sample sizes and the spatial and temporal scales are reasonable in relation to the programme's stated research objectives and whether non-lethal alternatives are not feasible to either replace or reduce the size of the lethal sampling being proposed'.

5.6.1 Common minke whales

The Panel **agrees** that there are several aspects of the coastal sampling procedure that make the design unusual for a scientific survey and will complicate and possibly compromise data analyses. In particular, the Panel **concludes** that:

(a) the design would lead to oversampling of the areas close to ports (the Panel was informed that an additional land-based station may be established in the northern Sanriku to better cover sub-areas 7CS and 7CN);
(b) the boats can search freely once they reach 30 n.miles from port if no whales have been encountered *en route* from port, which means the design is not fully specified in terms of the catches by the port-based boats; and
(c) the *Nisshin Maru* will conduct sampling if the number of common minke whales caught does not reach the target number, but no sampling plan for this contingency is provided.

The Panel **agrees** that the impact of non-random sampling of the inshore areas has different consequences for each Secondary Objective under primary objective I. In particular, the Panel **concludes** that it will substantially complicate:

(a) achievement of Secondary Objective I(i), for which random sampling is ideal, if not essential; and
(b) estimating the power to achieve Secondary Objective I(iii), which depends not only on sample size in the inshore and offshore areas (see Item 4.2.4), but also on how samples are collected within sub-areas 7CS, 7CN and 11.

The Panel **recommends** that analyses be conducted, before the start of the programme, to assess the extent of loss in precision due to the sampling strategy for the objectives related to common minke whales and the implications for the meeting Secondary Objectives. The Panel also **recommends** that the experience/data gained from JARPN II should be used by the proponents to investigate (a)-(c) above.

The Panel **concludes** that offshore sampling lines will not achieve uniform coverage of the research area and do not cover the whole distribution range of each whale species (Bando *et al.*, 2016). The unbalanced sample sizes in the offshore (27) and inshore (100) areas will complicate the estimation of the selectivity pattern for offshore common minke whales (if there is a single O-stock). It may lead to a dome-shaped selectivity pattern, which will need to be accounted for in any SCAA analysis, at the cost of additional parameters and lower precision. The survey plan allows for the possibility of taking multiple animals from a school, which could impact the power of analyses related to diet and genetic structure owing to the possibility of pseudo-replication. Additionally, the rather small sample size offshore may reduce the likelihood of detecting the effects of a major environmental shift on both the diets and the distributions of common minke whales. The Panel **concludes** that Proponents must thoroughly consider issues such as unbalanced sample sizes and the taking of multiple animals from the same school and provide further justification/modification to their current data collection plan (see details in Item 4.3.1).

With respect to sample sizes for common minke whales, as explained under Item 4.4.1, the Panel **agrees** that even if the power to detect a change in recruitment was high, the analyses in Annex 12 do **not** provide a defensible basis for assigning sample size (i.e. 50 from 7CS, 50 from 7CN and 27 from 7E-8-9). The proposed SCAA approach is not able to detect a change in recruitment even after 50 years, i.e. well beyond the project timeframe of 12 years. The Panel **notes** that the SCAA was able to provide unbiased estimates of total numbers even without age data.

Although the Panel had several technical concerns with the analyses presented, which could be addressed in further analyses, it **stresses** that these would **not** remove the fundamental problem that the planned sample size is not fully justified for the primary objective or any of the Secondary Objectives. While Annex D does refer to the use of age data for Objective I (iv), the Panel believes that the link with conditioning is rather weak and the number chosen not well justified in terms of management performance.

5.6.2 Sei whales

The Panel **agrees:**

(a) that there is no clear link between the ability to estimate natural mortality and improvements in the conservation and management of sei whales;
(b) even with the proponents' assumptions, the calculated sample size was underestimated because the analyses ignored the effects of age-reading error and age-readability, both of which will reduce the information content of the age data; such analyses must be updated to account for both of these source uncertainty;
(c) analyses must be undertaken such that the SCAA is not provided with information about MSYR and MSYL; and
(d) analyses should be undertaken in which the historical age-composition data are downweighted by various levels.

In conclusion, the Panel **agrees** that the proponents have **not** justified the sample size for sei whales.

5.7 Collaboration

Annex P asks that the Review Panel to assess 'the degree to which the programme coordinates its activities with related research projects'.

The Panel **welcomes** the information provided on collaboration and **encourages** further collaboration with international researchers. Given that the NEWREP-NP programme is ambitious with many varied research objectives, the Panel **encourages** the proponents to reach out to cutting edge researchers in many of the scientific fields associated with the objectives. Involvement of additional researchers will improve the quality of data, analysis, results and reporting, as is the case for any other large research programme.

5.8 Effects of catches upon stocks

Annex P asks that the Review Panel provide 'advice on the likely effects of the catches on the stock or stocks involved under various scenarios of length of the programme. This will include *inter alia* examination of abundance estimates provided and may involve a different analysis to that provided in the original proposal, including assumptions that short permit proposals may be projected further into the future.

5.8.1 Common minke whales

The Panel had two major concerns with the approach used to assess the potential effects of catches for common minke whales related to both the approaches used (SCAA projections for O-stock and HITTER for J-stock) and the assumptions made especially related to stock structure (especially with respect to the number of O- and J-stocks). Whilst it recognises that the proponents did not agree that the 2-O and 2-J-stocks scenario was realistic, The Panel **concludes** that it is appropriate to at least present the results for comparison, especially as part of the programme's objective is to finalise the stock structure issue. Even using the proponents' methods, the Panel **expresses concern** that the results showed a decline in J-stock for cases where $MSYR_{mat}$=1%.

The Panel provided a detailed **recommendation** (see Item 4.5.1 and Table 3) for a more robust way to estimate the possible effects on stocks based upon a subset of the *Implementation Simulation Trials* from 2013 updated to use $MSYR_{1+}$=1% and $MSYR_{mat}$=4% and fitted to the most recent estimates of abundance. Previous Expert Panels have recommended using the *Implementation Simulation Trials* approach (but not the *CLA* itself) as the best framework for evaluating the effects of catches upon stocks (IWC, 2010a, pp.76-77). The Panel **stresses** the importance of this work being completed before the programme commences.

5.8.2 Sei whales

The Panel **agrees** that the proponents' approach to evaluate the effects of catches for North Pacific sei whales was largely appropriate. However, the analysis is based on the (single) best estimate of abundance and $MSYR_{1+}$ values of 1% and 4%. The Panel **recommends** that the proponents develop additional analyses in which current abundance is assumed to be equal to the lower 95% confidence bound for the current estimate of abundance and present results for $MSYR_{1+}$=1% and $MSYR_{mat}$=4%, as these are the values selected by the Scientific Committee (IWC, 2014b).

5.8.3 General

The Panel notes that previous Expert Panels and the Scientific Committee have noted that where such a framework exists, RMP *Implementation Simulation Trials* (not using the *CLA*) should form the basis of any evaluation of the effects of catches on stocks (IWC, 2010a; 2017b). The Panel **recommends** that the Annex P is updated to provide clearer guidance on this.

Table 2a

Summary of the Panel's conclusions in light of Annex P – Part 1. PO=Primary Objective; SO=Secondary Objective.

Lethal	Importance: scientific prospective	Importance: conservation and management	Achievable with non-lethal methods	Equivalent objectives that can be achieved non-lethally?	Lethal components: magnitude and relevance for conservation and management	Design and implementation reasonable to achieve objectives?
PO I: Contribution to optimising the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan						
Y	**Yes**	**Yes**	**In part (see below)**			
SO I (i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status						
Y	Yes, particularly given availability of age structure. New compared to past programmes.	Not needed to run *CLA*, but increase accuracy of ISTs.	Currently not feasible, but current developments may change the situation in near future.	Replacing age with length is possible but not as precise	Magnitude and relevance of improving and understanding of spatial and temporal occurrence of J stock is useful but lethal components contribution not likely to be as substantial for overall management as addressing stock structure uncertainty and improving estimates of abundance.	The inshore sampling design makes analysis challenging and this has not been addressed. Field and laboratory implementation is reasonable.
SO I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan						
	Yes	Yes, for *CLA* and ISTs	NA	NA	NA	Yes. The split of abundance estimate to stock depends on appropriate modelling framework that includes stock structure
SO I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan						
Y	Yes	Yes, for ISTs	Yes	NA	Substantial impact. The performance of few RMP variants are critically dependent on whether there are one or two O stocks.	The design of the sampling scheme does not maximise the information available to assess whether there is a stock structure within O stock. The analysis of more genetic loci on the existing samples is more likely to meet the objective then additional sampling.
SO I (iv): Improve RMP trials by incorporating age data in their conditioning						
Y	Yes	Yes, for ISTs	Much of the age data already exist but has not been included in past ISTs. Age data for the future currently not feasible, but current developments may change the situation in near future.	The past age data could be included without collecting additional lethal samples.	Unclear because there are substantial historical samples which may be sufficient to improve conditioning without additional samples being collected.	Yes, this is a modelling exercise.
SO I (v): Investigation of the influence of regime shift on whale stocks						
Y	Yes for understanding responses of environmental change.	Not important	No	No	Little importance	Major concerns because of small sample sizes for common minke whales offshore, time-scale of programme against possible regime shifts occurring and requirement for better sampling of prey availability.
PO II: Contribution to the RMP/*IST* for North Pacific sei whale						
Y	**Yes**	**Yes (eventually)**	**Yes**			
SO II (i): Abundance estimates for North Pacific sei whale taking account additional variance						
	Yes	Yes, for IA	NA	NA	NA	Yes
SO II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*						
Y	Yes	Yes, for developing models for this species and IA.	Considerable age data already exist. Age data for the future but currently not feasible, but current developments may change the situation in near future.	The past age data could be included without collecting additional lethal samples.	Unclear because there are substantial historical samples which may be sufficient to improve conditioning without additional samples being collected.	Yes
SO II (iii): Additional analyses on stock structure in North Pacific sei whale for RMP *Implementation*						
Y	Very limited.	Yes, for IA	Limited	Yes	No	Yes
SO II (iv): Specification of RMP *ISTs* for North Pacific sei whale						
	Yes	Yes		Yes	NA	NA
SO II (v): Investigation of the influence of regime shift on whale stocks						
Y	Yes for understanding responses of environmental change.	Not important	No	No	Very little.	Major concerns because of time-scale of programme against possible regime shifts occurring and requirement for better sampling of prey availability.

Table 2b

Summary of the Panel's conclusions in light of Annex P – Part 2. PO=Primary Objective; SO=Secondary Objective.

Lethal	Degree of coordination with related projects?	Effects of catches on stocks	Intermediate targets	Any other relevant matter for the SC
PO I: Contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan				
Y				
SO I (i): Investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status				
Y	Build extensively on JARPN II	Not fully evaluated. If it is a single O stock the effect of catches is minimal. However, the analysis presented did not consider possibility of two O stocks.	Unclear the intermediate target for biopsy sampling feasibility study	Unlikely to be used for the 2018 *Implementation Review* but it could feed into that in 2024.
SO I (ii): Estimate the abundance of the J and O stocks in coastal waters of Japan				
	Yes	NA	Sufficient	Abundance relevant to much SC work. Surveys could provide information on other species.
SO I (iii): Verify that there is no structure in the O stock common minke whale in the Pacific side of Japan				
Y	Builds extensively on JARPN II	If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.	OK if sufficient analyses are carried out.	Small NEWREP-NP sample are expected to be available to be used for the 2018 *Implementation Review*, but it could feed in the 2024 *Implementation Review*.
SO I (iv): Improve RMP trials by incorporating age data in their conditioning				
Y	-	If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.	Sufficient	This require coordination with the SC in the upcoming *Implementation Review.*
SO I (v): Investigation of the influence of regime shift on whale stocks				
Y	Partial. Potential for coordination with many other initiatives.	If it is a single O stock the effect of catches is minimal. Unknown as the analysis presented did not consider possibility of two O stocks.	Reasonable	Data could be relevant to EM
PO II: Contribution to the RMP/IST for North Pacific sei whale				
Y				
SO II (i): Abundance estimates for North Pacific sei whale taking account additional variance				
	Yes	NA	Sufficient	Abundance relevant to much SC work. Surveys could provide information on other species.
SO II (ii): Estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*				
Y	Yes	Negligible	Adequate	
SO II (iii): Additional analyses on stock structure in North Pacific sei whale for RMP *Implementation*				
Y	Yes	Negligible	Adequate	
SO II (iv): Specification of RMP *ISTs* for North Pacific sei whale				
	NA	NA	Adequate	
SO II (v): Investigation of the influence of regime shift on whale stocks				
Y	Partial. Potential for coordination with other initiatives.	Negligible	Reasonable	Data could be relevant to EM

5.9 Review of progress

Annex P asks that the Review Panel determine 'whether the programme has specified intermediate targets that would allow for an adequate review of progress relative to programme objectives'.

The Panel noted that the proponents are proposing a mid-term review after 6 years. The Panel **agrees** that:

(a) a mid-term review is desirable;
(b) the proponents must ensure that data are promptly analysed to ensure a meaningful mid-term review; and
(c) adequate resources must be allocated to work on common minke whale biopsy sampling as soon as possible to facilitate the prompt use of non-lethal techniques – this specific effort should be reviewed before the mid-term review.

In order to achieve the above, the Panel **strongly recommends** the recruitment of sufficient highly trained and qualified analyst/modellers to improve NEWREP-NP study design, data analysis and review.

5.10 Overall conclusions

The Panel's tasks were twofold: (1) review the JARPN II programme including analyses of data up to 2016; and (2) review the NEWREP-NP proposal in light of Annex P.

With respect to the JARPN II programme, although the additional data for the period were provided, only some analyses were available, primarily on the work carried out comparing lethal and non-lethal techniques. The Panel **agrees** that a full 'final' review of the JARPN II programme will be possible only when final analyses are completed, in line with the IWC Scientific Committee-agreed timeframe for analyses, and a full consolidated report made available. The Panel made several recommendations related to this item, including some directed at clarifying Annex P with respect to final reviews.

With respect to the review of NEWREP-NP, the Panel recognised the considerable work that had been undertaken by the proponents in developing the proposal and **commends** their efforts to: (a) follow Annex P and the Checklist; and (b) provide additional information during the Workshop itself (Annex D).

The Panel **agrees** that the Primary and most of the Secondary Objectives are important for conservation and management, although the level of the contribution varies. Despite the work undertaken by the proponents, the Panel **concludes** that, in its current version, (1) the Proposal does not adequately justify the need for lethal sampling and the proposed sample sizes, particularly with

Table 3

Summary of recommendations made relevant to NEWREP-NP.

No.	Agenda item	Panel recommendations	Comment/timeline
1	4.1.5	The Panel **recommends** that a more thorough quantitative review of the relative contribution of those data types that can only be obtained by lethal sampling to the ability of the proponents to meet their primary objectives is warranted for a full evaluation of options in terms of lethal *vs* non-lethal methods in relation to the objectives (see also Item 4.2).	Required for any revised proposal.
2	4.1.5	The Panel **recommends** that any Special Permit programme should include a specific Primary Objective to continually review new techniques as these become available to facilitate discussions of methods and samples sizes at milestones such as the mid-term reviews. *If* present data do not allow for this, a focussed pilot study to enable a full and proper evaluation of lethal vs present non-lethal methods integrated across objectives should be undertaken, prior the full programme starting; where such data already exist then the desktop-study evaluation should be undertaken *before* the permit programme begins. Such evaluations could be undertaken in light of an expanded framework as recommended under Item 3.3.4 and must be properly designed to enable more effective reviews of sample sizes/methods during mid-term reviews.	Whilst relevant to the proponents, this is directed primarily at the Scientific Committee and linked to Recommendation 19.
3	4.2.1	*Sexual maturity:* The Panel **recommends** that levels of progesterone in blubber and serum should be compared with sexual maturity and reproductive status of examined females. This comparison is valuable for assessing the efficacy of biopsy sampling for assessing reproductive status.	Add to the research protocols for any revised proposal.
4	4.2.1 and 4.3.2	*Sightings surveys*: The Panel highlighted several issues that must be considered when designing line transect surveys that are expected to provide abundance information to address multiple objectives. The Panel **recommends** that these issues related to survey design, data collection protocols and priorities, data analyses and coordination are included in the plans to be submitted to the Scientific Committee for approval, before the surveys start. The main additional issues that should be covered in the proposals for surveys submitted to the Scientific Committee are: (a) **Evaluation of past surveys' analytical difficulties**. These new surveys provide an important opportunity to evaluate and potentially add/modify the variables or values of variables that are collected. Evaluating the shortcomings of previous surveys (for example, sample size issues and the amount of effort expended, problems that arose in analyses of past data) could suggest ways to supplement the future surveys. (b) **Appropriate temporal stratification** of the surveys. (c) **Appropriate direction of travel** for the survey vessel(s) and direction of track lines to account for migrating animals. (d) **Use of independent observer (IO) mode,** especially in the offshore waters where the weather and sea state conditions are poorer. (e) **Use of passive independent observer mode** with abeam closing to get the benefits of estimating $g(0)$ and also improving the precision of the group sizes. (f) **Development of protocols/priorities for biopsy-related activities**. (g) **Evaluation of additional variance analysis and spatial model methods** to determine which is preferred or whether both methods are investigated. (h) **'Regime shift'-related aspects** require that consideration should be given to whether sampling of prey is possible during the line transect surveys - obtaining simultaneously collected prey and whale data seems ideal, however logistically challenging.	Address in individual survey plans submitted to the Scientific Committee.
5	4.2.5	Care is required during sub-sampling of prey in whale stomachs to ensure that the sample is representative when stomach volumes are large and prey diverse; the Panel **recommends** that the proponents specify how this is to be achieved in the field protocols.	Add to the research protocols for any revised proposal.
6	4.2.5	To demonstrate the feasibility of meeting the Secondary Objective related to regime shift, the Panel **recommends** that the proponents specify more fully: (a) quantitative criteria with respect to identifying [major] environmental change and potential responses by whales; (b) the adequacy of the methods and effort to specify the distribution, seasonality, and precision of the environmental data, for the regions in which the whales being studied are feeding; (c) taking into account uncertainty, conduct a power analysis to determine the sample sizes/effort for the characterisation of the environment and whales (including distribution and prey use) needed to determine if there are changes before and after a major environmental change occurred, should one occur during the programme.	Required for any revised proposal if the proponents wish to continue with this Secondary Objective for either or both species.
7	4.2.11	In order to achieve aim of research item (i) the Panel **recommends** that any immune function assays used should be those already established for cetaceans (Schwacke *et al.*, 2012) so that the results are comparable to published studies.	Add to the research protocols for any revised proposal.
8	4.2.11	Following previous expert panel recommendations, the Panel **strongly reiterates** that all lipophilic compounds being measured must be reported on a lipid weight and not a wet weight basis.	Add to the research protocols for any revised proposal.
9	4.2.11	Research item (iii) relates to novel compound exposure and indicates that the levels of polybrominated diphenyl ethers (PBDEs) and other flame retardants would be quantified in blubber, prey and marine debris (presumably micro- and macro-plastics found in whale stomachs). However, there is no indication of how these results would be related to 'adverse effects' as stated in the objective. The Panel therefore **recommends** an integration and combined analysis of the results obtained by all three research items (i.e. relating exposure to polychlorinated biphenyls, flame retardants and novel compounds from plastics to responses) such as immune function and enzyme induction, including controlling for any effects of age (emphasizing the need to use the age estimates obtained from the earplugs rather than body length) and nutritional condition. This would require samples from the same individuals to be included in each of the three research items.	Recommendation for analyses of results relevant for any mid-term review.
10	4.2.12	The Panel **recommends** coordination with IWC-POWER with respect to sightings surveys, biopsy sampling and photo-ID for large whales to ensure consistent data collection and processing, as appropriate. The Panel also **recommends** information on these species are included in annual reports to the Scientific Committee to encourage collaboration with scientists involved with research on these two species.	Preparation for sightings surveys and presentation of results.
11	4.3.1	*Coastal component*: The Panel **recommends** that analyses be conducted, before the start of the programme, to assess the extent of loss in power and precision due to the sampling strategy for the objectives related to common minke whales and the implications for meeting Secondary Objectives. The experience/data gained from JARPN II should be used by the proponents to investigate issues (a)-(c) below: (a) the design would lead to oversampling of the areas close to ports (the Panel was informed that an additional land-based station may be established in the northern Sanriku to better cover sub-areas 7CS and 7CN); (b) the boats can search freely once they reach 30 n.miles from port if no whales have been encountered *en route* from port, which means the design is not fully specified in terms of the catches by the port-based boats; and (c) the *Nisshin Maru* will conduct sampling if the number of common minke whales caught does not reach the target number, but no sampling plan for this contingency is provided.	Add to the research protocols for any revised proposal.
12	4.3.1	*Offshore component*: During the Workshop, the proponents provided the Panel with the sampling strategy (samples by month, year, and sub-area) and the Panel **recommends** that this information be included in the version of the proposal that is provided to the Scientific Committee. The Panel also **recommends** that tables of past samples in the same format as the new samples should be included in a revised proposal to place the new samples in a spatio-temporal context.	Required for any revised proposal.

No.	Agenda item	Panel recommendations	Comment/timeline
13	4.4.2	The Panel **recommends** conducting analyses in which the historical age-composition data are downweighted by various levels.	Required for any revised proposal.
14	4.4.3.2	The Panel **recommends** the implementation of biopsy sampling to reduce the lethal sample size as soon as it is deemed feasible rather than wait until the mid-term review.	As soon as feasible.
15	4.4.3.2 and 4.6.2	Given the discussion under Item 3.3.4, the Panel **recommends** that a properly designed experiment to assess the efficiency of biopsy sampling of common minke whales be undertaken (there is already sufficient detail on catch to render additional capture experiments unnecessary). This should incorporate at least: (a) the use of the expected vessels in the programme (i.e. the small type whaling vessels); (b) the use of vessels (that may be different from the expected vessels) considered suitable by scientists already experienced with biopsy sampling this species; (c) suitable levels of effort to allow a statistical comparison (effort for biopsy sampling should be measured or converted to the same units used for examining catching efficiency); (d) effort should be carried out in various environmental conditions (e.g. sea state, swell, visibility) up to the maximum conditions that would apply to whaling; (e) advice and training from invited experienced minke whale biopsy samplers (e.g. Christian Ramp or Lars Kleivane); and (f) analyses that provide a proper comparison of biopsy sampling and catching (including time to process samples under various variables such as experience of sampler, vessel, equipment, effort under similar conditions). The Panel **reiterates** its comments that the proponents must (a) ensure that data are promptly analysed to ensure a meaningful mid-term review – it also refers to its comments about providing adequate resources into work on common minke whale biopsy sampling as soon as possible to facilitate the prompt use of non-lethal techniques.	High priority to begin as soon as possible this year.
16	4.4.3.2	The Panel **recommends** the proponents attend the IWC-ONR joint Workshop on Tag Development, Follow-Up Studies and Best Practices to be held in September 2017 in Silver Spring, MD (USA) to become acquainted with the most current tagging technologies and deployment methods.	September 2017.
17	4.4.3.2	Rather than set an arbitrary number of telemetry tags for deployment, the Panel **recommends** that the number, location and timing of tag deployments should reflect the questions being addressed.	Add to protocols for any revised proposal.
18	4.4.3.2	Once a suitable tag is developed, the Panel **recommends** tagging North Pacific common minke whales within the study area to address stock structuring within the NEWREP-NP study region. Again, tag deployment location and tag design should be tailored to the question being addressed.	As soon as practical.
19	4.4.3.2	The Panel **recommends** using the extensive amount of data in age-related methylation in mammal model species (e.g. humans) where thousands of CpG sites have been identified in which the level of methylation correlates with age, similar to the approach taken by Polanowski *et al.* (2014) who assessed 37 CpG sites originally identified in humans. Once putative aging CpG sites have been identified among the candidate CpG sites observed in humans, a more targeted approach may be developed by identifying the homologous loci in the minke whale genome, thereby presumably increasing the precision of methylation-based aging in North Pacific minke whales. This work should be undertaken in the context of whether the technique shows a suitable level of precision for meeting conservation and management objectives requiring age data, not whether it achieves a comparable level of precision to ear plug readings.	Can start with existing data.
20	4.4.3.2	The Panel **recommends** that the similar data/results from the Icelandic sampling programme are incorporated in the analyses. The Panel **reiterates** that non-lethal techniques should be incorporated into the programme as soon as they are deemed plausible	-
21	4.4.3.2	*Sample size (potential reduction of lethal sample size)*: An important component of determining appropriateness of techniques is determination of sample size - as non-lethal techniques become appropriate, non-lethal and lethal sample sizes will need to be recalculated to ensure that objectives are met. The Panel noted there was no discussion in the proposal as to what the strategy would be to determine sample sizes or how the current methods that determine sample sizes might be modified to determine the new sample sizes. The Panel **recommends** this issue be considered by the proponents and a strategy to be included in the project proposal before the start of the fieldwork.	Required for any revised proposal.
22	4.4.3.2	Sample size (in general): The Panel strongly recommends that the Proponents take full advantage of existing materials and data to assess the suitability of the planned efforts under NEWREP-NP to resolve the current stock structure hypotheses in the targeted species, before collecting more samples. Simulation studies based upon data collected from the current samples are recommended to adjust the experimental design to address the targeted levels of population divergence/heterogeneity. Such simulations may reveal that an increase in data from existing samples may prove beneficial over collecting additional samples.	Required for any revised proposal.
23	4.5.1.2	In relation to the impact of catches on common minke whales, the Panel **recommends** that the assessment of the effects of catches on stocks be based on a subset of the trials on which the 2013 *Implementation* was based (including two levels for MSYR and all three stock hypotheses) as this will better account for uncertainty regarding current abundance and future bycatch, as well as time-variation in the J-O mixing proportion. The trials will also be able to account for the location (sub-area) and timing (month) of future catches. However, the trials on which the 2013 *Implementation* was based consider $MSYR_{mat}$=1%, whereas the Scientific Committee has agreed that the lower bound for MSYR should be $MSYR_{1+}$=1% (IWC, 2014b).	Required for any revised proposal.
24	4.5.1.2	Furthermore, the analyses for common minke whales did not use the most recent estimates of abundance. Thus, before a full consideration of the effects of the catches can be concluded, the Panel **recommends** that the proponents update the trials so that trials are conducted for $MSYR_{1+}$=1% and $MSYR_{mat}$=4% are fit to the most recent estimates of abundance. The Panel **recognises** that modifying trials is a substantial undertaking (and must be accompanied by evidence of satisfactory conditioning) and it may not be possible to update even a subset of the trials prior to the 2017 Annual Meeting. However, the Panel it **stresses** the importance of this being completed before the programme commences.	Required for any revised proposal.
25	4.5.2.2	In relation to North Pacific sei whales, the Panel **recommends** that the proponents consider additional analyses in which current abundance is assumed to equal to the lower 95% confidence bound for the current estimate of abundance and present results for $MSYR_{1+}$=1% and $MSYR_{mat}$=4%, as these are the values selected by the Scientific Committee (IWC, 2014b).	Required for any revised proposal.
26	4.6.2	The Panel **recommends** that the proponents collaborate with wildlife immunologists and immunotoxicologists to assist them as optimising, validating and interpreting the results from any immune assays requires specialist skill and knowledge; it is **not** a trivial undertaking.	Prior to undertaking the immune function analyses.
27	4.6.2	Although a new graduate analyst has been appointed, the Panel **remains concerned**, that as has been the case for all previous special permit programmes undertaken by Japan, field and laboratory work and laboratory analyses have been allocated much higher priority than analyses and modelling. This has been reflected in the long times taken to complete analyses (some of which remain incomplete). The Panel **strongly recommends** the recruitment of sufficient highly trained and qualified analyst/modellers to improve NEWREP-NP study design, data analysis and review.	Prior to undertaking the programme.
28	4.6.2	Additional information on sample and data archiving, relational database(s) as noted by previous expert panels would be welcome.	Include as part of any revised proposal.
29	4.6.2	The proponents recognised the need for a backup contingency plan in the event of disruption of the programme. The primary contingency is for the cruise leader to adjust sampling efforts and locations, if necessary, for example due to bad weather preventing the collection of data in a certain location. The Panel **agrees** that contingency plans are needed, but noted that the proponents have not yet developed a more detailed plan/protocol, *a priori*, for how research will be modified in the event of disruption. It **recommends** that this be done.	Add to protocols for any revised proposal.

respect to quantifying the likely extent of management and conservation improvement in the context of the IWC and (2) has basic design shortcomings. The Panel **recommends** that the lethal sampling components of the programme should not occur until the additional work identified in its report is undertaken and reviewed. The detailed rationale for this can be found in the full report. In short, the Panel's main concerns relate to:

(1) insufficient justification for the proposed sampling design and sample sizes for the lethal components;
(2) insufficient justification that *additional* age data will notably improve conservation and management; and
(3) the proponents' approach used to assess the potential effects of catches on common minke whales (and especially that even under the approach taken by the proponents, J-stock was shown to decline under some scenarios).

The Panel has provided **recommendations** on additional analyses that should be undertaken to limit some of these shortcomings (summarised in Table 3).

The Panel has also developed **recommendations** to improve the Annex P process, including the need to develop agreed frameworks to compare lethal and non-lethal approaches, to quantify 'improvements' in management in an IWC context and to evaluate the effects of catches on stocks.

6. ADOPTION OF REPORT

The report was largely adopted by email on 1 March 2017 and updated after fact checking on 17 March 2017. The Chair deeply thanked all members of the Panel for their tireless dedication during both the meeting and the revision of the report (through email exchanges at impossible hours and weekends), with professionalism and good temper. She was grateful to them for having donated their time to this important activity of the Scientific Committee and Commission as part of the Annex P process.

The Chair also thanked the Proponents for their kindness, logistical support and patience during the process of the revision of the report.

The Panel expressed its thanks to the Chair for her excellent skills in leading it through a review of a complicated document, ensuring that the Annex P process was followed. It expressed special thanks to Greg Donovan, who in exceedingly trying times, contributed fully to the review and once again created a report that clearly and accurately reflected the review and the Panel conclusions. The Panel sent its continuing best wishes to Jette Donovan Jensen for a full recovery.

REFERENCES

Bando, T., Yoshida, H., Kishiro, T., Yasunaga, G., Mogoe, T., Konishi, K., Tamura, T., Fujise, Y. and Kato, H. 2016. Further information on sampling design of JARPNII. Paper SC/66b/SP04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 23pp. [Paper available from the Office of this Journal].

Citta, J.J., Quakenbush, L.T., George, J.C., Small, R.J., Heide-Jørgensen, M.P., Brower, H., Adams, B. and Brower, L. 2012. Winter movements of bowhead whales (*Balaena mysticetus*) in the Bering Sea. *Arctic* 65(1): 13-34.

Daxinger, L. and Whitelaw, E. 2012. Understanding transgenerational epigenetic inheritance via the gametes in mammals. *Nature. Rev. Genet.* 13: 153-62.

Elshire, R.J., Glaubitz, J.C., Sun, Q., Poland , J.A., Kawamoto, K., Buckler, E.S. and Mitchell, S.E. 2011. A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. *PLoS ONE* 6.

Florath, I., Butterbach, K., Müller, H., Bewerunge-Hudler, M. and Brenner, H. 2014. Cross-sectional and longitudinal changes in DNA methylation with age: an epigenome-wide analysis revealing over 60 novel age-associated CpG sites. *Hum. Mol. Gen.* 23: 1,186-1,201.

Gaichas, S., Aydin, K. and Francis, R.C. 2015. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. *Prog. Oceanog.* 138: 1-17.

Garrigue, C., Dodemont, R., Steel, D. and Baker, C.S. 2004. Organismal and 'gametic' capture recapture using microsatellite genotyping confirm low abundance and reproductive autonomy of humpback whales on the wintering grounds of New Caledonia (South Pacific). *Mar. Ecol. Prog. Ser.* 274: 251-62.

George, J.C., Druckenmiller, M., Laidre, K.L., Suydam, R. and Person, B. 2015. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. *Prog. Oceanog.* 136: 250-62.

Goto, M., Yoshida, H. and Pastene, L.A. 2016. A note with an estimate of microsatellite genotyping error rate for common minke whales. Paper SC/66b/DNA01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 4pp. [Paper available from the Office of this Journal].

Government of Japan. 2016. Results of the analytical work on NEWREP-A recommendations on sample size and relevance of age information for the RMP. Paper SC/66b/SP10 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 24pp. [Paper available from the Office of this Journal].

Hall, A.J. and Williams, R. 2015. The potential effect of PCBs on killer whales - using the 'SPOC' individual based pollution model approach to estimate impacts on population growth. Paper SC/66a/E02 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 12pp. [Paper available from the Office of this Journal].

Harwood, L.A., Smith, T.G., George, J.C., Sandstrom, S.J., Walkusz, W. and Divoky, G.J. 2015. Change in the Beaufort Sea ecosystem: diverging trends in body condition and/or production in five marine vertebrate species *Prog. Oceanog.* 136: 263-73. [Available from: http://dx.doi.org/10.1016/j.pocean.2015.05.003].

Heide-Jørgensen, M.P., Laidre, K.L., Jensen, M.V., Dueck, L. and Postma, L.D. 2006. Dissolving stock discreteness with satellite tracking: bowhead whales in Baffin Bay. *Mar. Mamm. Sci.* 22(1): 34-45.

Hey, J. 2010. Isolation with migration models for more than two populations. *Mol. Biol. Evol.* 27: 905-20.

Hey, J. and Machado, C.A. 2003. The study of structured populations - new hope for a difficult and divided science. *Nature Reviews Genetics* 4: 535-43.

Hirakawa, S., Imaeda, K., Nakayama, M., Udaka, E.Y., Kim, T., Kunisue, M., Ogawa, T., Matsuda, S., Matsui, E.A., Petrov, V.B., Batoev, B., Tanabe, S. and Iwata, H. 2011. Integrative assessment of potential effects of dioxins and related compounds in wild Baikal seals (*Pusa sibirica*): application of microarray and biochemical analyses. *Aquat. Toxicol.* 105: 88-99.

Hoban, S., Bertorelle, B. and Gaggiotti, O.E. 2012. Computer simulations: tools for population and evolutionary genetics (L Orlando, Ed,). *Nature. Rev. Genet.* 13: 110-22.

Horvath, S. 2013. DNA methylation age of human tissues and cell types. *Genome Biology* 14(10): 3156. DOI: 10.1186/gb-2013-14-10-r115.

International Whaling Commission. 1998. Report of the Intersessional Working Group to review data and results from Special Permit research on minke whales in the Antarctic, Tokyo, 12-16 May 1997. *Rep. Int. Whal. Comm.* 48:377-412.

International Whaling Commission. 2008a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1-74.

International Whaling Commission. 2008b. Report of the Scientific Committee. Annex G1. Report of the working group on the in-depth assessment of western North Pacific common minke whales, with a focus on J stock. *J. Cetacean Res. Manage. (Suppl.)* 10:197-206.

International Whaling Commission. 2010a. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1-98.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex G1. Report of the Working Group on the In-Depth Assessment of Western North Pacific Common Minke Whales, with a focus on 'J' stock. *J. Cetacean Res. Manage (Suppl.)* 11(2):198-217.

International Whaling Commission. 2011. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 12:1-75.

International Whaling Commission. 2012. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2013a. Chair's Report of the 64th Annual Meeting. Annex D. Resolutions Adopted at the 64th Annual Meeting. Resolution 2012-1. Resolution on the importance of continued scientific research with regard to the impact of the degredation of the marine environment on the health of cetaceans and related human health effects. *Ann. Rep. Int. Whaling Comm.* 2012:77.

International Whaling Commission. 2013b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.

International Whaling Commission. 2014a. Report of the Expert Workshop to Review the Icelandic Special Permit Research Programme, 18-22 February 2013, Reykjavik, Iceland. *J. Cetacean Res. Manage. (Suppl.)* 15:455-88.

International Whaling Commission. 2014b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.
International Whaling Commission. 2014c. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 15:112-88.
International Whaling Commission. 2016a. Report of the RMP Intersessional Workshop on the *Implementation Review* for North Atlantic Fin Whales, 16-20 February 2015, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 17:485-94.
International Whaling Commission. 2016b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 17:1-92.
International Whaling Commission. 2017a. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.
International Whaling Commission. 2017b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.
International Whaling Commission. 2017c. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 18:264-76.
International Whaling Commission. 2017d. Report of the Scientific Committee. Annex O. Report of the Working Group on DNA. *J. Cetacean Res. Manage. (Suppl.)* 18:398-402.
Jablonka, E. and Raz, G. 2009. Transgenerational epigenetic inheritance: prevalence, mechanisms, and implications for the study of heredity and evolution. *Q. Rev. Biol.* 84: 131-76.
Jarman, S.N., Polanowski, A.M., Faux, C.E., Robbins, J., De Paoli-Iseppi, R., Bravington, M. and Deagle, B.E. 2015. Molecular biomarkers for chronological age in animal ecology. *Mol. Ecol.* 24: 4,826-47.
Jung, M. and Pfeifer, G.P. 2015. Aging and DNA methylation. *BMC Biol.* 13: 7pp.
Kato, H. 1986. Study on changes in biological parameters and population dynamics of southern minke whales. Phd Thesis, Hokkaido University. 145pp. In Japanese.
Kellar, N.M., Trego, M.L., Chivers, S.J. and Archer, F.I. 2013. Pregnancy patterns of pantropical spotted dolphins (*Stenella attenuata*) in the eastern tropical Pacific determined from hormonal analysis of blubber biopsies and correlations with the purse-seine tuna fishery. *Mar. Biol. Res.* 2013: 12pp.
King, J.R. 2005. Report of the study group on fisheries and ecosystem responses to recent regime shifts. *PICES Sci. Rep.* 28: 0-161.
Kitakado, T., An, Y.-R., Choi, S.-G., Miyashita, T., Okamura, H. and Park, K.-J. 2010. Update of the integrated abundance estimates for common minke whales in sub-areas 5, 6 and 10 using sighting data from Japanese and Korean surveys. Paper SC/62/NPM8 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 8pp. [Paper available from the Office of this Journal].
Kitakado, T., Hakamada, T. and Miyashita, T. 2012. Extrapolation of abundance to unsurveyed areas in sub-areas 8, 11 and 12NE for the western North Pacific common minke whales by using prediction with a linear model. Paper SC/64/NPM5 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 6pp. [Paper available from the Office of this Journal].
Kitakado, T. and Maeda, H. 2016. Fitting to catch-at-age data for North Pacific common minke whales in the Pacific side of Japan. Paper SC/F16/JR43 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 16pp. [Paper available from the Office of this Journal].
Kitakado, T., Murase, H. and Tamura, T. 2016. Predation impacts on sandlance population by consumption of common minke whales off Sanriku region. Paper SC/F16/JR29 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 11pp. [Paper available from the Office of this Journal].
Landguth, E.L. and Schwartz, M.K. 2014. Evaluating sample allocation and effort in detecting population differentiation for discrete and continuously distributed individuals. *Conserv. Genet.*: 981-92.
Lockyer, C. 1987. Evaluation of the role of fat reserves in relation to the ecology of North Atlantic fin and sei whales. pp.183-203. *In*: Huntley, A.C., Costa, D.P., Worthy, G.A.J. and Castellini, M.A. (eds). *Approaches to Marine Mammal Energetics*. Society for Marine Mammalogy, Lawrence, Kansas. xviii+253pp.
Maeda, H., Kawamoto, T. and Kato, H. 2013. A study on the improvement of age estimation in common minke whales using the method of gelatinized extraction of earplug. *NAMMCO Sci. Publ.* DOI: http://dx.doi.org/10.7557/3.2609. [Published paper].
Mansour, A.A.H., McKay, D.W., Lien, J., Orr, J.C., Banoub, J.H., Øien, N. and Stenson, G. 2002. Determination of pregnancy status from blubber samples in minke whales (*Balaenoptera acutorostrata*). *Mar. Mamm. Sci.* 18(1): 112-20.
Masters, P.M., Bada, J.L. and Zigler, J.S. 1977. Aspartic acid racemization in the human lens during ageing and in cataract formation. *Nature* 268: 71-3.
Matsuoka, K., Hakamada, T. and Miyashita, T. 2016. Distribution of blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and north Pacific right (*Eubalaen japonica*) whales in the western North Pacific based on JARPN and JARPNII surveys (1994 to 2014). Paper SC/F16/JR09 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 13pp. [Paper available from the Office of this Journal].
Mazzio, E.A. and Soliman, K.F.A. 2014. Basic concepts of epigenetics: impact of environmental signals on gene expression. *Epigenetics* 7: 119-30.
Mello, D., Colosio, A., Marcondes, M., Viau, P. and Olivera, C. 2017. Feasibility of using humpback whale blubber to measure sex hormones. *J. Exp. Mar. Biol. Ecol.* 486: 32-41.
Miller, M.R., Dunham, J.P., Amores, A., Cresko, W.A. and Johnson, E.A. 2007. Rapid and cost-effective polymorphism identification and genetyping usinf restriction site associated DNA (RAD) markers. *Genome Research* 17: 240-48.
Mogoe, T., Tamura, T., Yoshida, H., Kishiro, T., Yasunaga, G., Bando, T., Kitamura, T., Kanda, N., Nakano, K., Katsumata, H., Handa, Y. and Kato, H. 2016. Field and analytical protocols for the comparison of using lethal and non-lethal techniques under the JARPNII with preliminary application to biopsy and faecal sampling. Paper SC/66b/SP08 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].
Murase, H., Hakamada, T., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Tojo, N. and Kitakado, T. 2014. Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-subtropical transition area of the western North Pacific in relation to oceanic fronts. *Deep Sea Res. II* 107: 22-28. [Published paper].
Murase, H., Hakamada, T., Sasaki, H., Matsuoka, K. and Kitakado, T. 2016. Seasonal spatial distributions of common minke, sei and Bryde's whales in the JARPNII survey area from 2002 to 2013. Paper SC/F16/JR07 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].
Nakao, M. 2001. Epigenetics: interaction of DNA methylation and chromatin. *Gene* 278(1): 25-31.
Nielsen, R., Mattila, D.K., Clapham, P.J. and Palsbøll, P.J. 2001. Statistical approaches to paternity analysis in natural populations and applications to the North Atlantic humpback whale. *Genetics* 157(4): 1673-82.
Niimi, S., Imoto, M., Kunisue, T., Watanabe, M.X., Kim, E.Y., Nakayama, K., Yasunaga, G., Fujise, Y., Tanabe, S. and Iwata, H. 2014. Effects of persistent organochlorine exposure on the liver transcriptome of the common minke whale (*Balaenoptera acutorostrata*) from the North Pacific. *Ecotoxicology and Environmental Safety* 108: 95-105. [Published paper].
Niimi, S., Watanabe, M.X., Kim, E.Y., Iwata, H., Yasunaga, G., Fujise, Y. and Tanabe, S. 2005. Molecular cloning and mRNA expression of cytochrome P4501A1 and 1A2 in the liver of common minke whales (*Balaenoptera acutorostrata*). *Mar. Poll. Bull.* 51: 784-93.
O'Hara, T.M., George, J.C., Tarpley, R.J., Burek, K. and Suydam, R.S. 2002. Sexual maturation in male bowhead whales (*Balaena mysticetus*). *J. Cetacean Res. Manage.* 4(2): 143-48.
Okamura, H., Miyashita, T. and Kitakado, T. 2010. *g*(0) estimates for western North Pacific common minke whales. Paper SC/62/NPM9 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 7pp. [Paper available from the Office of this Journal].
Palsboll, P.J., Bérubé, M., Andersen, L.W. and Witting, L. 2005. Individual assignment and migrant detection probabilities at high levels of gene flow; how many loci and samples to estimate the proportion immigrant minke whales off West Greenland. SC/57/AWMP11 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 7pp. [Paper available from the Office of this Journal].
Pastene, L.A., Goto, M. and Taguchi, M. 2016. Additional genetic analyses on stock structure in North Pacific Bryde's and sei whales. Paper SC/66b/SD01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].
Polanowski, A.M., Robbins, J., Chandler, D. and Jarman, S.N. 2014. Epigenetic estimation of age in humpback whales. *Mol. Ecol. Resour.* 14(5): 976-87.
Punt, A., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93-116.
Robbins, J., Clapham, P., Gales, N., Gulland, F. and Zerbini, A. In Prep. Evaluating potential effects of satellite tagging in large whales: a case study with Gulf Of Maine humpback whales. 6pp.

Robinson, J.D., Bunnefield, L., Hearn, J., Stone, G.N. and Hickerson, M.J. 2014. ABC inference of multi-population divergence with admixture from unphased population genomic data. *Mol. Ecol.* 23: 4458-71.

Rosa, C., Zeh, J., George, J.C., Botta, O., Zauscher, M., Bada, J. and O'Hara, T.M. 2013. Age estimates based on aspartic and racemization for bowhead whales (*Balaena mysticetus*) harvested in 1998-2000 and the relationship between racemization rate and body temperature. *Mar. Mamm. Sci.* 29(3): 424-45.

Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S.I. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. *Fish. Oceanog.* 22(6): 496-508. [Published paper].

Sasaki, H., Tamura, T., Hakamada, T., Matsuoka, K., Murase, H. and Kitakado, T. 2016. Spatial estimation of prey consumption by common minke, Bryde's and sei whales in the western North Pacific: A preliminary attempt. Abstract presented to the 2016 PICES Annual Meeting, OMNI Hotel, San Diego, USA, 3 November 2016.

Schick, R.S., New, L.F., Thomas, L., Costa, D.P., Hindell, M.A., McMahon, C.R., Robinson, P.W., Simmons, S.E., Thums, M., Harwood, J. and Clark, J.S. 2013. Estimating resource acquisition and at-sea body condition of a marine predator. *J. Anim. Ecol.* 82: 1300-15.

Schwacke, L.H., Zolman, E.S., Balmer, B.C., De Guise, S., George, R.C., Hoguet, J., Hohn, A.A., Kucklick, J.R., Lamb, S., Levin, M., Litz, J.A., McFee, W.E., Place, N.J., Townsend, F.I., Wells, R.S. and Rowles, T.K. 2012. Anaemia, hypothyroidism and immune suppression associated with polychlorinated biphenyl exposure in bottlenose dolphins (*Tursiops truncatus*). *Proc. Roy. B.* 279: 48-57.

Tamura, T., Kishiro, T., Bando, T., Yasunaga, G., Murase, H., Maeda, H., Kitakado, T. and Pastene, L.A. 2016a. Response to the 'Report of the Expert Panel of the final review on the Western North Pacific Japanese Special Permit Program (JARPNII)'. Paper SC/66b/SP01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 18pp. [Paper available from the Office of this Journal].

Tamura, T., Konishi, K. and Isoda, T. 2016b. Updated estimation of prey consumption by common minke, Bryde's and sei whales in the western North Pacific. Paper SC/F16/JR15 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 59pp. [Paper available from the Office of this Journal].

Tamura, T., Murase, H., Sasaki, H. and Kitakado, T. 2016c. Preliminary attempt of spatial estimation of prey consumption by sei whales in the JARPNII survey area using data obtained from 2002 to 2013. Paper SC/F16/JR16 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 22pp. [Paper available from the Office of this Journal].

Teramitsu, I.Y., Yamamoto, I., Chiba, H., Iwata, S., Tanabe, Y., Fujise, A., Kazusaka, F., Akahori and Fujita, S. 2000. Identification of novel cytochrome P450 1A genes from five marine mammal species. *Aquat. Toxicol.* 51: 145-53.

Tiedemann, R., Tiedemann, M.R., Gunnlaugsson, T., Pampoulie, C. and Víkingsson, G. 2014. Finding relatives among North Atlantic common minke whales (*Balaenoptera acutorostrata*) based on microsatellite data: the relationship between false discovery rate (FDR) and detection power. Paper SC/65b/RMP05 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 8pp. [Paper available from the Office of this Journal].

Trego, M.L., Kellar, N.M. and Danil, K. 2013. Validation of blubber progesterone concentrations for pregnancy determination in three dolphin species and a porpoise. *PLoS ONE* 8: e69709.

Trucchi, E., Mazzarella, A.B., Gilfillan, G.D., Lorenzo, M.T., Schönswetter, P. and Paun, O. 2016. BsRADseq: screening DNA methylation in natural populations of non-model species. *Mol. Ecol.* 25(8): 1,697-713.

Van der Zee, J.P. and Punt, A.E. 2014. Evaluting critical dispersal rates for whale management under the IWCs Revised Management Procedure: an application for North Atlantic common minke whales. *J. Cetacean Res. Manage* 14: 125-32.

Watari, S., Murase, H., Yonezaki, S., Okazaki, M., Kiyofuji, H., Tamura, T., Hakamada, T. and Kitakado, T. 2017. Ecosystem modeling in the western North Pacific with a focus on small pelagic fish. Abstract presented to the International Symposium on Drivers of Dynamics of Small Pelagic Fish Resources. Victoria Conference Centre, Victoria, Canada, 6-11 March, 2017.

Wayland, M., Gilchrist, H.G., Marchant, T., Keating, J. and Smits, J.E. 2002. Immune function, stress response, and body condition in arctic-breeding common eiders in relation to cadmium, mercury, and selenium concentrations. *Environ. Res.*: 47-60.

Weyrich, A., Lenz, D., Jeschek, M., Chung, T.H., Rübensam, K., Göritz, F., Jewgenow, K. and Fickel, J. 2015. Paternal intergenerational epigenetic response to heat exposure in male wild guinea pigs. *Mol. Ecol.* 25(8): 1729-40.

Xiong, Z. and Laird, P.W. 1997. COBRA: a sensitive and quantitative DNA methylation assay. *Nucleic Acids Res.* 25: 2,532-34.

Yang, A.S., Estecio, M.R.H. and Doshi, K. 2004. A simple method for estimating global DNA methylation using bisulfite PCR of repetitive DNA elements. *Nucleic Acids Res.* 32: e38.

Yasunaga, G., Hakamada, T. and Fujise, Y. 2016a. Update of the analyses on temporal trend of PCB levels in common minke whales from the western North Pacific for the period 2002-2014. Paper SC/66b/E07 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].

Yasunaga, G., Hakamada, T. and Fujise, Y. 2016b. Update of the analyses on temporal trend of total Hg levels in three baleen whale species based on JARPN and JARPNII data for the period 1994-2014. Paper SC/66b/E08 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 19pp. [Paper available from the Office of this Journal].

Yim, H.S., Cho, J.S., Guang, X., Kang, S.G., Jeong, J.Y., Cha, S.S., Oh, H.M., Lee, J.H., Yang, E.C., Kwon, K.K., Kim, Y.J., Kim, T.W., Kim, W., Jeon, J.H., Kim, S.J., Choi, D.H., Jho, S., Kim, H.M., Ko, J., Kim, H., Shin, Y.A., Jung, H.J., Zheng, Y., Wang, Z., Chen, Y., Chen, M., Jiang, A., Li, E., Zhang, S., Hou, H., Kim, T.H., Yu, L., Liu, S., Ahn, K., Cooper, J., Park, S.G., Hong, C.P., Jin, W., Kim, H.S., Park, C., Lee, K., Chun, S., Morin, P.A., O'Brien, S.J., Lee, H., Kimura, J., Moon, D.Y., Manica, A., Edwards, J., Kim, B.C., Kim, S., Wang, J., Bhak, J., Lee, H.S. and Lee, J.H. 2014. Minke whale genome and aquatic adaptation in cetaceans. *Nat. Genet.* 46: 88-92.

Yoshioka, M. and Fujise, Y. 1992. Serum testosterone and progesterone levels in southern minke whales (*Balaenoptera acutorostrata*). Paper SC/44/SHB13 presented to the IWC Scientific Committee, June 1992 (unpublished). 4pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

PANEL

Greg Donovan, IWC Secretariat

Caterina Fortuna, National Institute for Environmental Protection and Research, Italy

Sarah Gaichas, NOAA Fisheries Service, Northeast Fisheries Science Center, USA

Craig George, North Slope Borough, USA

Ailsa Hall, University of St Andrews, UK

George Hunt, University of Washington, USA

Debra Palka, NOAA Fisheries Service, Northeast Fisheries Science Center, USA

Per Palsbøll, GELIFES-Groningen Institute for Evolutionary Life Sciences, The Netherlands

André Punt, University of Washington, USA

Robert Suydam, North Slope Borough, USA

Ralph Tiedemann, University of Potsdam, Germany

PROPONENTS

Fisheries Agency of Japan (FAJ)
Hideki Moronuki
Naohito Okazoe
Yuki Morita
Hiroyuki Morita
Haruya Kumakiri

Ministry of Foreign Affairs of Japan (MOFA)
Mr. Yukiya Tsuno

Ministry of Justice
Mr. Eiichiro Yamazaki

Tokyo University of Marine Science and Technology, Japan (TUMSAT)
Joji Morishita
Hidehiro Kato
Toshihide Kitakado

National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Hideyoshi Yoshida
Hiroto Murase
Hikari Maeda

Institute of Cetacean Research, Tokyo, Japan (ICR)
Yoshihiro Fujise
Luis A. Pastene
Tsutomu Tamura
Koji Matsuoka
Takeharu Bando
Takashi Hakamada
Genta Yasunaga
Mutsuo Goto
Mioko Taguchi
Megumi Takahashi
Satoko Inoue
Dan Goodman

INTERPRETERS

Saemi Baba
Hiroko Yasokawa

SCIENTIFIC COMMITTEE OBSERVERS (*INCLUDING REMOTE)

Australia
William K. de la Mare
John McKinlay*

Germany
Justin Cooke

Norway
Arne Bjørge*

USA
Scott Baker*
Robert Brownell, Jr.
Paul Wade

Other
Doug S. Butterworth
Mason Weinrich*

Annex B
Agenda

1. Introductory remarks
    1.1 Welcome
    1.2 Available documents
    1.3 Adoption of the Agenda
2. Objectives of the Workshop
    2.1 Introduction to the Annex P process
    2.2 Introduction to the RMP process
3. Review of the JARPN II programme
    3.1 Overview of the Panel and Scientific Committee recommendations and the earlier JARPN II review
    3.2 Update analyses incorporating data up to 2016 and responding to recommendations made in IWC (2017)
    3.3 Conclusions and recommendations
4. Review of the research programme proposal
    4.1 Objectives of the proposal
        4.1.1 Importance of stated objectives from a scientific perspective and for the purposes of conservation and management of whale stocks
            4.1.1.1 Contribution to past recommend-ations of the Scientific Committee
            4.1.1.2 Contribution to the completion of the Comprehensive Assessment or progress for future in-depth assessments
            4.1.1.3 Contribution to the carrying out of *Implementations* or *Implement-ation Reviews* of the RMP or AWMP
            4.1.1.4 Contribution to improved understanding of other priority issues as identified in the Scientific Committee Rules of Procedure or in its reports
            4.1.1.5 Contribution to recommendations of other intergovernmental organisations
        4.1.2 Improvement in the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part
            4.1.2.1 Contribution to past recommend-ations of the Scientific Committee
            4.1.2.2 Contribution to the completion or carry-ing out Comprehensive Assessment, in-depth assessments, *Implementation Reviews* of the RMP or AWMP
            4.1.2.3 Contribution to improved under-standing of other priority issues as identified in the Scientific Committee Rules of Procedure or in its reports
            4.1.2.4 Contribution to recommendations of other intergovernmental organ-isations
        4.1.3 Hypotheses testing not directly related to the management of living marine resources
        4.1.4 Evaluation of options in terms of lethal vs non-lethal methods in relation to objectives
    4.2 Methods to address objectives: study area(s), sample size, sampling design and data analysis
        4.2.1 Evaluation of sample sizes, spatial and temporal scales and analytical methods in relation to the programme's stated research objectives
        4.2.2 Feasibility of non-lethal alternatives to either replace or reduce the size of proposed lethal sampling
    4.3 Assessment of potential effect of catches
    4.4 Logistics and project management
    4.5 Co-operative research
5. Conclusions

REFERENCE

International Whaling Commission. 2017. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.

Annex C
List of Documents

PRIMARY DOCUMENTS

SC/J17/JR

1. Government of Japan. Proposed Research Plan for New Scientific Whale Research Programme in the western North Pacific (NEWREP-NP).
2. Rev1. Tsutomu Tamura, Toshihide Kitakado and Luis A. Pastene. Progress Report of the Work Responding Recommendations from the JARPN II Final Review Workshop.
3. Genta Yasunaga, Toshihiro Mogoe, Tsutomu Tamura, Hideyoshi Yoshida, Takeharu Bando and Hidehiro Kato. Results of the feasibility study on non-lethal techniques to address the key research objective of JARPN II, based on data and samples obtained in the period 2014-16.
4. Government of Japan. Addendum to Annex 12.

OBSERVERS STATEMENTS AND RESPONSES

SC/J17/O

1. Government of New Zealand. New Zealand Statement to the NEWREP-NP Special Permit Expert Panel Review Workshop.
2. W.K. De La Mare. Observers Statement to the NEWREP-NP Special Permit Expert Panel Review Workshop.
3. The NEWREP-NP Proponents. Response to the New Zealand Statement to the NEWREP-NP Special Permit Expert Panel Review Workshop (SC/J17/O01).
4. The NEWREP-NP Proponents. Response to Observer Statement to the NEWREP-NP Special Permit Expert Panel Workshop by W.K. de la Mare (SC/J17/O02).

FOR INFORMATION DOCUMENTS

SC/J17/ForInfo

1. International Whaling Commission. Annex P Process for the Review of Special Permit Proposals and Research Results from Existing and Completed Permits.
2. International Whaling Commission. Extracts from SC Report on JARPN II [uncorrected page proof].
3. International Whaling Commission. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II) [uncorrected page proof].
4. International Whaling Commission. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for western North Pacific common minke whales (2014).
5. International Whaling Commission. 2014 SC Report (*JCRM Suppl.* 15) on NP minke whale *Implementation*. pp.11-15.

Annex D

A Compilation of Proponent's Responses to Questions and Request for Data from the NEWREP-NP Review Panel

The NEWREP-NP Proponents

This document presents a compilation of the proponent's responses to questions and request for data from the NEWREP-NP Review Panel. The responses and data were provided to the Review Panel as 'Morning Papers', and these are presented here in chronological order. These papers were prepared as unofficial information to assist the review by the Panel, and thus the contents and the view of the proponents may be revised further.

Morning paper, 31 Jan 2017-A: Issues derived from discussion on Document SC/J17/JR02Rev1

1. AGEING ISSUES

Progress in ageing techniques using earplugs for North Pacific minke and sei whales

Information on whale age is of key importance for estimate life-history parameters that can be used for stock management. At present, earplug is considered the most reliable source of absolute age determination in baleen whales.

Age reading from the earplugs of the common minke whale was generally believed to be difficult and impractical because of their softness and poor formation of growth layers. In the past, it was reported that age readability of common minke whales off Northern Japan collected by commercial whaling was only 8.7% (Kato, 1992, p.444). However, under JARPN and JARPN II survey, all earplugs were carefully collected and tried to read growth layers (Fig. 1). Furthermore, it was tried to improve age readability especially young animals to prevent breakage and losing neonatal line using new collection technique 'gelatinized extraction'. In recent years, this new technique had been applied to sei whales. In this document progress in ageing techniques using earplug is presented. This document also provides information of progress of age data since JARPN II review in 2016 including investigation on whether there is any relationship between body length or sex and age readability.

A new sampling method named 'gelatinized extraction method' was presented previously, which remove the earplugs safely from external auditory meatus using gelatin. In this method, gelatin is injected into the external auditory meatus for embedding earplugs to protect soft and easily broken parts at the collection stage. It was revealed that embedding earplugs by gelatin minimize breakage and lacking neonatal line.

This was effective especially in younger animals. It was suggested that gelatinized collection is found to be useful for improvement readability.

Under JARPN and JARPNII surveys, readability of common minke whale was improved from 8.7% to 44.1% because of careful treatment and efforts in technical development of sampling and introduction of Gelatinized extraction. Earplugs of North Pacific common minke whales, it had not been available for age estimation. However, it was found that some of earplugs of common minke whales are useful as a valid age tool for obtaining valuable age information. In recent years, gelatinized extraction method had been applied to sei whales. Problem on earplugs in this species is that it had already fallen apart inside the external auditory meatus before sampling. At the stage of preparation and ageing in the laboratory, it is difficult to reconstruct and it takes a time to determine their age. This method is effective for improving age readability and easy to handle at the stage of preparation and ageing for sei whale.

To have clearer core surface image of growth layers, we have examined histological sections (thickness 4μm) sliced by the Kawamoto specialized frozen sectioning techniques,

Table 1

Progress of age reading from the JARPN II review in 2016.

	2016 JARPN II Review	Additional data
Common minke whale		
Research year	1994-2013	2014-16
Number of whales	2,572	188
With readable earplugs	1,135	96
Sei whale		
Research year	2002-13	2014-15*
Number of whales	1,084	160*
With readable earplugs	683	118*

*Analysis of samples is still ongoing.

Table 2

Age readability of common minke whales collected by JARPN and JARPN II surveys from 1994 to 2016 by sex and maturity status.

	Sex	Number of whales	With readable earplugs	Age readability (%)
Combined	Male	2,085	963	46.2
	Female	775	326	42.1
Sexually immature	Male	625	231	37.0
	Female	563	200	35.5
Sexually mature	Male	1,460	732	50.1
	Female	212	126	59.4
Total		2,860	1,289	45.1

Table 3

Age readability of sei whales collected by JARPN II surveys from 2002 to 2015 by sex and maturity status.

	Sex	Number of whales	With readable earplugs	Age readability (%)
Combined	Male	575	379	65.9
	Female	678	425	62.7
Sexually immature	Male	179	95	53.1
	Female	157	77	49.0
Sexually mature	Male	396	284	71.7
	Female	522	317	60.7
Total		1,253	804	64.2

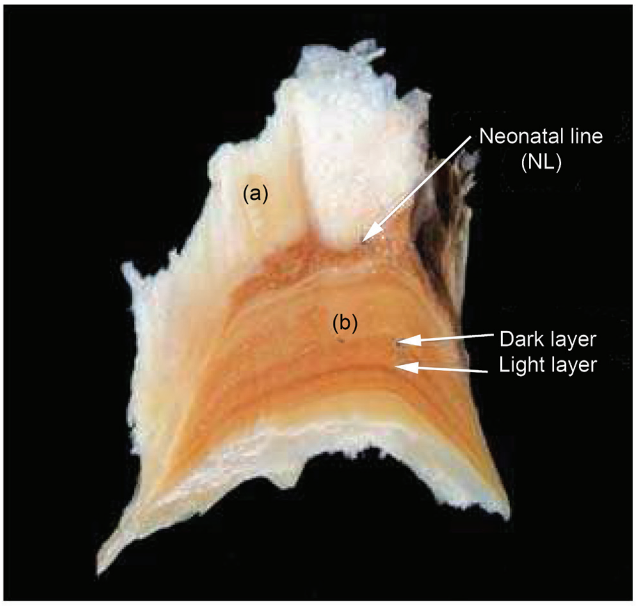


Fig. 1. Bisected surface of an earplug of a common minke whale. (a) outer covering; (b) core. Scale bar: 5mm.

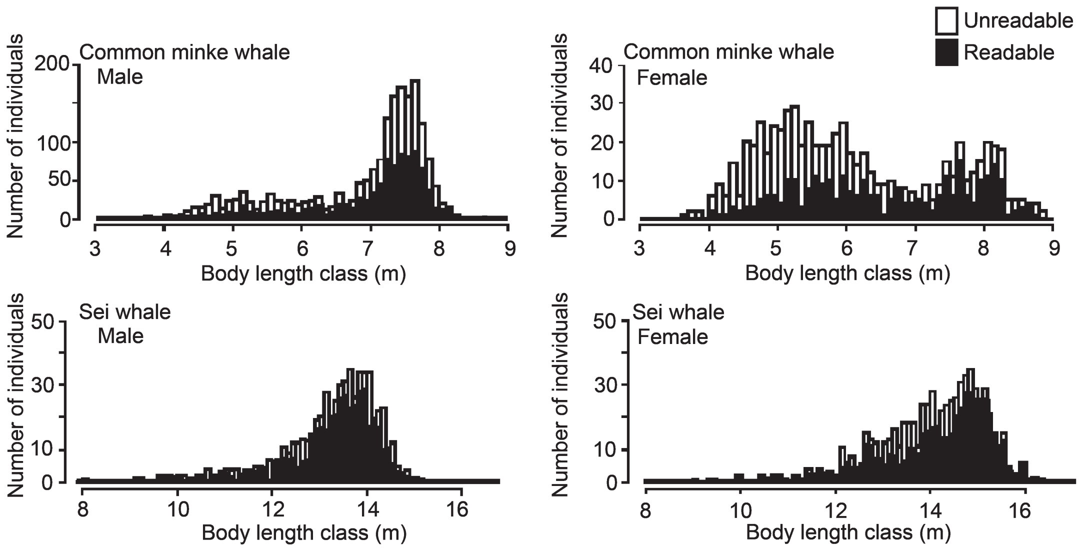


Fig. 2. Body length distributions of common minke whales during 1994 to 2016 by sex (top), sei whale during 2002 to 2015 by sex (bottom). Black bar represents number of readable earplugs.

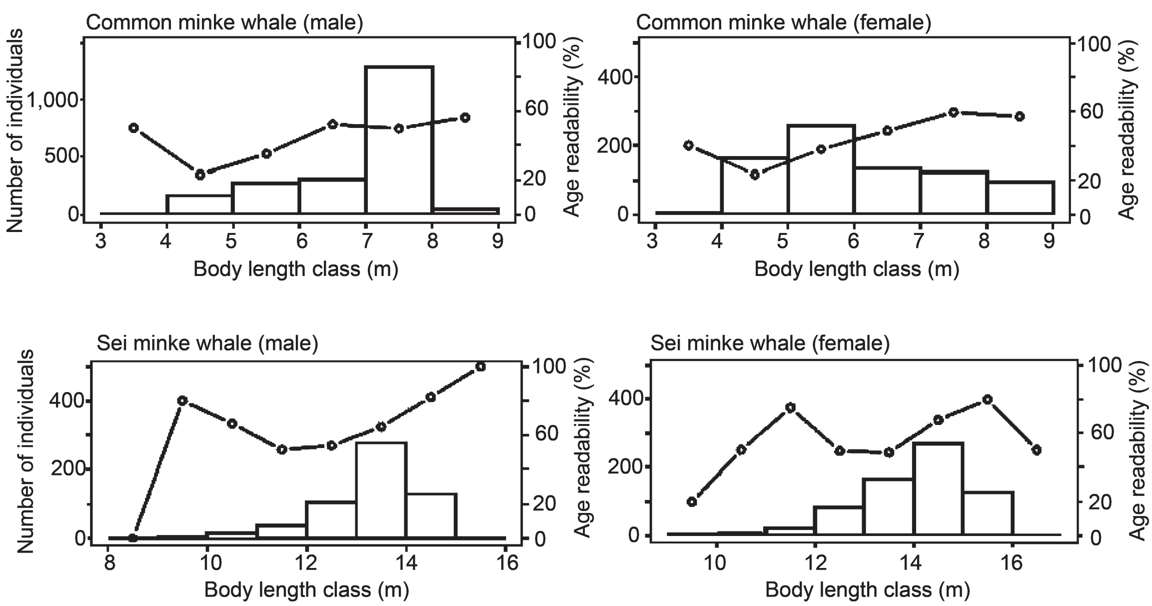


Fig. 3. Relationship between body length class and age readability of common minke whales (top) and sei whales (bottom) by sex.

with stained by Toluidine Blue, Hematoxylin and Eosin, SudanIII, SudanVII and Alizarin red-S. The histological section with Alizarin red gave the clearest lamination image that we easily identified both dark and pale laminations, suggesting close relation to the seasonal changes intake of calcium through feedings. Previous age determination has focused on a fat content in the growth layers, however there is the potential for the improvement in readability of unclear the growth layers when we focus on calcium.

Progress of age reading from JARPN II review in 2016

For earplugs collected in 2014 to 2016, laboratory work was carried out to read growth layers after 2016 JARPN II review. We added new age data (96 for common minke whale, 118 for sei whale) and investigated into whether there is any relationship between body length or sex and readability (Table 1).

About age readability of common minke collected during 1994 to 2016, age readability of all animals was 46.2% for males, 42.0 % for females (Table 2). Readability of mature animals was higher than immature animals in both sexes. Fig. 2 shows body length distributions of common minke whales and sei whale by sex. It is shown that body length compositions of readable earplugs in each sex are not always reflect entire whales. Fig. 3 shows age readability for each body length class of common minke whales and sei whale by sex. Both male and female showed the same tendency, readability was increased with body length class in common minke whale. Sei whales age readability by body length class was around 60 to 70%.

Age data from earplugs can contribute to conditioning SCAA models and the specification of RMP/*IST* trails. Since the readability varies depending on body length composition and species, it is necessary to take that into consideration when used for analysis like population dynamics and so on. Furthermore age data from earplugs can contribute to calibrating other age estimation methods such as AAR study or DNA methylation study.

Age reading error

Result of age-reading errors experiment for North Pacific common minke whale and sei whale are given in Appendix 1.

2. ECOSYSTEM MODELING ISSUES

After SC/66b, preliminary assessment on quality of input data were conducted and pedigree (ranking of data quality) in accordance with Gaichas *et al.* (2015) was assigned based on the assessment. Preliminary check on a series of pre-balance diagnostics, PREBAL (Link, 2010) was also conducted for improvement. These results were integrated in an improved version of Ecopath and some of the results will be presented to 'ICES/PICES: Drivers of dynamics of small pelagic fish resources' in March 2017 (Watari *et al.*, 2017) to invite comments from experts of small pelagic fish. Reconsideration of input data of Ecopath presented to the JARPN II Final Review Workshop (Murase *et al.*, 2016) will be necessary based on results of the additional analyses. Proponents recognize that it is premature to present the results in a form of scientific paper for consideration by the Panel and/or the IWC/SC at this stage. Proponents would submit fully improved version including Ecosim part of the modelling to the IWC/SC in the near future (hopefully after 2018) however considerable tasks need to be completed to obtain such results.

REFERENCES

Gaichas, S., Aydin, K. and Francis, R.C. 2015. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. *Prog. Oceanog.* 138: 1-17.

Kato, H. 1992. Body length, reproduction and stock separation of minke whales off northern Japan. *Rep. Int. Whal. Comm.* 42: 443-53.

Link, J.S. 2010. Adding rigor to ecological network models by evaluating a set of pre-balance diagnostics: A plea for PREBAL. *Ecol. Model.* 221: 1582-93.

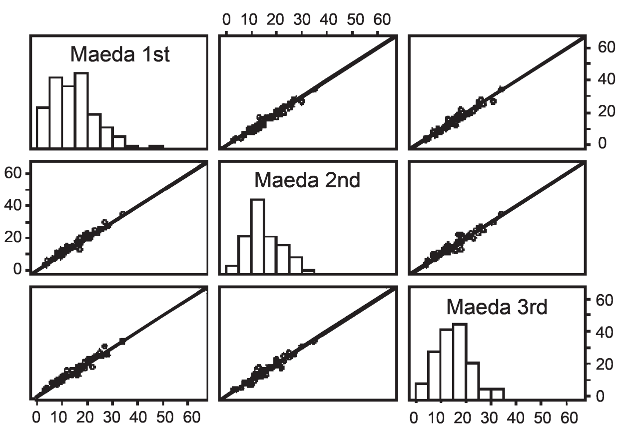
Murase, H., Tamura, T., Hakamada, T., Watari, S., Okazaki, M., Kiyofuji, H., Yonezaki, S. and Kitakado, T. 2016. Ecosystem modelling in the western North Pacific from 1994 to 2013 using Ecopath with Ecosim (EwE): some preliminary results. Paper SC/F16/JR28 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 70pp. [Paper available from the Office of this Journal].

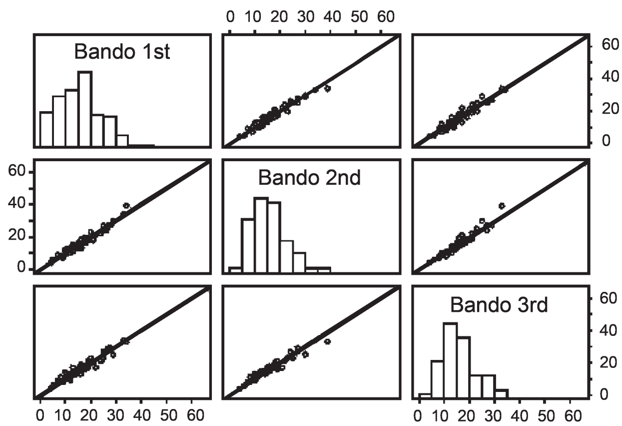
Watari, S., Murase, H., Yonezaki, S., Okazaki, M., Kiyofuji, H., Tamura, T., Hakamada, T. and Kitakado, T. 2017. Ecosystem modeling in the western North Pacific with a focus on small pelagic fish. Abstract presented to the International Symposium on Drivers of Dynamics of Small Pelagic Fish Resources. Victoria Conference Centre, Victoria, Canada, 6-11 March, 2017.

Appendix 1

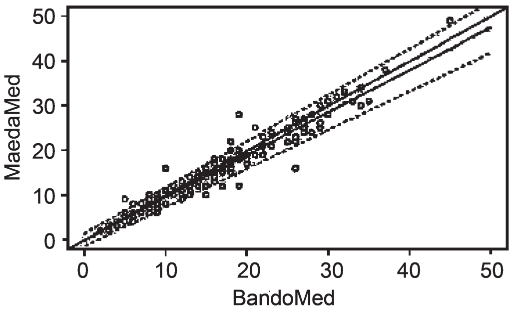
Age-reading error for the WNP minke whale

Data presentation





Estimation of age-reading error

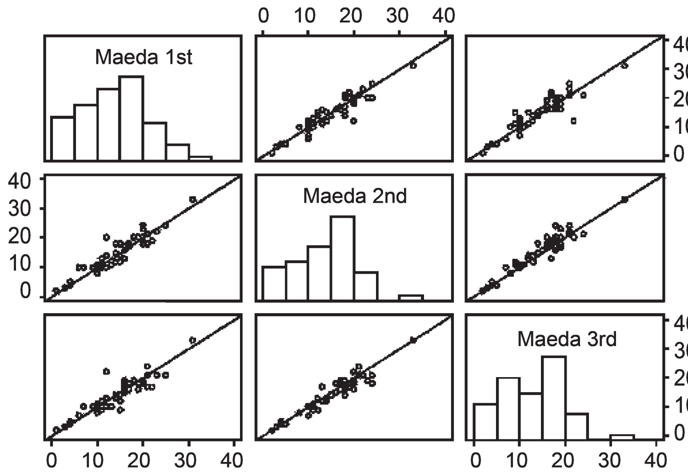


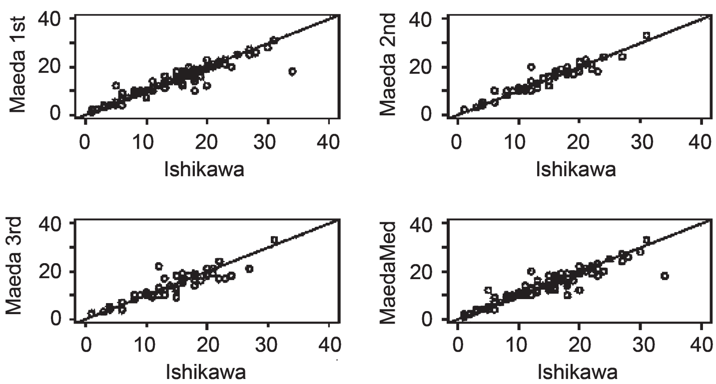
Appendix 2

Age-reading error experiment for NP sei whale

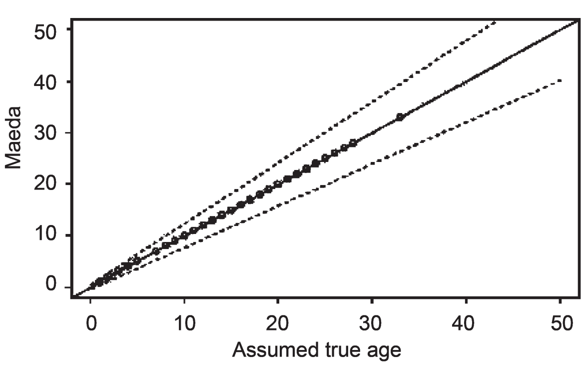
Assumption

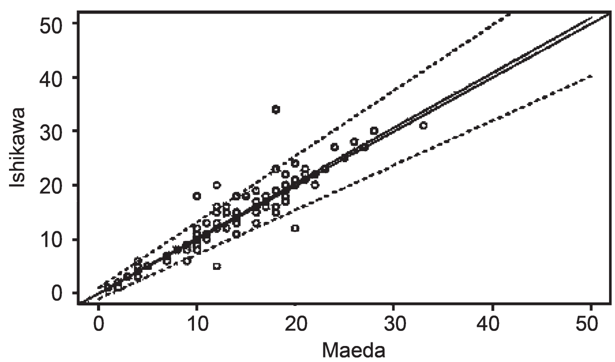
150 samples were used for 'age-reading experiment'. Maeda (2011-13) read three times at maximum (50 for the second and third times) as a 'control reader'. Ishikawa (2002-10) read once as a 'test reader'.



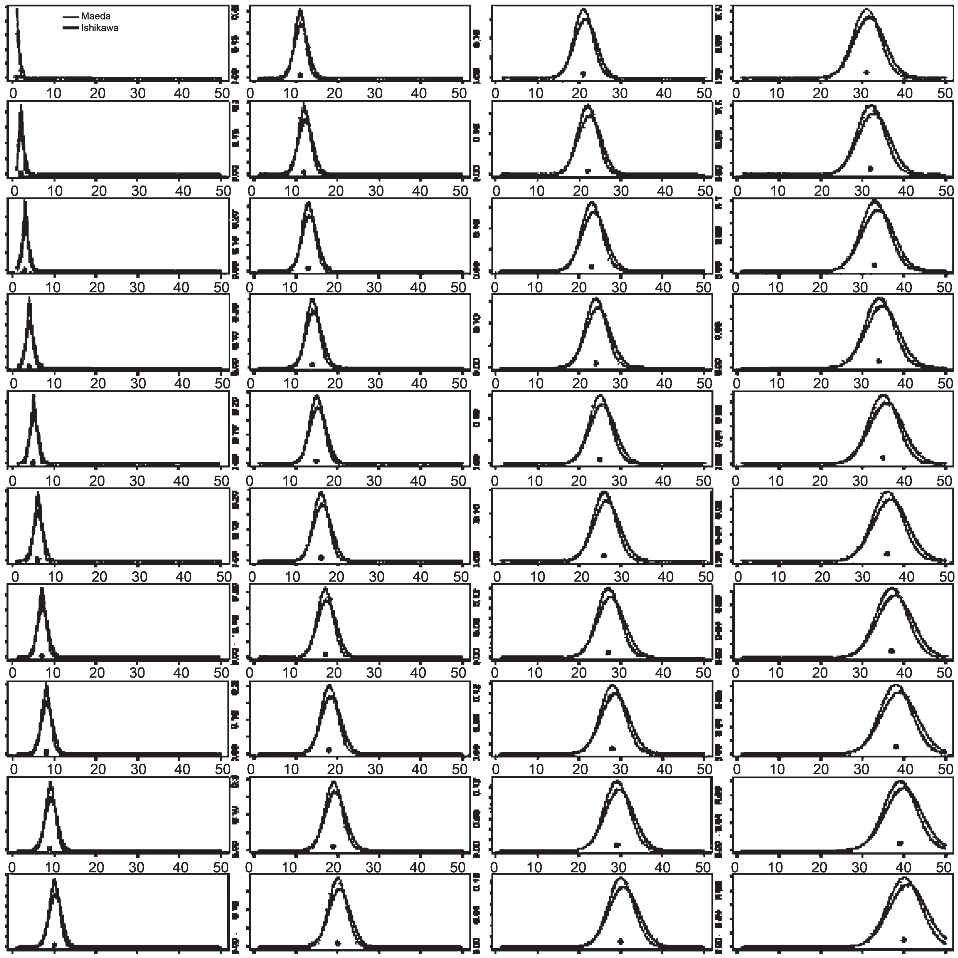


Estimation of age-reading error





Comparison of age-reading errors between the two readers



Morning paper, 31 Jan 2017-B: Issues derived from discussion on Document SC/J17/JR03

1. SUMMARY OF EVALUATION

Panel raised question about wording of 'Yes' or 'No' used by the proponents in their evaluation table.

Proponents had the same intent - this was a language issue- we will modify 'Yes' and 'No' to 'Possible' and 'Difficult' or 'Very Difficult' (see Table 1).

2. THE DATA SET OF JARPN II AND IWC/POWER CRUISES FOR BIOPSY SAMPLING

Proponents collected the same data set for biopsy sampling for the JARPN II as for the IWC POWER cruises. Table 2 shows the summary of the effort expended on biopsy sampling by species summed over 2014 and 2016.

Table 3 shows success proportion by species aggregated over years and methods. Assuming a binomial distribution these are as follows with standard errors in parenthesis. The differences are clearly statistically significant for all three species. The average time taken for sei and Bryde's whales to be biopsy sampled is around 47 and 27 minutes respectively, whilst common minke whales take match longer at around 172 minutes.

3. THE EXPERIENCE OF RESEARCHER FOR BIOPSY SAMPLING (LARSEN SYSTEM)

The Larsen gun is considered one of the most efficient method for biopsy sampling and it is used regularly during the IWC POWER surveys in the North Pacific. The shooters of Larsen system were experienced crew member for JARPN II. It has been noted that experience and training can play an important role in the efficiency of biopsy sampling. However, since the Larsen system was introduced for 2010 POWER surveys, we consider that for the offshore component the experience and training of shooters in JARPN II was sufficient. In the coastal component, the Larsen system was introduced for the 2015 JARPN II. Here the shooters would benefit from more experience and training time.

4. EFFORT OF FAECAL SAMPLING

During discussion, the Panel pointed out that the evaluation on faecal sampling was premature because of the small sample size (only five samples were taken in three years).

However, observation of excretion was conducted through 2,430 experiments for all three whale species combined in the period 2014-2016, involving a total observation time of 548.7 hours. Proponents spent huge effort and time conducting such experiments. Therefore, irrespective of the proportion of successful attempts, the low returns per time invested in this approach are clear.

5. PRECISION IN THE ESTIMATES OF ISOTOPE RATIOS

Such estimates will be provided by the next IWC SC Annual Meeting.

[Tables on next page]

Table 1

Evaluation of non-lethal methods.

		Biopsy sample				Faecal sample			
		Sanriku	Kushiro	Offshore		Sanriku	Kushiro	Offshore	
	Criteria	Minke	Minke	Sei	Bryde's	Minke	Minke	Sei	Bryde's
Q1	Probability of sampling	Possible	Possible	Possible	Possible	Very difficult	Very difficult	Possible	Very difficult
Q2	Efficiency of sampling	Difficult	Difficult	Possible	Possible	Very difficult	Very difficult	Very difficult	Very difficult
Q3	Data quality in non-lethal							Difficult	Difficult
Q4	Whale cost for non-lethal								

Table 2

Success rates, sampled whale numbers, target whale (experiment) numbers and time of experiment in sei, Bryde's and common minke whales of: (a) biopsy; and (b) lethal sampling in the JARPN II surveys for 2014-16.

Species	Year	Success rate	Sampled/ targeted	Time in experiment (min.)
1. Biopsy sampling				
Larsen system				
Sei whale	2015	0.615	16/26	507
	2016	0.533	16/30	456
Bryde's whale	2015	0.786	33/42	763
	2016	0.778	28/36	755
Minke whale (Sanriku)	2015	0.000	0/1	95
	2016	0.200	1/5	145
Minke whale (Kushiro)	2014	0.500	1/2	98
	2015	0.000	0/7	236
	2016	0.000	0/1	38
Crossbow				
Sei whale	2014	0.381	16/42	1,275
Bryde's whale (SSVs)	2014	0.641	25/39	789
Bryde's whale (SVs)	2014	0.533	16/30	402
Minke whale (Kushiro)	2014	0.500	1/2	110
LKARTS				
Minke whale (Kushiro)	2014	0.600	3/5	312
Totals				
Sei whale	2014-16	0.490	48/98	2,238
Bryde's whale	2014-16	0.694	102/147	2,709
Minke whale	2014-16	0.261	6/23	1,034
2. Lethal sampling				
Sei whale	2014	0.874	90/103	1,925
	2015	0.891	90/101	1,508
	2016	0.918	90/98	1,999
Bryde's whale	2014	0.926	25/27	264
	2015	0.862	25/29	534
	2016	1.000	25/25	401
Minke whale (Sanriku)	2014	0.652	30/46	2,546
	2015	0.594	19/32	1,509
	2016	0.696	16/23	1,587
Minke whale (Kushiro)	2014	0.680	51/78	3,616
	2015	0.718	51/71	2,940
	2016	0.618	21/34	1,769
Totals				
Sei whale	Total	0.894	270/302	5,432
Bryde's whale	Total	0.926	75/81	1,199
Minke whale	Total	0.662	188/284	13,967

Table 3

Success proportion of biopsy and lethal sampling and significances of binomial tests for differences in sei, Bryde's and common minke whales.

Species	Biopsy	Lethal	*P*
Sei whale	0.490 (0.050)	0.894 (0.018)	<0.0001
Bryde's whale	0.694 (0.038)	0.926 (0.029)	<0.0001
Common minke whale	0.261 (0.092)	0.662 (0.028)	0.00016

Morning Paper, 1 February 2017: Issues raised during discussion of Agenda item 4.1

1. LIST OF HISTORICAL AND FUTURE DATA RELEVANT TO RMP *IMPLEMENTATION* (NUMBER OF INDIVIDUAL WHALES)

Research year	Body length	Sexual maturity	Age from earplugs
(a) Common minke whale			
JARPN			
1994	21	21	11
1995	100	100	40
1996	77	77	35
1997	100	100	41
1998	100	100	34
1999	100	100	43
JARPN II			
2000	40	40	14
2001	100	100	41
2002	150	150	64
2003	150	150	70
2004	159	158	72
2005	220	220	109
2006	195	195	91
2007	207	207	101
2008	169	169	74
2009	162	162	61
2010	119	119	41
2011	126	126	66
2012	182	182	78
2013	95	95	49
2014	81	81	36
2015	70	70	41
2016	37	37	19
NEWREP-NP			
2017	174	174	78*
2018	174	174	78*
2019	174	174	78*
2020	174	174	78*
2021	174	174	78*
2022	174	174	78*
(b) Sei whale			
JARPN II			
2002	39	39	26
2003	50	50	34
2004	100	100	59
2005	100	100	68
2006	100	100	40
2007	100	100	59
2008	100	100	54
2009	100	100	71
2010	100	100	70
2011	95	95	69
2012	100	100	67
2013	100	100	66
2014	90	90	69
2015	90	90	53**
2016	90	90	0**
NEWREP-NP			
2017	140	140	90***
2018	140	140	90***
2019	140	140	90***
2020	140	140	90***
2021	140	140	90***
2022	140	140	90***

*Considering the total age readability for the period 1994-2016 (45.1%). **Analysis of earplugs is still ongoing. ***Considering the total age readability for the period 2002-15 (64.2%).

2. CLARIFICATION REGARDING THE FUTURE SIGHTING SURVEYS UNDER AND OUTSIDE THE NEWREP-NP

In order to estimate abundance estimate for western North Pacific common minke whale for J and O stocks and sei whale in North Pacific, sighting surveys are planned under NEWREP-NP. To cover the whole of distribution area for these whale species, information from sighting surveys from other programmememes will be considered as well.

Tentative plan for sighting surveys under NEWREP-NP
Table 2 below shows a tentative plan for dedicated sighting surveys under NEWREP-NP during 2018-2028. Sub-areas are defined as shown in Figure 1. The tentative plan for the first six year is planned to be repeated in the second six years.

Plan for sighting surveys outside NEWREP-NP
Table 2 also shows plans for sighing surveys other than those under NEWREP-NP. A Korean sighting survey in sub-area 5 is planned in 2017 (Park *et al.*, 2016). Sighting surveys in part of Sea of Okhotsk (Sub-area 12 NE) were conducted in 2015, 2016 and are planned for 2017 (Myasnikov *et al.*, 2016; Tiupeleev *et al.*, 2016).

The area east of 170°E and north of 40°N was covered during 2010-12 POWER surveys. Future plans for 2020 and later under POWER have yet to be developed.

3. NEWREP-NP CONTRIBUTING TO ALL RMP PROCESSES INCLUDING *PRE-IMPLEMENTATION ASSESSMENT*

A member of the Panel commented that the IWC has not decided yet on conducting a RMP *Implementation* for North Pacific sei whale, and that currently the IWC SC is conducting an *in-depth assessment* of the species in the North Pacific. He further noted that before an RMP *Implementation* is decided, a *pre-Implementation assessment* should be carried out and results accepted by the IWC SC. The proponents would like to clarify that data to be collected by the NEWREP-NP is relevant to all these exercises, and will be provided to the IWC SC for its work in all those assessments before the RMP *Implementation*, including for the *pre-Implementation assessment.*

4. OCEAN BASIN *IMPLEMENTATION*

In regard to the proponents suggesting an RMP *Implementation* for the oceanic component only of the North Pacific sei whale, a query was raised by the Panel whether IWC practice is to conduct *Implementations* only on a whole Ocean basin basis. There are however precedents for the former. Thus *Implementations* have been conducted by the IWC SC for the Northeast Atlantic minke whales which considered essentially that region of the North Atlantic alone, without requiring detailed modelling in *ISTs* of all of the more westerly populations of minke whales in the North Atlantic as a whole.

5. REGARDING THE UTILITY OF AGE DATA

The SCAA assessment of Antarctic minke whale populations by Punt *et al.* (2014) was a major advance for the IWC SC because it pointed to the extent of recruitment changes that could occur, and its results did not conform closely to the behaviour predicted by the standard population models used both the assess and to provide *ISTs* for baleen whale populations. This important insight was possible only because of the availability of age data (as well as survey estimates of abundance) for these populations.

It is important that *ISTs* reflect the true dynamics of the whale populations concerned as closely as possible so that analyses for which they serve as a basis lead to the most appropriate management approaches and decisions. The example above shows that age data are needed for conditioning these trials so that recruitment and its changes may be reflected far better. This is the primary reason the proponents supported the use of age data for the conditioning of the next set of *IST*s for the North Pacific common minke whale. Naturally recruitment is hardly estimable for other than past years spanned by the collection of age data, so for future sets of *IST*s also to best reflect underlying dynamics, age data must continue to be collected.

Table 2

Dedicated sighting surveys conducted during 2010-16 and tentative plan for dedicated sighting surveys during 2017-28. JR: JARPN II, JD: Japanese dedicated sighting survey N: NEWREP-NP, KD: Korean dedicated surveys, RD: Russian dedicated surveys. P: IWC-POWER.

	NEWREP-NP													
	Coastal					Offshore				Other surveys				
	Sub-area													
Year	6E	10E	11	7CS	7CN	7WR	7E	8	9	5	6W	12NE	12SW	170°E-135°W
2010	-	-	-	-	-	-	-	-	-	-	KD	-	-	P
2011	-	-	-	-	-	-	-	JR	JR	KD	-	-	-	P
2012	-	-	-	JR	JR	JR	JR	-	-	-	KD	-	-	P
2013	-	-	-	-	-	JR	JR	JR	-	KD	-	-	-	-
2014	-	JD	JD	-	JD	-	-	-	-	KD	-	-	-	-
2015	-	-	-	-	-	-	-	-	JR	-	-	RD	-	-
2016	-	-	-	JR	JR	JR	-	-	-	-	-	RD	-	-
2017*	-	-	JD	JD	JD	-	-	-	-	KD	-	RD	-	-
2018	N	N	N	-	-	-	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	N	N	N	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-	N	-	-	-	-	-
2021	N	N	N	-	-	-	-	-	-	-	-	-	-	-
2022	-	-	N	N	N	-	-	-	-	-	-	-	-	-
2023	-	-	N	N	N	-	-	-	-	-	-	-	-	-
2024	N	N	N	-	-	-	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	N	N	N	-	-	-	-	-	-
2026	-	-	-	-	-	-	-	-	N	-	-	-	-	-
2027	N	N	N	-	-	-	-	-	-	-	-	-	-	-
2028	-	-	N	N	N	-	-	-	-	-	-	-	-	-

*Sighting surveys are planned to start in May.

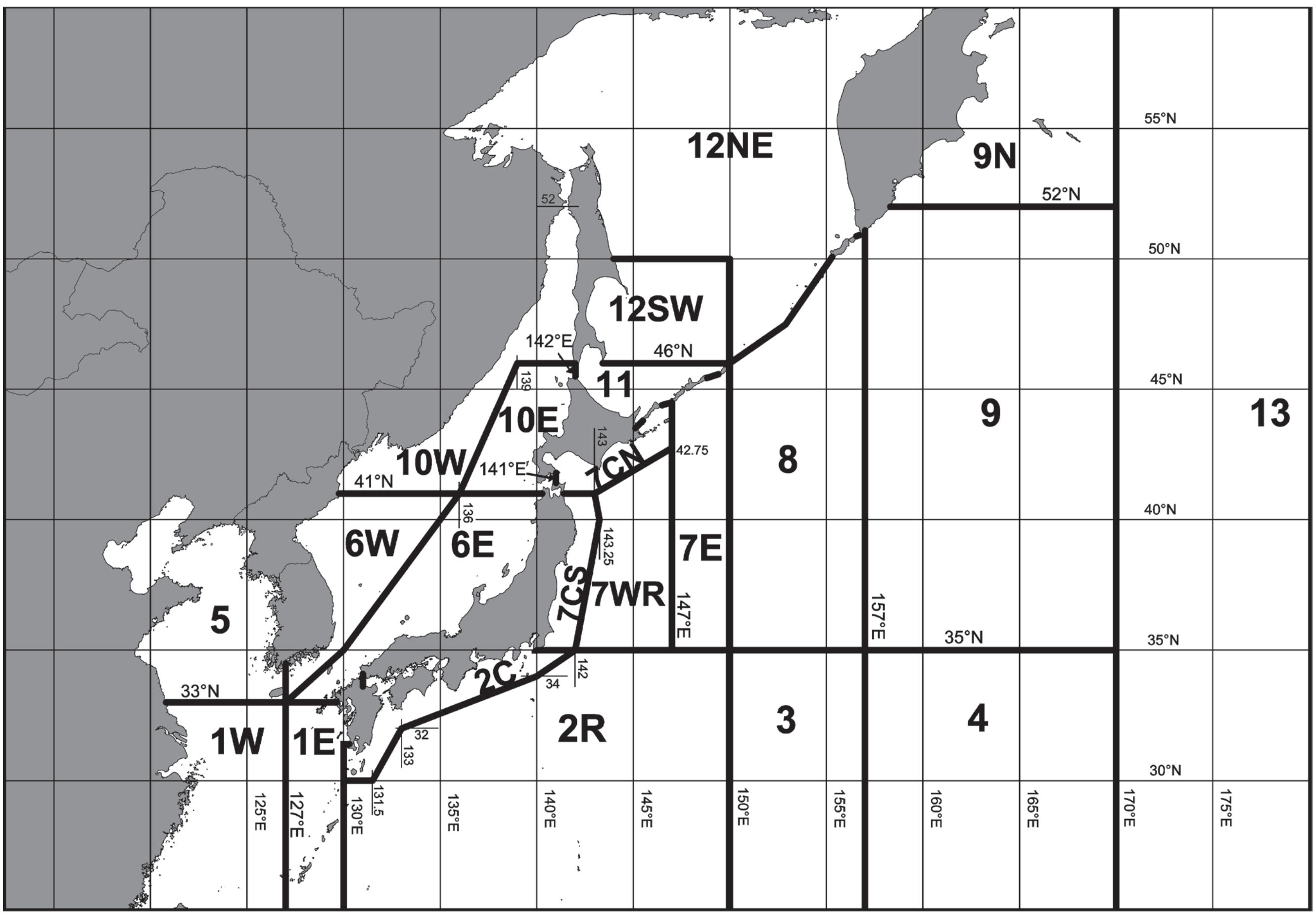


Fig. 1. The 22 sub-areas used for the *Implementation Simulation Trials* for North Pacific minke whales.

Table 3

Abundance estimates for common minke whales used to condition the *IST*s (from IWC, 2014).

Sub-area	Year	Season	Survey type[1]	Mode[2]	Areal coverage (%)	STD estimate[3]	CV[4]	Conditioning	Source
5	2001	Apr.-May	KD	NC	13.0	1,534	0.523	Min	An *et al.* (2010)
	2004	Apr.-May	KD	NC	13.0	799	0.321	Min	Ditto
	2008	Apr.-May	KD	NC	13.0	680	0.372	Min	Ditto
6W	2000	Apr.-May	KD	NC	14.3	549	0.419	Min	Ditto
	2002	Apr.-May	KD	NC	14.3	391	0.614	Min	Ditto
	2003	Apr.-May	KD	NC	14.3	485	0.343	Min	Ditto
	2005	Apr.-May	KD	NC	14.3	336	0.317	Min	Ditto
	2006	Apr.-May	KD	NC	14.3	459	0.516	Min	Ditto
	2007	Apr.-May	KD	NC	14.3	574	0.437	Min	Ditto
	2009	Apr.-May	KD	NC	14.3	884	0.286	Min	Ditto
6E	2002	May-Jun.	JD	NC	79.1	891	0.608	Yes (see #)	Miyashita (2010)
	2003	May-Jun.	JD	NC	79.1	935	0.357	Yes (see #)	Ditto
	2004	May-Jun.	JD	NC	79.1	727	0.372	Yes (see #)	Ditto
7CS	2004	May	JR	NC	100.0	886	0.502	Yes	Hakamada and Kitakado (2010) (rev)
	2006	Jun.-Jul.	JR	NC	100.0	3,690	1.199	Yes	Hakamada and Kitakado (2010) (rev)
7CN	2003	May	JR	NC	75.4	184	0.805	Yes	Hakamada and Kitakado (2010) (rev)
7WR	2003	May-Jun.	JR	NC	54.2	524	0.700	Min	Hakamada and Kitakado (2010) (rev)
	2004	May-Jun.	JR	NC	88.8	863	0.648	Yes	Hakamada and Kitakado (2010) (rev)
	2007	Jun.-Jul.	JR	NC	88.8	546	0.953	Yes	Hakamada and Kitakado (2010) (rev)
7E	2004	May-Jun.	JR	NC	57.1	440	0.779	Yes	Hakamada and Kitakado (2010) (rev)
	2006	May-Jun.	JR	NC	57.1	247	0.892	Yes	Hakamada and Kitakado (2010) (rev)
8	1990	Aug.-Sep.	JD	NC	61.8	1,057	0.705	Yes	IWC (2004, p.124)
	2002	Jun.-Jul.	JR	NC	65.0	0	482[5]	Yes	Hakamada and Kitakado (2010) (rev)
	2004	Jun.	JR	NC	40.5	1,093	0.576	Yes	Ditto
	2005	May-Jul.	JR	NC	65.0	132	1.047	Yes	Ditto
	2006	May-Jul.	JR	NC	65.0	309	0.677	Yes	Ditto
7E+8	2007	Jun.-Jul.	JR	NC	65.0	391[6]	1.013	Yes	Ditto
9	1990	Aug.-Sep.	JD	NC	35.0	8,264	0.396	Yes	IWC (2004, p.124)
	2003	Jul.-Sep.	JR	NC	33.2	2,546	0.276	Min	Hakamada and Kitakado (2010) (rev)
9N	2005	Aug.-Sep.	JD	IO-PS	67.8	420	0.969	Yes	Extract from Miyashita and Okamura (2011)
10W	2006	May-Jun.	JD	IO-PS	59.9	2,476	0.312	Yes	Ditto
10E	2002	May-Jun.	JD	NC	100.0	816	0.658	Yes	Miyashita (2010)
	2003	May-Jun.	JD	NC	100.0	405	0.566	Yes	Ditto
	2004	May-Jun.	JD	NC	100.0	474	0.537	Yes	Ditto
	2005	May-Jun.	JD	NC	100.0	666	0.444	Yes	Ditto
11	1990	Aug.-Sep.	JD	NC	100.0	2,120	0.449	Yes	IWC (2004, p.124)
	1999	Aug.-Sep.	JD	NC	100.0	1,456	0.565	Yes	Ditto
	2003	Aug.-Sep.	JD	IO-AC	33.9	882	0.820	Yes	Extract from Miyashita and Okamura (2011)
	2007	Aug.-Sep.	JD	IO-PS	20.2	377	0.389	Min	Ditto
12SW	1990	Aug.-Sep.	JD	NC	100.0	5,244	0.806	Yes	IWC (2004, p.124)
	2003	Aug.-Sep.	JD	IO-AC	100.0	3,401	0.409	Yes	Extract from Miyashita and Okamura (2011)
12NE	1990	Aug.-Sep.	JD	NC	100.0	10,397	0.364	Yes	IWC (2004, p.124) extract from SC/46/NP6
	1999	Aug.-Sep.	JD	NC	89.4	11,544	0.380	Yes	Ditto
	2003	Aug.-Sep.	JD	IO-AC	46.0	13,067	0.287	Yes	Extract from Miyashita and Okamura (2011)
# Trial 19: Use estimates in full area in 2002 & 2003 (originally 100% coverage) and one extrapolated to the full area in 2004 (79.1% coverage)									
6E	2002	May-Jun.	JD	NC	100.0	1,795	0.458	Yes	Miyashita (2010)
	2003	May-Jun.	JD	NC	100.0	1,059	0.322	Yes	Ditto
	2004	May-Jun.	JD	NC	100.0	919	0.372	Yes	Ditto
Trial 20: Use only in sensitivity as an estimate extrapolated to the full area									
10E	2007	May-Jun	JD	IO-PS	100.0	552	0.159	Yes	From Miyashita

[1]KD=Korean dedicated survey, JD=Japanese dedicated survey, JR=JARPN II. [2]NC=Normal-closing, IO-PS=Passing with IO mode, IO-AC=Abeam-closing with IO mode. (STD estimates by different modes, NC, IO-AC, IO-NC, are considered comparable.). [3]Standard (STD) estimate based on 'Top and Upper bridge', which will be corrected by estimate of $g(0)$ for the combined platform 'Top and Upper bridge'. [4]CV does not consider any process errors. [5]Average of the SEs for the non-zero estimates. [6]The estimate of 0 from sub-area 7E was combined with the estimate of 391 from sub-area 8.

References [from original table]

An, Y.R., Choi, C.D., Moon, D.Y. and Park, K.H. 2010. Summary of the information on Korean dedicated sighting surveys for abundance estimates of common minke whales. Paper SC/D10/NPM15 presented to the First Intersessional Workshop for Western North Pacific Common Minke Whales, 14-17 December 2010, Pusan, Republic of Korea (unpublished). 7pp. [Paper available from the Office of this Journal].

Hakamada, T. and Kitakado, T. 2010. Summary of the information on dedicated sighting surveys for abundance estimation in JARPN and JARPN II. Paper SC/D10/NPM12rev presented to the First Intersessional Workshop for Western North Pacific Common Minke Whales, 14-17 December 2010, Pusan, Republic of Korea (unpublished). [Paper available from the Office of this Journal].

International Whaling Commission. 2004. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 6:75-184.

International Whaling Commission. 2014. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 15:112-88.

Miyashita, T. 2010. Summary of the information on Japanese dedicated sighting surveys for abundance estimation. Paper SC/D10/NPM11 presented to the First Intersessional Workshop for Western North Pacific Common Minke Whales, 14-17 December 2010, Pusan, Republic of Korea (unpublished). 6pp. [Paper available from the Office of this Journal].

Miyashita, T. and Okamura, H. 2011. Abundance estimates of common minke whales using the Japanese dedicated sighting survey data for RMP *Implementation* and CLA - Sea of Japan and Sea of Okhotsk. Paper SC/63/RMP11 presented to the IWC Scientific Committee, June 2011, Tromsø, Norway (unpublished). 34pp. [Paper available from the Office of this Journal].

Furthermore, given the greater importance that now needs to be placed on possible recruitment changes, it becomes more important to estimate natural mortality M. That is because it is the value of M that determines how fast or slowly a population can respond to changes, as for example in recruitment (i.e. it plays a major role in determining how long transient effects in the population will persist). *ISTs* need to capture such effects accurately. Fisheries scientists would never consider managing sardine and cod the same way, yet in relative terms the difference between M values for minke and bowhead whales are probably greater than the difference between those values sardine and cod. This is why having information on M for whales has become more important.

De la Mare's paper and presentation have reflected a number of mis-statements and misunderstandings. In the context above, his paper stated that:

These analyses illustrate that the prospects of reliably estimating MSYR and/or M from the amount of data proposed is remote. This is not surprising since this was also attempted in JARPA with results that lacked useful precision'.

This statement is incorrect as the analyses concerned showed that JARPA data provided reasonably precise estimates of M, as well as estimates of historical increase rates that inform a lower bound on Antarctic minke whale productivity (Punt *et al.*, 2014).

Then in his presentation De la Mare criticised the proponents' analyses of the sample size for sei whales because they had failed to provide a demonstration that estimates of MSYR would be improved. Estimating MSYR is certainly important, but that was not the intended focus of the analyses presented, because those related to estimation after 12 years only of NEWREP-NP, and it was evident to the proponents that that would be too short a period to achieve MSYR estimation satisfactorily. Instead the proponents addressed the question of estimating M within the framework of the current standard approach to *IST*s, which is to condition each on a fixed MSYR. Estimation of M was considered within that framework, given its growing importance for the reasons explained above. The process followed was perfectly appropriate for that context and yielded results on bias and precision to be expected after 12 years of survey and age data from NEWREP-NP, finally advocating a sample size on that basis.

However, a data input error to these calculations has been identified very recently. A presentation later today will explain that and the consequent action planned.

6. AIMS OF THE WORK ON THE EFFECT OF 'REGIME SHIFT' ON WHALE STOCKS

A member of the Panel raised a question about wording: 'regime shift'. Although there are many definitions of regime shift, the study group of fisheries and ecosystem responses to a recent regime shift under PICES (North Pacific Marine Science Organization) defined regime shift as 'a relative rapid change from one decadal-scale period of a persistent state to another decadal-scale period of persistent state' (King, 2005).

However, the objective under NEWREP-NP is not to detect a regime shift directly. Rather, this aspect of the NEWREP-NP will be focused on following two issues (see Annex 11).

(a) Contribution to the understanding of a regime shift based on phenomena such as the change in distribution of whales and their prey species.
(b) Data collection for elucidation of the cause of the change in distribution of whales and their prey species.

Proponents had the same intent with the expression 'Regime shift' as 'Major environmental change'. Proponents will modify 'Regime shift' to 'Major environmental change (e.g. regime shift)'. The proponents will focus on following two issues.

(a) Contribution to the understanding of the major environmental change (e.g. regime shift) based on phenomena such as the change in distribution of whales and their prey species.
(b) Data collection for elucidation of the cause of the change in distribution of whales and their prey species.

The research will contribute to the scientific understanding of the impact of prey shift on common minke and

Table 4

NEWREP-NP contributing to all RMP processes including *pre-Implementation assessment.*

Year	Source	April	May	June	July	August	September	October	November	Total
1984	Commercial	13	24				2			46
1985	Commercial	13								13
1986	Commercial	13	10	6		2				31
1987	Commercial	13	4	6	1	2	3			31
1996	JARPN					30				30
1999	JARPN				50					50
2001	Bycatch						2	1		3
2002	Bycatch		1		1			1	2	5
2003	Bycatch			1				3	4	8
2004	Bycatch		2	1						3
2005	Bycatch		1	2					3	6
2006	Bycatch			1				2		3
2007	Bycatch		1	1				2	2	6
2008	Bycatch		1					1	1	3
2009	Bycatch								1	1
2010	Bycatch		1	2			1			4
2011	Bycatch			1						1
2012	Bycatch		1	2					1	4
2014	Bycatch		1		1					2
2017	NEWREP-NP				47					47
2018	NEWREP-NP						47			47
2019	NEWREP-NP		47							47
2020	NEWREP-NP						47			47
2021	NEWREP-NP		47							47
2022	NEWREP-NP						47			47

*DNA and other biological data from whales sampled in a given year will be available in the next year.

sei whales and their geographical movements in the western North Pacific during the long-term research activity of NEWREP-NP. For example, changes are currently being observed in migration timing and nutritional condition that may be caused by changes in prey availability because of a major environmental change (e.g. regime shift).

7. NUMBER OF HISTORICAL AND FUTURE SAMPLE/DATA OF COMMON MINKE WHALES IN SUB-AREA 11

See Table 4.

8. CLARIFICATION OF SECONDARY OBJECTIVE II (III) ON STOCK STRUCTURE OF THE SEI WHALE, AND EASTERN BOUNDARY FOR THE OFFSHORE SURVEY

The survey design in p.132 of the NEWREP-NP research plan indicates that the western boundary of the offshore survey is approximately at 142°E. This coincides approximately with the western boundary of the DNA analysis of the sei whale (143°E) conducted under the JARPN II. No sei whale has been sighted by sighting surveys conducted west of 143°E. The area of the offshore survey coincides with part of the tentative area of the 'pelagic stock' under one of the stock structure hypotheses for the North Pacific sei whale.

The analyses on stock structure under the NEWREP-NP have as their main purpose to verify that whales in the area of the offshore survey (see map on p.132) correspond to a single stock. This will be verified by conducting additional analyses recommended by the JARPN II Review Workshop and the IWC SC in 2016, and by investigating movement (within the feeding grounds and between feeding grounds and breeding ground) using satellite tracking.

9. AIM OF THE ANCILLARY OBJECTIVE I

A member of the Panel pointed out that Ancillary Objective I could not be achieved by the design of NEWREP-NP, because the sample size is not large enough to assess adverse effects such as immunosuppression to PCBs on whale 'stocks'. The proponents would like to clarify that the objective here is not a comprehensive assessment of adverse effects of pollutants on whale 'stocks'. Rather the objective is monitoring of possible adverse effects of pollutants, species differences in sensitivity and response to pollutants, and unknown risk for novel chemicals at the individual level, not the 'stock' level. This is a basic topic in environmental toxicology.

Another member of the Panel asked whether there is any pollutant-specific adverse effect on whales. OMICS approach mentioned in research item (ii) of this ancillary objective can be used to identify pollutant-specific effect on whales.

REFERENCES

King, J.R. 2005. Report of the study group on fisheries and ecosystem responses to recent regime shifts. *PICES Sci. Rep.* 28: 0-161.

Myasnikov, V.G., Vinnikov, A.V., Ryabov, A.A., Tyupeleev, P.A., Gushcherov, P.S., Samanov, V.I. and Miyashita, T. 2016. Cruise report of the cetacean sighting survey in the northern part of the Sea of Okhotsk in 2015. Paper SC/66b/IA17 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 25pp. [Paper available from the Office of this Journal].

Park, K.J., Kim, H.W., Sohn, H.S., Lee, K.L. and Choi, Y.M. 2016. Plan for the Korean sighting survey in the Yellow Sea in 2017. Paper SC/66b/RMP05 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 4pp. [Paper available from the Office of this Journal].

Punt, A., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93-116.

Tiupeleev, P.A., Gushcherov, P.S., Samanov, V.I. and Miyashita, T. 2016. Plan of the cetacean sighting survey in the northern part of the Sea of Okhotsk in 2016 (revised). Paper SC/66b/IA11rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 6pp. [Paper available from the Office of this Journal].

Morning Paper, 2 Feb 2017-A: Overview of the Proponents' views related to age data

Note: This overview largely repeats comments already made/documented by the proponents. The reason for its preparation in this form is to consolidate material related to age data and simulation studies presented to the review meeting, and in particular to address queries which were raised during the discussions under agenda item 4.2.1.

(1) The SCAA assessment of Antarctic minke whale populations by Punt *et al.* (2014) was a major advance for the IWC SC because, through its ability to take account of age in addition to survey abundance data, it pointed to the extent of recruitment changes that could occur, and its results did not conform closely to the behaviour predicted by the standard population models used to assess and hence to provide *IST*s for baleen whale populations.

(2) This has been an important step in contributing to the evolution of the RMP towards a more efficient version which is based on better conditioned operating models and is stock specific (as is the AWMP) rather than generic as at present. Age data contribute to this better conditioning and may also be able to improve the performance of a refined version of the RMP, as has been demonstrated in the case of Antarctic minke whales. The NEWREP-NP proposal, with its analyses, has the intent that the age data to be collected will contribute to this evolutionary process.

(3) It is important that *IST*s reflect the true dynamics of the whale populations concerned as closely as possible, so that the analyses for which they serve as a basis lead to choices of the most appropriate management approaches and decisions. The Antarctic minke whale example above showed that age data are needed for conditioning those trials so that recruitment and its changes may be reflected far better.

(4) This is the primary reason that justifies the decision to use age data for the conditioning of the next set of *IST*s for the North Pacific common minke whale. Naturally recruitment is hardly estimable for other than the past years spanned by the collection of age data, so that for future sets of *IST*s also to best reflect underlying dynamics, age data must continue to be collected for those updated *IST*s to include recruitment estimates for the most recent years.

(5) The only question that then remains is how much age data are needed to make a meaningful improvement to that NP minke whale conditioning. A detailed calculation for this would need to be based on the planned updated conditioned (including with the age data available at that time) set of NP minke *IST*s, and consequently must await completion of that exercise which is the responsibility of the IWC Scientific Committee.

(6) In the interim, calculations based on a restricted simpler model related to the previous *IST*s were carried out as an illustration. Given their illustrative nature, and pending the conditioning update of the NP minke trials, it was unnecessary for this model to attempt to include 'every'

factor that might play some role in MP performance (such as selectivity doming or inter-annual variation). The intent of the exercise (which was successfully achieved) was to ascertain whether the proposed level of sampling was at about that which would provide meaningful improvement in the conditioning. Once the updated conditioning is complete, that could be used to update this sampling level, though any difference would not be expected to be large.

(7) Comments were made that the associated simulations presented for North Pacific minke whales extended beyond the 12 years duration of the current proposal. Given the relatively slow dynamics of minke whales, coupled to the nature of the information content of age data, the improvements to *IST*s achieved by use of these data take time to reveal their full extent, so that there is a need to show results for projections over a number of decades. Self-evidently the results for these larger numbers of years must be taken into account; otherwise the injudicious situation would arise that research with longer term benefits would never commence because those benefits could never become evident in the short term.

(8) Given the greater importance that now needs to be placed on possible recruitment changes, it becomes more important to estimate natural mortality M. That is because it is the value of M that determines how fast or slowly a population can respond to changes, as for example in recruitment (i.e. it plays a major role in determining how long transient effects in the population will persist). *IST*s need to capture such effects accurately for subsequent improved choices amongst management procedures. Fisheries scientists would never consider managing sardine and cod the same way, yet in relative terms the difference between M values for minke and bowhead whales is probably greater than the difference between those values for sardine and cod. This is why having information on M for whales has become more important with the necessary move towards improved operating models for *IST*s that has become possible as age data have become available for conditioning.

(9) In his presentation De la Mare criticised the proponents' analyses of the sample size for sei whales because they had failed to provide a demonstration that estimates of MSYR would be improved. Estimating MSYR is certainly important, but that was not the intended focus of the analyses presented, because those analyses related to estimation after 12 years only of NEWREP-NP, and it was evident to the proponents that that would be too short a period to achieve satisfactory MSYR estimation. Instead the proponents addressed the question of estimating M within the framework of the current standard approach to *IST*s, which is to condition each on a fixed value MSYR. Estimation of M was considered within that framework, given its growing importance for the reasons explained above. The process followed was completely appropriate for that (interim) context.

REFERENCE

Punt, A., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93-116.

Morning Paper, 2 February 2017-B: Issues raised during discussion of Agenda item 4.2.1

1. ISSUES ABOUT FEEDING ECOLOGY STUDY

The Panel raised questions regarding major environmental change (e.g. regime shift) and geographical heterogeneity of stomach contents and the amount of consumption.

Major environmental changes

The objective under NEWREP-NP is not to detect a major environmental change (e.g. regime shift) directly. However, the proponents plan to cover almost the whole research area every season.

It will be useful for the understanding of the regime shift based on phenomena such as the change in distribution of whales and their prey species. The proponents also consider that detection of effect of the major environmental changes (e.g. regime shift) on whales (e.g. change in prey species composition) can be achieved through investigation by post hoc analysis rather than a priori analysis, because these changes are difficult to predict and usually occur non-linearly.

Investigation on the effect of environmental variability on various pelagic fish (e.g. anchovy, sardine) in North Pacific has been conducted in a retrospective manner (Yatsu *et al.*, 2008), where their study was a qualitative rather than quantitative assessment.

Geographical heterogeneity of feeding habit of whales

Geographical heterogeneity of stomach contents and the amount of consumption will be investigated based on a model based approach (i.e. spatial modelling) and preliminary results were presented to the final Review Workshop on JARPN II (Tamura *et al.*, 2016).

Fig. 1 shows as an example one case of spatial distribution of estimated amount of euphausiids consumed by sei whales (t/day) in 1×1 longitude and latitude grids from May to September.

The proponents will apply the spatial model-based approach for the objectives I (v) and II (v) using sighting data and observed stomach contents data.

2. ISSUES ABOUT SAMPLING SURVEY DESIGN

The Panel raised some questions about the design of the sampling survey.

The proponents described the sampling survey design for the coastal component (common minke whale) in Annex 6 of SC/J17/JR01 and that for the offshore component (common minke and sei whales) in Annex 13. Some clarifications are included below.

(i) Sampling in sub areas 7CN, 7CS and 11 (see Annex 6)

A land-based operation system will be incorporated for whale sampling in the coastal sub-areas. Basically the vessels depart the port every morning, and return to the port every night. In order to cover a larger area within sub areas 7CS and 7CN (excluding the EEZ zones of foreign countries), establishing a new land-based research station in northern Sanriku region is under consideration.

In JARPN II, surveys were mainly conducted within a 30 nautical miles radius from the port in respective area (the Kushiro port or the Ayukawa port), and limited within the maximum of 50 n.miles radius from the port so as to

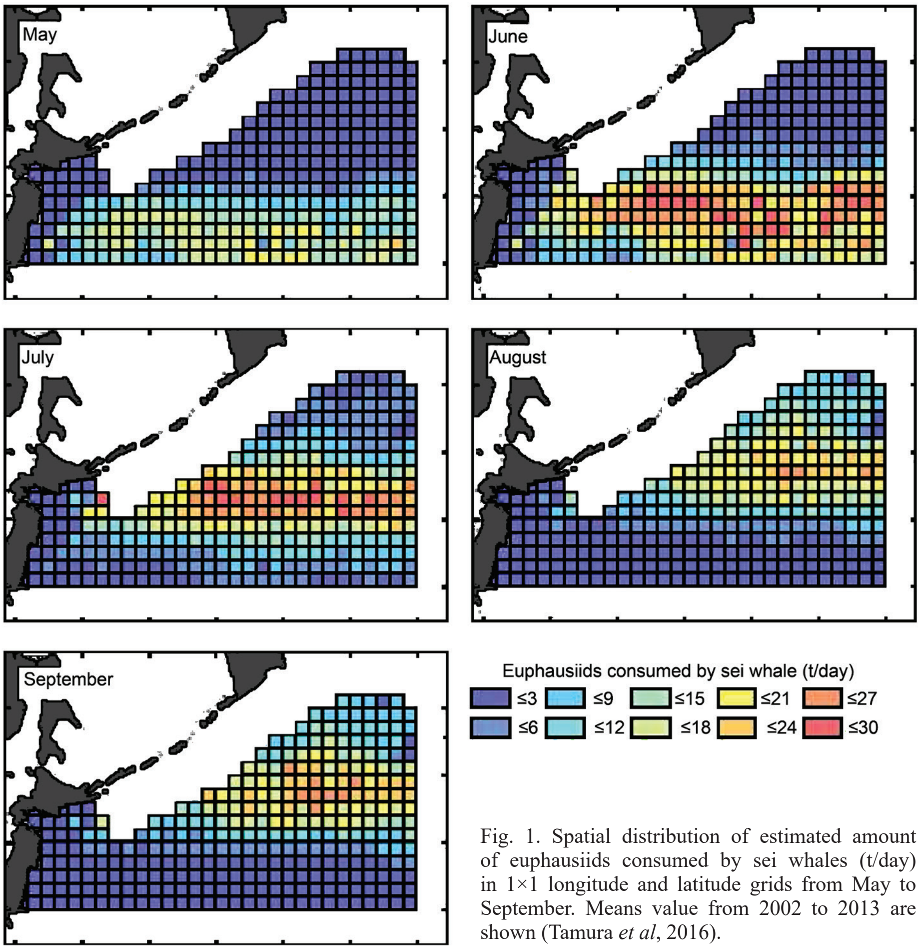


Fig. 1. Spatial distribution of estimated amount of euphausiids consumed by sei whales (t/day) in 1×1 longitude and latitude grids from May to September. Means value from 2002 to 2013 are shown (Tamura *et al*, 2016).

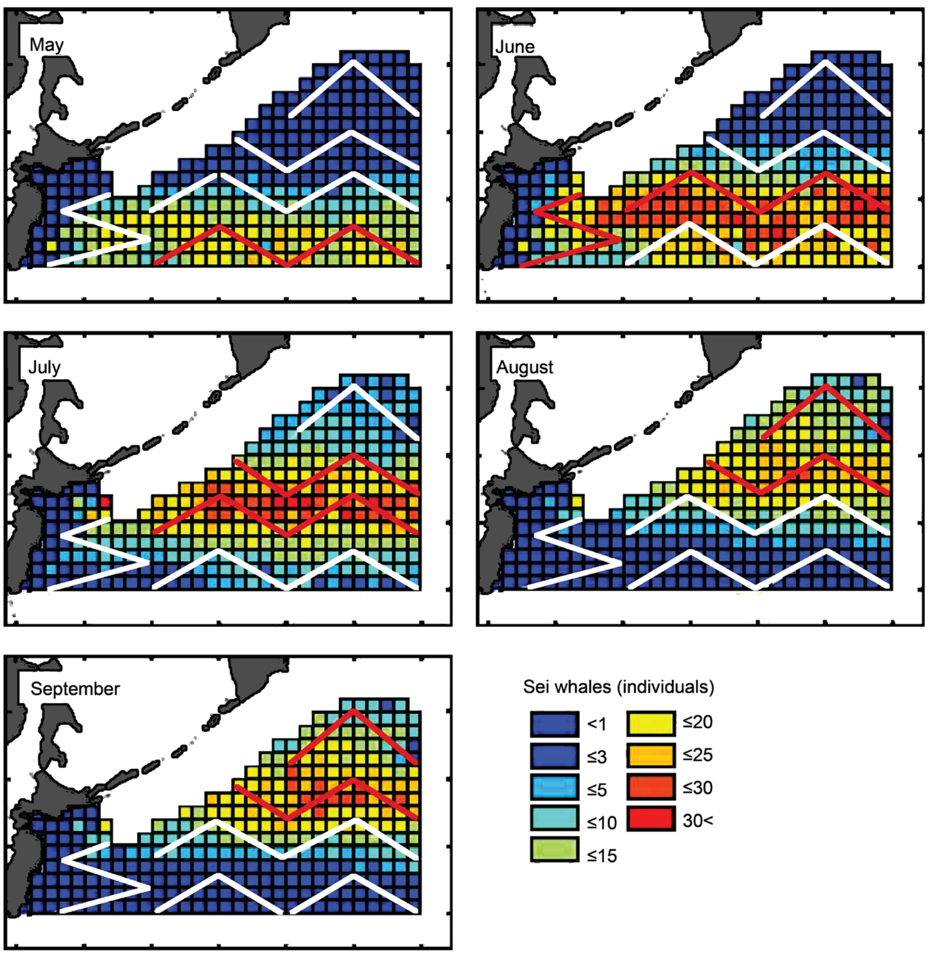


Fig. 2. The tentative survey track design in each month in the offshore survey (red line) based on the estimated spatial distribution of sei whales from May to September from 2002 to 2013. Means of estimated number of individuals in 1×1 longitude and latitude grids were shown (Tamura *et al,* 2016).

keep the stomach contents fresh enough for feeding ecology study. However, in NEWREP-NP, the sampling area is no limited. The proponents plan to cover almost whole survey area (7CN, 7CS and 11).

Note that this sampling design may not achieve random sampling of these areas, which is not a requirement for nearly all analyses. While that is desirable for some approaches to the analysis of age data, it is not essential for SCAA because under the likely reasonable assumption of full selectivity at the largest ages, non-randomness is taken into account through the estimation of the rest of the selectivity function.

(ii) Sampling in sub-areas 7WR, 7E, 8 and 9 (see Annex 13)
Sampling of common minke whales and sei whales in offshore waters will be carried out by the sampling and sighting vessels attached to the research base *Nisshin Maru*.

The tracklines and the allocation of vessels will be set in a similar manner as in previous JARPN II surveys. A zigzag-shaped track line will be set in the research area. The proponents plan to cover almost all the whale research area every season, and the design will consider the seasonal distribution of common minke and sei whales. An ideal sampling design is shown in Fig. 2. The proponents will consider adjustment to track line in cases of bad weather (e.g. typhoon and/or dense fog). All sei whales and common minke whales sighted as primary and secondary sightings, excluding cow and calf pairs, will be targeted for sampling.

3. SIGHTING SURVEY DESIGNS

In general the protocol for conducting sighting surveys will follow that used during the IWC SC POWER survey. Sighting survey plans will be presented to the Annual Meeting of the IWC SC to ensure that they follow the guidelines of the Committee.

Trackline design
Cruise track for the dedicated sighting survey will be designed by using the programme DISTANCE (Ver. 6.2) following the Requirements and Guidelines for Surveys under the RMP (IWC, 2012), in particular information on the distribution of the common minke and the sei whales will be taken into account in the design of the survey. Fig. 3 shows examples of cruise tracks to be implemented in NEWREP-NP, which are the same as were used in previous sighting surveys endorsed by the IWC SC and with IWC oversight.

Survey direction
Arrows in Fig. 3 show the survey order. Given that common minke whales migrate from south to north in spring and summer, in principle surveys will be conducted from north to south to avoid double counting. For sub-areas 7WR, 7E, 8 and 9, the pattern of cruise track design used in the 2013 dedicated sighting surveys will be repeated. The 2013 survey had oversight by IWC/SC (IWC, 2014).

IO mode
Sighting survey in IO mode will be conducted sub-area 11 as in previous surveys. Proponents understand importance of estimating $g(0)$ for situations of bad weather condition, and therefore, the proponents will consider to conduct the surveys in IO mode in other sub-areas.

Time allocations for experiments
Allocation of time for experiments such as photo-id and biopsy will be assigned following the criteria used for the IWC POWER surveys (IWC, 2017), and will be decided by the cruise leader.

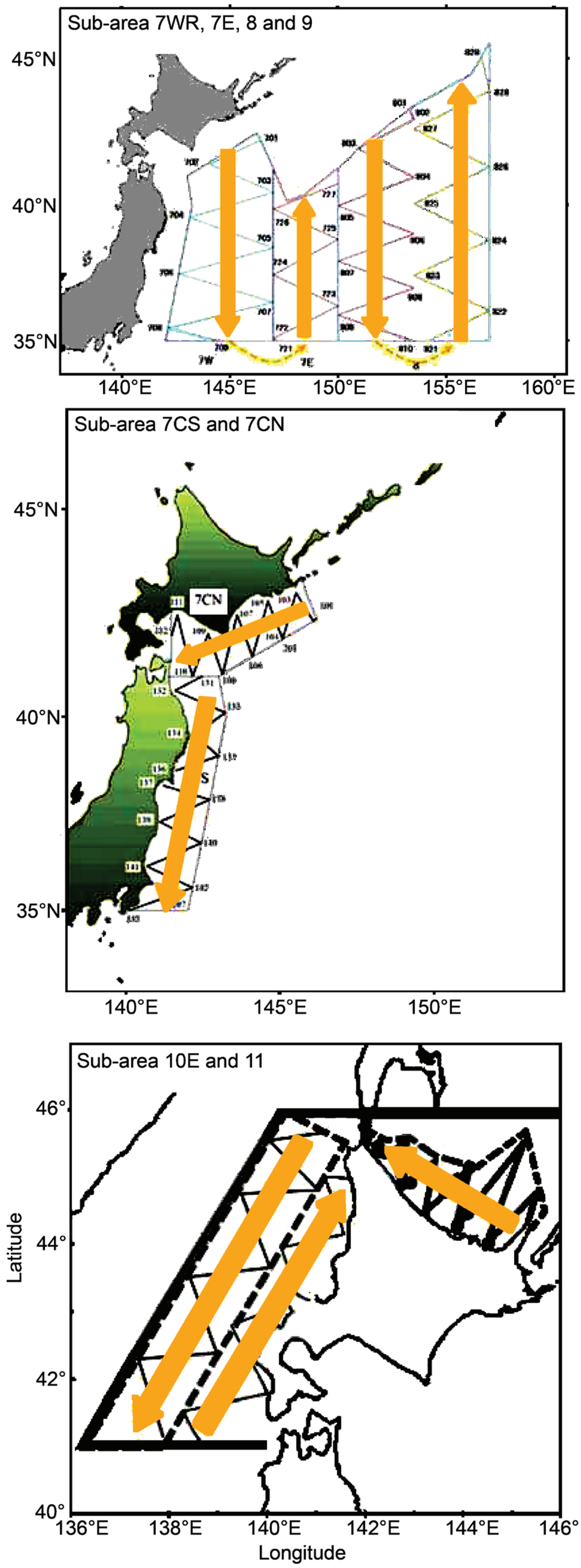


Fig. 3. Examples of previous trackline designs in sub-areas 7CS, 7CN, 7WR, 7E, 8, 9, 10E and 11. Arrows indicate survey order which were endorsed by the IWC SC. These will be followed for NEWREP-NP.

4. DETAILED INFORMATION OF HISTORICAL AND FUTURE BIOLOGICAL DATA

See tables on following pages.

REFERENCES

International Whaling Commission. 2012. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2014. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.

International Whaling Commission. 2017. Report of the Planning Meeting for the 2016 IWC-POWER Cruise in the North Pacific, 9-10 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:477-87.

Tamura, T., Murase, H., Sasaki, H. and Kitakado, T. 2016. Preliminary attempt of spatial estimation of prey consumption by sei whales in the JARPNII survey area using data obtained from 2002 to 2013. Paper SC/F16/JR16 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 22pp. [Paper available from the Office of this Journal].

Yatsu, A., Aydin, K.Y., King, J.R., McFarlane, G.A., Chiba, S., Tadokoro, K., Kaeriyama, M. and Watanabe, Y. 2008. Elucidating dynamic responses of North Pacific fish populations to climatic forcing: influence of life-history strategy. *Prog. Oceanog.* 77: 252-68.

Table 1

Common minke whale - number of samples on body length and sexual maturity by JARPN.

Research year	Total	Sub-areas																	
		1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
1994-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-7	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
1994-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-
1994-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
1994-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-
1995-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	-	-
1995-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-
1995-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-7	77	-	-	-	-	-	-	-	-	-	-	-	-	1	-	11	-	-	-
1996-8		-	-	-	-	-	-	-	-	-	30	-	15	-	-	5	-	-	-
1996-9		-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-
1996-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-	-
1997-6		-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	40	-	-
1997-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	-	-	-
1997-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-5		-	-	-	-	-	-	-	-	-	-	-	-	25	31	8	-	-	-
1998-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	-	-	-
1998-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-6		-	-	-	-	-	-	-	-	-	-	1	47	2	-	-	-	-	-
1999-7		-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-
1999-8	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.1

Common minke whale - number of samples on body length and sexual maturity by JARPNII.

Research year	Total	Sub-areas																	
		1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2000-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-7	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-8		-	-	-	-	-	-	-	-	-	-	4	2	-	-	-	16	-	-
2000-9		-	-	-	-	-	-	-	-	-	-	1	17	-	-	-	-	-	-
2000-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-5		-	-	-	-	-	-	-	-	-	-	14	-	14	-	-	-	-	-
2001-6		-	-	-	-	-	-	-	-	-	-	-	10	5	7	-	-	-	-
2001-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	24	-	-
2001-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
2001-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-7	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-
2002-8		-	-	-	-	-	-	-	-	-	-	-	5	1	-	7	5	-	-
2002-9		-	-	-	-	-	-	-	-	-	-	-	91	-	-	1	6	-	-
2002-10		-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
2002-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-4		-	-	-	-	-	-	-	-	-	-	49	-	-	-	-	-	-	-
2003-5		-	-	-	-	-	-	-	-	-	-	13	-	5	5	19	-	-	-
2003-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	11	-	-
2003-7	150	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2003-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	-	-
2003-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-7	159	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-
2004-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-
2004-9		-	-	-	-	-	-	-	-	-	-	-	51	-	-	-	-	-	-
2004-10		-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-
2004-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-4		-	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	-	-
2005-5		-	-	-	-	-	-	-	-	-	-	28	-	-	-	10	10	-	-
2005-6		-	-	-	-	-	-	-	-	-	-	5	9	-	-	-	3	-	-
2005-7		-	-	-	-	-	-	-	-	-	-	-	17	1	-	4	3	-	-
2005-8	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	-	-
2005-9		-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-
2005-10		-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-
2005-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.2

Common minke whale - number of samples on body length and sexual maturity by JARPNII.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2006-4		0	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-
2006-5		-	-	-	-	-	-	-	-	-	-	54	-	3	-	-	-	-	-
2006-6		-	-	-	-	-	-	-	-	-	-	3	-	6	2	26	10	-	-
2006-7	195	-	-	-	-	-	-	-	-	-	-	-	10	1	-	12	14	-	-
2006-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006-9		-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-
2006-10		-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
2006-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-4		-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
2007-5		-	-	-	-	-	-	-	-	-	-	47	-	-	-	1	1	-	-
2007-6		-	-	-	-	-	-	-	-	-	-	40	33	6	-	14	5	-	-
2007-7	207	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-8		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2007-9		-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-
2007-10		-	-	-	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-
2007-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008-4		-	-	-	-	-	-	-	-	-	-	37	-	-	-	-	-	-	-
2008-5		-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-
2008-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	3	-	-
2008-7	169	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	-	-
2008-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-
2008-9		-	-	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	-
2008-10		-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-
2008-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009-4		-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
2009-5		-	-	-	-	-	-	-	-	-	-	45	-	-	4	1	3	-	-
2009-6		-	-	-	-	-	-	-	-	-	-	1	2	8	-	-	4	-	-
2009-7	162	-	-	-	-	-	-	-	-	-	-	-	4	-	-	16	-	-	-
2009-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009-9		-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-	-
2009-10		-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-
2009-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-4		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2010-5		-	-	-	-	-	-	-	-	-	-	36	-	-	-	-	-	-	-
2010-6		-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
2010-7	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-
2010-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2010-9		-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-
2010-10		-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
2010-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011-5		-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-
2011-6		-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
2011-7	126	-	-	-	-	-	-	-	-	-	-	23	24	-	-	-	-	-	-
2011-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
2011-9		-	-	-	-	-	-	-	-	-	-	-	31	-	-	-	-	-	-
2011-10		-	-	-	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-
2011-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-4		-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
2012-5		-	-	-	-	-	-	-	-	-	-	76	32		-	-	-	-	-
2012-6		-	-	-	-	-	-	-	-	-	-	-	9	5	-	3	-	-	-
2012-7	182	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-9		-	-	-	-	-	-	-	-	-	-	-	26	-	-	-	-	-	-
2012-10		-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-
2012-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013-4		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2013-5		-	-	-	-	-	-	-	-	-	-	28	-	-	-	-	-	-	-
2013-6		-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
2013-7	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
2013-9		-	-	-	-	-	-	-	-	-	-	-	46	-	-	-	-	-	-
2013-10		-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-
2013-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-4		-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
2014-5		-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-
2014-6		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2014-7	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-9		-	-	-	-	-	-	-	-	-	-	-	51	-	-	-	-	-	-
2014-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-4		-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
2015-5		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2015-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-7	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-9		-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	-	-
2015-10		-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-
2015-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-4		-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
2016-5		-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
2016-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-7	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-9		-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-
2016-10		-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
2016-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3

Common minke whale - number of samples on body length and sexual maturity by NEWREP-NP.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2017-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017-6		-	-	-	-	-	-	-	-	-	47	-	-					-	-
2017-7	174	-	-	-	-	-	-	-	-	-		-	-	27				-	-
2017-8		-	-	-	-	-	-	-	-	-	-							-	-
2017-9		-	-	-	-	-	-	-	-	-	-	100						-	-
2017-10		-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
2017-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2018-5		-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-
2018-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2018-7	174	-	-	-	-	-	-	-	-	-	-		-	27				-	-
2018-8		-	-	-	-	-	-	-	-	-	47	-						-	-
2018-9		-	-	-	-	-	-	-	-	-		-	50					-	-
2018-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2018-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2019-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2019-5		-	-	-	-	-	-	-	-	-	47	50	-	-	-	-	-	-	-
2019-6		-	-	-	-	-	-	-	-	-			-					-	-
2019-7	174	-	-	-	-	-	-	-	-	-	-		-	27				-	-
2019-8		-	-	-	-	-	-	-	-	-	-	-						-	-
2019-9		-	-	-	-	-	-	-	-	-	-	-	50					-	-
2019-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2019-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2020-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2020-5		-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-
2020-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2020-7	174	-	-	-	-	-	-	-	-	-	-		-	27				-	-
2020-8		-	-	-	-	-	-	-	-	-	47	-						-	-
2020-9		-	-	-	-	-	-	-	-	-		-	50					-	-
2020-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2020-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2021-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2021-5		-	-	-	-	-	-	-	-	-	47	50	-	-	-	-	-	-	-
2021-6		-	-	-	-	-	-	-	-	-			-					-	-
2021-7	174	-	-	-	-	-	-	-	-	-	-		-	27				-	-
2021-8		-	-	-	-	-	-	-	-	-	-	-						-	-
2021-9		-	-	-	-	-	-	-	-	-	-	-	50					-	-
2021-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2021-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2022-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2022-5		-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-
2022-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2022-7	174	-	-	-	-	-	-	-	-	-	-		-	27				-	-
2022-8		-	-	-	-	-	-	-	-	-	47	-						-	-
2022-9		-	-	-	-	-	-	-	-	-		-	50					-	-
2022-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2022-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-

Table 4

Common minke whale - number of age data by JARPN.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
1994-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-7	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
1994-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
1994-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
1994-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
1995-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-
1995-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-
1995-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-7	77	-	-	-	-	-	-	-	-	-	-	-	-	1	-	6	-	-	-
1996-8		-	-	-	-	-	-	-	-	-	15	-	5	-	-	4	-	-	-
1996-9		-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
1996-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
1997-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-
1997-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-
1997-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-5		-	-	-	-	-	-	-	-	-	-	-	-	13	9	1	-	-	-
1998-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
1998-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-6		-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-
1999-7	100	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-
1999-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.1

Common minke whale - number of age data by JARPNII.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2000-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-7	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-8		-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	-	-
2000-9		-	-	-	-	-	-	-	-	-	-	1	9	-	-	-	-	-	-
2000-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-5		-	-	-	-	-	-	-	-	-	-	5	-	6	-	-	-	-	-
2001-6		-	-	-	-	-	-	-	-	-	-	-	9	3	3	-	-	-	-
2001-7	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	7	-	-
2001-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
2001-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002-7	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-
2002-8		-	-	-	-	-	-	-	-	-	-	-	1	-	-	6	2	-	-
2002-9		-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	1	-	-
2002-10		-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-
2002-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-4		-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-
2003-5		-	-	-	-	-	-	-	-	-	-	3	-	4	4	10	-	-	-
2003-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	6	-	-
2003-7	150	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2003-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-
2003-9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-7	159	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-
2004-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-	-
2004-9		-	-	-	-	-	-	-	-	-	-	-	26	-	-	-	-	-	-
2004-10		-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
2004-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-4		-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-
2005-5		-	-	-	-	-	-	-	-	-	-	13	-	-	-	3	4	-	-
2005-6		-	-	-	-	-	-	-	-	-	-	3	4	-	-			-	-
2005-7	220	-	-	-	-	-	-	-	-	-	-	-	10	1	-	2	1	-	-
2005-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-
2005-9		-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-
2005-10		-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
2005-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.2

Common minke whale - number of age data by JARPNII.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2006-4		-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
2006-5		-	-	-	-	-	-	-	-	-	-	33	-	2	-	-	-	-	-
2006-6		-	-	-	-	-	-	-	-	-	-	1	-	2	2	7	4	-	-
2006-7	195	-	-	-	-	-	-	-	-	-	-	-	6	1	-	6	7	-	-
2006-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006-9		-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-
2006-10		-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
2006-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-4		-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
2007-5		-	-	-	-	-	-	-	-	-	-	18	-	-	-	1	-	-	-
2007-6		-	-	-	-	-	-	-	-	-	-	23	15	4	-	11	1	-	-
2007-7	207	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-9		-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
2007-10		-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-
2007-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008-4		-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-
2008-5		-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-
2008-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
2008-7	169	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-
2008-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-
2008-9		-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-
2008-10		-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
2008-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009-4		-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-
2009-5		-	-	-	-	-	-	-	-	-	-	14	-	-	2	-	-	-	-
2009-6		-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	1	-	-
2009-7	162	-	-	-	-	-	-	-	-	-	-	-	3	-	-	10	-	-	-
2009-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009-9		-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
2009-10		-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-
2009-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-4		-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
2010-5		-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-
2010-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-7	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
2010-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2010-9		-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-
2010-10		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
2010-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011-5		-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-
2011-6		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
2011-7	126	-	-	-	-	-	-	-	-	-	-	10	13	-	-	-	-	-	-
2011-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
2011-9		-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-
2011-10		-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-
2011-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-4		-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
2012-5		-	-	-	-	-	-	-	-	-	-	27	15	-	-	-	-	-	-
2012-6		-	-	-	-	-	-	-	-	-	-	-	2	3		2	-	-	-
2012-7	182	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2012-9		-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-
2012-10		-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-
2012-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2013-4		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-		-	-
2013-5		-	-	-	-	-	-	-	-	-	-	11	-	-	-	-		-	-
2013-6		-	-	-	-	-	-	-	-	-	-	1	-	-	-	-		-	-
2013-7	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
2013-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2013-9		-	-	-	-	-	-	-	-	-	-	-	24	-	-	-		-	-
2013-10		-	-	-	-	-	-	-	-	-	-	-	7	-	-	-		-	-
2013-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
2014-4		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2014-5		-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
2014-6		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2014-7	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-9		-	-	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-
2014-10		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-4		-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
2015-5		-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
2015-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-7	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015-9		-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-
2015-10		-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-
2015-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-4		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2016-5		-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
2016-6		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-7	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016-9		-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-
2016-10		-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
2016-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-

Table 6

Common minke whale - number of age data by NEWREP-NP.

Research year	Total	1W	1E	2R	3	4	5	6E	6W	10E	11	7CS	7CN	7WR	7E	8	9	12NE	12SW
2017-4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017-5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2017-6		-	-	-	-	-	-	-	-	-	21	-	-					-	-
2017-7	174	-	-	-	-	-	-	-	-	-		-	-	12				-	-
2017-8		-	-	-	-	-	-	-	-	-	-							-	-
2017-9		-	-	-	-	-	-	-	-	-	-	45						-	-
2017-10		-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
2017-11		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2018-5		-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-
2018-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2018-7	174	-	-	-	-	-	-	-	-	-	-		-	12				-	-
2018-8		-	-	-	-	-	-	-	-	-	21	-						-	-
2018-9		-	-	-	-	-	-	-	-	-		-	23					-	-
2018-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2018-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2019-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2019-5		-	-	-	-	-	-	-	-	-	21	23	-	-	-	-	-	-	-
2019-6		-	-	-	-	-	-	-	-	-			-					-	-
2019-7	174	-	-	-	-	-	-	-	-	-	-		-	12				-	-
2019-8		-	-	-	-	-	-	-	-	-	-	-						-	-
2019-9		-	-	-	-	-	-	-	-	-	-	-	23					-	-
2019-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2019-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2020-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2020-5		-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-
2020-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2020-7	174	-	-	-	-	-	-	-	-	-	-		-	12				-	-
2020-8		-	-	-	-	-	-	-	-	-	21	-						-	-
2020-9		-	-	-	-	-	-	-	-	-		-	23					-	-
2020-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2020-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2021-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2021-5		-	-	-	-	-	-	-	-	-	21	23	-	-	-	-	-	-	-
2021-6		-	-	-	-	-	-	-	-	-			-					-	-
2021-7	174	-	-	-	-	-	-	-	-	-	-		-	12				-	-
2021-8		-	-	-	-	-	-	-	-	-	-	-						-	-
2021-9		-	-	-	-	-	-	-	-	-	-	-	23					-	-
2021-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2021-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2022-4		-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-
2022-5		-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-
2022-6		-	-	-	-	-	-	-	-	-	-		-					-	-
2022-7	174	-	-	-	-	-	-	-	-	-	-		-	12				-	-
2022-8		-	-	-	-	-	-	-	-	-	21	-						-	-
2022-9		-	-	-	-	-	-	-	-	-		-	23					-	-
2022-10		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
2022-11		-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-

Table 7

Sei whales - number of samples on body length and sexual maturity by JARPNII.

Research year	Total	Sub-areas 7	8	9	Research year	Total	Sub-areas 7	8	9
2002-5		-	-	-	2010-5		-	-	-
2002-6		-	-	-	2010-6		10	9	18
2002-7	39	-	4	32	2010-7	100	-	6	29
2002-8		-	-	-	2010-8		-	-	28
2002-9		-	3	-	2010-9		-	-	-
2003-5		-	3	-	2011-5		-	-	-
2003-6		1	16	11	2011-6		-	5	26
2003-7	50	4	-	12	2011-7	95	-	11	11
2003-8		-	-	3	2011-8		1	13	28
2003-9		-	-	-	2011-9		-	-	-
2004-5		-	-	-	2012-5		-	-	-
2004-6		-	2	9	2012-6		-	31	21
2004-7	100	-	-	36	2012-7	100	-	3	45
2004-8		-	-	27	2012-8		-	-	-
2004-9		-	-	26	2012-9		-	-	-
2005-5		-	12	5	2013-5		-	-	-
2005-6		-	3	41	2013-6		-	-	-
2005-7	100	-	16	17	2013-7	100	-	-	-
2005-8		-	-	6	2013-8		-	10	36
2005-9		-	-	-	2013-9		-	-	54
2006-5		-	-	-	2014-5		-	3	13
2006-6		1	19	19	2014-6		-	10	49
2006-7	100	4	29	5	2014-7	90	-	8	7
2006-8		-	-	23	2014-8		-	-	-
2006-9		-	-	-	2014-9		-	-	-
2007-5		-	16	22	2015-5		-	-	-
2007-6		2	2	23	2015-6		-	7	-
2007-7	100	4	6	16	2015-7	90	-	10	44
2007-8		-	-	9	2015-8		-	-	29
2007-9		-	-	-	2015-9		-	-	-
2008-5		-	-	-	2016-5		4	6	12
2008-6		-	24	35	2016-6		-	4	48
2008-7	100	-	9	15	2016-7	90	-	16	-
2008-8		-	-	17	2016-8		-	-	-
2008-9		-	-	-	2016-9		-	-	-
2009-5		-	11	18					
2009-6		-	1	38					
2009-7	100	-	19	13					
2009-8		-	-	-					
2009-9		-	-	-					

Table 9

Sei whales - number of age data by JARPNII.

Research year	Total	Sub-areas 7	8	9	Research year	Total	Sub-areas 7	8	9
2002-5		-	-	-	2010-5		-	-	-
2002-6		-	-	-	2010-6		5	4	14
2002-7	39	-	2	23	2010-7	100	-	5	20
2002-8		-	-	-	2010-8		-	-	22
2002-9		-	1	-	2010-9		-	-	-
2003-5		-	1	-	2011-5		-	-	-
2003-6		-	11	8	2011-6		-	4	16
2003-7	50	3	-	9	2011-7	95	-	9	8
2003-8		-	-	2	2011-8		-	8	24
2003-9		-	-	-	2011-9		-	-	-
2004-5		-	-	-	2012-5		-	-	-
2004-6		-	-	8	2012-6		-	22	16
2004-7	100	-	-	18	2012-7	100	-	2	27
2004-8		-	-	18	2012-8		-	-	-
2004-9		-	-	15	2012-9		-	-	-
2005-5		-	9	4	2013-5		-	-	-
2005-6		-	3	25	2013-6		-	-	-
2005-7	100	-	11	12	2013-7	100	-	-	-
2005-8		-	-	4	2013-8		-	6	21
2005-9		-	-	-	2013-9		-	-	39
2006-5		-	-	-	2014-5		-	3	8
2006-6		1	8	8	2014-6		-	7	39
2006-7	100	2	10	-	2014-7	90	-	6	6
2006-8		-	-	11	2014-8		-	-	-
2006-9		-	-	-	2014-9		-	-	-
2007-5		-	11	15	2015-5		-	-	-
2007-6		2	2	16	2015-6		-	4	-
2007-7	100	1	3	6	2015-7	90	-	7	24
2007-8		-	-	3	2015-8		-	-	18
2007-9		-	-	-	2015-9		-	-	-
2008-5		-	-	-	2016-5		-	-	-
2008-6		-	14	20	2016-6		-	-	-
2008-7	100	-	4	8	2016-7	90	-	-	-
2008-8		-	-	8	2016-8		-	-	-
2008-9		-	-	-	2016-9		-	-	-
2009-5		-	8	11					
2009-6		-	1	29					
2009-7	100	-	12	10					
2009-8		-	-	-					
2009-9		-	-	-					

Table 8

Sei whales - number of samples on body length and sexual maturity by NEWREP-NP.

Research year	Total	Sub-areas 7	8	9
2017-5				
2017-6				
2017-7	140		140	
2017-8				
2017-9				
2018-5				
2018-6				
2018-7	140		140	
2018-8				
2018-9				
2019-5				
2019-6				
2019-7	140		140	
2019-8				
2019-9				
2020-5				
2020-6				
2020-7	140		140	
2020-8				
2020-9				
2021-5				
2021-6				
2021-7	140		140	
2021-8				
2021-9				
2022-5				
2022-6				
2022-7	140		140	
2022-8				
2022-9				

Table 9

Sei whales - number of age data by NEWREP-NP.

Research year	Total	Sub-areas 7	8	9
2017-5				
2017-6				
2017-7	140		90	
2017-8				
2017-9				
2018-5				
2018-6				
2018-7	140		90	
2018-8				
2018-9				
2019-5				
2019-6				
2019-7	140		90	
2019-8				
2019-9				
2020-5				
2020-6				
2020-7	140		90	
2020-8				
2020-9				
2021-5				
2021-6				
2021-7	140		90	
2021-8				
2021-9				
2022-5				
2022-6				
2022-7	140		90	
2022-8				
2022-9				

Morning Paper, 3 February 2017: Issues raised of non-lethal techniques and sample sizes (Responses to questions from one Panel member)

(1) Improving the feasibility of non-lethal technique is not one of the objectives of NEWREP-NP. Rather, it is a challenge for the whole SC. However, we will continue our efforts in the feasibility study regarding non-lethal techniques with the intention to contribute to the IWC SC efforts in this field.

(2) The effort to be allocated to the feasibility study on biopsy sampling of common minke whale under the NEWREP-NP will depend on the results of the analyses recommended by the Review Panel. Results from some preliminary analyses were presented as a Morning Paper of 31 January 2017.

(3) Only experienced persons participated (and will participate) in the feasibility study (see Morning Paper of 31 January 2017).

(4) The design and results of the Icelandic exercise will be taken into account in the design, implementation and interpretation of results of the NEWREP-NP feasibility studies. However the biological and oceanographic conditions in the western North Pacific and eastern North Atlantic are different, and therefore region-specific design and results are to be expected.

(5) The types of analyses to be conducted are similar to those already presented to the Review Panel (see Morning Paper of 31 January 2017).

Report of the Planning Meeting for the 2017 IWC-POWER Cruise in the North Pacific with Initial Discussions for the 2018 and 2019 Cruises

Report of the Planning Meeting for the 2017 IWC-POWER Cruise in the North Pacific with Initial Discussions for the 2018 and 2019 Cruises[1]

The meeting was held in Tokyo from 15-17 September 2016. The list of participants is given as Annex A.

1. OPENING REMARKS AND WELCOMING ADDRESS

Kato (as Convenor) and Okazoe (on behalf of the Fisheries Agency of Japan) welcomed participants to Tokyo and to the meeting.

Okazoe noted that the seventh IWC-Japan Joint Cetacean Sighting Survey Cruise (IWC-POWER) had been completed successfully with the return of the vessel on 30 August 2016. On behalf of the Fisheries Agency of Japan, he thanked all the researchers who participated in the cruise and also the Government of the USA for issuing the research permit in its EEZ. He also welcomed the participants in the planning meeting and expressed his wish to have a good discussion in preparation for the next three cruises in the Bering Sea.

On behalf of the IWC, Donovan expressed his pleasure at once again being present at such a meeting. He particularly wished to thank the organisers for providing the excellent facilities in the Japanese Fisheries Agency Crew House. He also wanted to express continued appreciation to the ship's crew on behalf of the researchers; their cooperation on the cruises is essential for the continued success of the research. The IWC-POWER cruises are extremely important to the IWC; a considerable amount of very valuable information is being accrued (e.g. see Annex D) and the programme continues to provide an excellent example of international cooperation. He looked forward to a successful planning meeting for the 2017 cruise as well as discussions on the 2018 and 2019 cruises – the three together will provide a comprehensive cover of the Bering Sea and complete the first phase of the IWC-POWER programme.

The meeting was pleased to note that this year it had been possible for Semii and Tsuda (Chief Radio Operators) of Kyodo Senpaku Co. Ltd. were able to be present on the final day. Crew members are welcome at all planning meetings where their practical experience is extremely valuable.

2. APPOINTMENT OF CHAIR AND RAPPORTEURS

Kato was elected Chair. Clapham and Donovan acted as rapporteurs, with assistance from Matsuoka.

3. ADOPTION OF AGENDA

The agreed Agenda is given as Annex B.

4. ORGANISATION OF MEETING

Kato thanked the organisers for providing such excellent facilities.

5. REVIEW OF AVAILABLE DOCUMENTS

Documents available are listed in Annex C.

[1]Presented to the Scientific Committee as SC/67a/Rep02.

6. REVIEW OF DISCUSSIONS AT IWC/66B

Donovan noted that the report of last year's Technical Advisory Group (IWC, 2017a) had been taken into account in the discussions and recommendations made at the Scientific Committee meeting. He provided a brief summary of the recommendations of the Committee relevant to the 2017-19 period. Details are provided under the relevant agenda items below. Perhaps the most important recommendation for the Planning Meeting was that the plan to cover the Bering Sea between 2017-19 was endorsed (see Fig. 1) as well as the use of passive acoustic monitoring using sonobuoys. Logistical details and planning of blocks, strata and cruise tracks was referred to this Planning Meeting.

Matsuoka (Cruise Leader) reported that the 7th annual IWC-POWER cruise was successfully conducted between 02 July to 30 August, 2016 in the central North Pacific (north of 20°N, south of 30°N, between 160°W and 135°W including US EEZ – see Fig. 2) using the Japanese Research Vessel *Yushin-Maru No.3*. Survey coverage was 97.2% and a total of 2,237.5 n.miles was surveyed in the research area in the Passing with abeam closing mode (NSP) and the Independent Observer passing mode (IO). Additionally, 626.2 and 580.1 n.miles were surveyed during transit to and from the research area respectively. Sightings of: blue (1 school/1 individual), sei (1/1), Bryde's (28/32), sperm (32/125), Cuvier's beaked (2/5), *Mesoplodon* spp. (2/3), *Ziphiidae* (7/11), short finned pilot (2/31), pygmy killer (1/16) whales; Risso's (2/19), bottlenose (1/37), common (8/217), striped (5/378) and spotted (1/133) dolphins were observed.

6.1 Progress during the intersessional period

6.1.1 Distance and angle experiments

Distance and Angle Experiments (DAE) are a routine component of line transect surveys because possible biases in distance and angle observations cause over-/under-estimation of the effective strip width and hence of the population density/abundance. About eight observers were subject to the DAE before/during IWC-POWER sighting surveys, and the observers were not informed of their performance.

At the TAG meeting last year, some issues were raised for the DAE, primarily related to: (i) if there is homogeneity/heterogeneity in performance of measurements across observers; and (ii) if there is any difference between results of DAE with newly equipped GPS approach and the conventional radar system. In IWC-POWER cruises, a conventional radar system has been used for measuring the true distance and angle to the target object until last year. Intersessionally, a voluntary working team consisting of Kitakado and his students group (Katayama, Murata, Otsuyama, Zhou, Chiba, Seike and Ga), called 'Team DAE', was established and conducted analyses for examining the above issues by developing better statistical models. Katayama provided an excellent summary of the preliminary results given the limited time. At this stage only the perpendicular distance data (not the direct distances and angles) have been analysed.

The team firstly investigated basic measurement error models to account for linearity and nonlinearity in the 'bias' of observed errors with respect to the true distance. Two

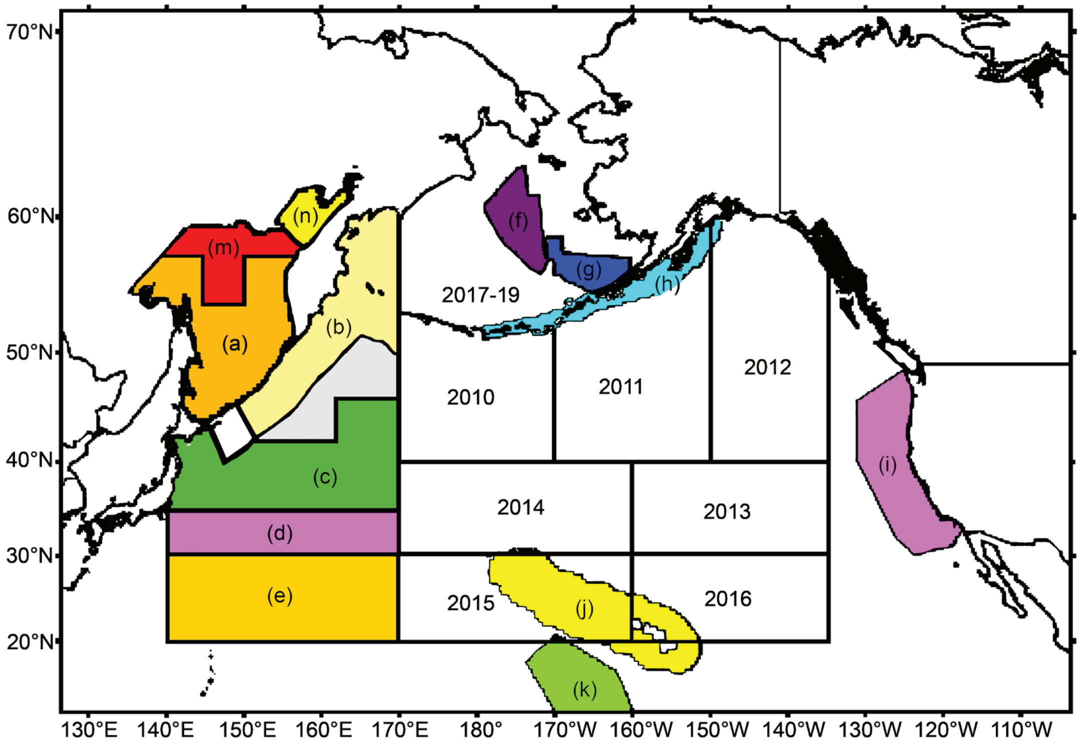


Fig. 1. Schematic showing the proposed areas for coverage in the 2016-19 period prior to the medium term period. Coloured areas represent surveys conducted in the North Pacific in recent years: (a) Miyashita and Berzin (1991); (b) Miyashita (2006); (c) Pastene *et al.* (2009); (d) Matsuoka *et al.* (2013); (e) Matsuoka *et al.* (2014); (f) Moore *et al.* (1999); (g) Moore *et al.* (2002); (h) Zerbini *et al.* (2007); (i) Barlow and Forney (2007); (j) (Barlow (2006a); Bradford *et al.* (2013); (k) Barlow (2006b); (l) Rone *et al.* (2016); (m) Myasnikov *et al.* (2016); and (n) Guschcherov *et al.* (to be submitted to SC/67a).

variance structures in the observation were tested. Platform effects (Top/IO or Bridge) were also incorporated into the model. The parameters were estimated with the maximum likelihood method and model selection was performed by the AIC. Secondly, a hierarchical model was developed to account for observer effects (here assumed as random effects) for better estimation of parameters in the model as well as for comparison of overall performance among years. For this purpose, Bayesian estimation with an MCMC algorithm was employed. In addition, comparison of difference between results of DAE with GPS and radar systems were conducted using 2015 data, where the both of systems were used in the experiment.

As a result, a straight line intersecting at the origin was selected as the best model for the expectation of perpendicular distance (PD) although it was quite similar with other estimated nonlinear curve. A model with standard error depending on the true PD was selected. These outcomes are not counterintuitive, but the platform effects were not necessarily significant in some years. Regarding the observer effects, the posterior distributions showed that inter- and intra- observer effects differed among years (e.g. the observer effect looks significantly large in 2010, but it is not the case in 2013). Finally, whilst it is better is to use GPS comparison of the results shows that they are similar and thus the results of the previous experiments with the radar have an acceptable quality.

The meeting thanked Team DAE for these preliminary results and encouraged further work. In particular, it noted the importance of:

(1) considering both platform and observer effects;
(2) examining both radial distance and angle data;
(3) examining the performance of the same observers across years;

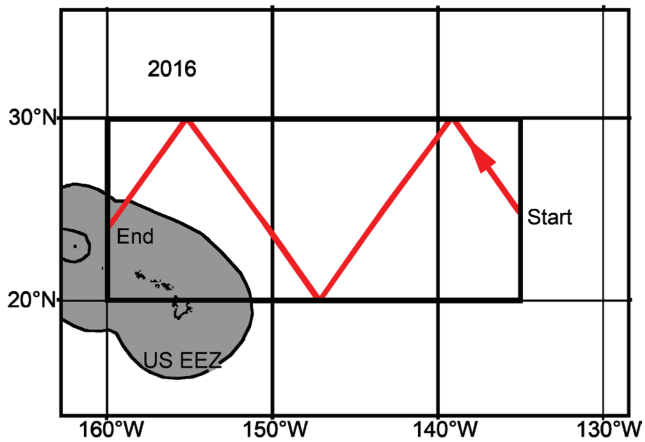


Fig. 2. The 2016 research area (black bold line) and pre-determined trackline (red) with start and end points.

(4) taking into account environmental conditions should there be sufficient data to do so; and
(5) examining the impact of the errors with respect to abundance estimation.

6.2 Update on future work plan

It was agreed that this would be provided by Kitakado with assistance from Donovan after the meeting.

7. PRELIMINARY RESULTS FROM THE 2016 CRUISE

The Estimated Angle and Distance Training Exercises and Experiments were completed with improvements following Scientific Committee and Technical Advisory Group suggestions. Photo-identification data for 12 Bryde's whales, 2 sperm whales were collected. A total of 23 biopsy (skin and blubber) samples was collected from 1 blue, 1 sei, 16 Bryde's whales and 5 sperm whales using the Larsen-system. A total of 153 objects of marine debris items were observed.

The meeting thanked Matsuoka, as Cruise Leader, the researchers and the crew, for their hard work that had made the cruise a success, especially the great efforts made to conduct as much IO mode as possible and to improve the distance and angle experiments. It noted that the lack of sightings of Bryde's whales in the research area, whilst disappointing for the researchers on the vessel, was an extremely valuable piece of scientific information. It also noted the sightings of both sei and Bryde's whales at a similar latitude (around 38°N). It congratulated Matsuoka and his colleagues on producing such a comprehensive report at such short notice.

The meeting **agreed** that a final definitive version of the Cruise Report would be prepared for circulation to steering group members for their comments, noting that final responsibility for the report rests with the authors.

8. AVAILABILITY OF RESEARCH VESSELS

8.1 Research vessel offered by Japan

Okazoe noted that while a *Yushin-Maru No.3*-type vessel will be available, the Fisheries Agency of Japan is still discussing the possibility of getting the status of an international vessel. A final decision on whether the vessel will be able to get the international status for the cruise next year will be made during September 2016. He expressed his hope to share the decision with the participants soon after the planning meeting. Discussions are also underway with Kyodo Senpaku Co. Ltd. with respect to the addition of an extra cabin to allow for an additional researcher.

As noted in the draft initial proposal developed by Japanese scientists for the period 2017-19, if international vessel status is obtained this will allow refuelling and provisioning of the vessel in foreign ports with an extension of the time the vessel can be away from its home port. The maximum period that the vessel can be away without refuelling is 60 days – with international status it will be possible for the vessel to be away for 85 days with a maximum of 60 days in the research area (without this the time in the research area will be around 20 days less).

The Planning Meeting **greatly appreciated** the consideration of this issue by the Government of Japan and **strongly encouraged** obtaining international status and having space for one more researcher. It **stressed** the considerable benefits to the IWC-POWER programme not only for the 2017-19 period but for the medium to long-term programme. These benefits include:

(a) the ability to improve coverage by about 30% - the concomitant increased sample size will lead to *inter alia* more precise and accurate abundance estimates which will increase the power of the surveys to estimate trends, should they occur;
(b) the ability to take advantage of developments in acoustic technology to improve understanding of distribution of several species, assist with studies of rare and endangered species/populations (e.g. North Pacific right whales) by improving the ability to detect and find them for targeted studies;
(c) the ability to expand the studies undertaken at present (e.g. to take into account other habitat-related work to improve understanding of spatial distribution and interpret possible trends) and to test and use new technologies e.g. drones, telemetry to improve the ability of the cruises to meet the agreed objectives of the programme; and
(d) to include scientists from more range states on the cruises to improve capacity within the region.[2]

8.2 Other possibilities

The meeting was informed that there were no dedicated US or Russian cetacean cruises expected in the Bering Sea in 2017.

9. PRIORITY FOR THE 2016 CRUISE

The meeting confirmed that the 2017 cruise objectives would be broadly the same as in previous years with the important addition of an acoustic component, as endorsed by the Scientific Committee. Thus the cruise will focus on the collection of line transect data to estimate abundance as well as collection of acoustic, biopsy and photo-identification data. This will make a valuable contribution to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific in a number of ways, including providing:

(a) information for the in-depth assessments of North Pacific sei, humpback and gray whales in terms of abundance, distribution and stock structure;
(b) information on the critically endangered North Pacific right whale population in the eastern Pacific;
(c) completion of coverage of the northern range of fin whales following on from the IWC-POWER cruises in 2010-12;
(d) baseline information on distribution, stock structure and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(e) essential information for the development of the medium-long term international programme in the North Pacific in order to meet the Commission's long-term objectives.

10. REVIEW OF THE BUDGET

The meeting **noted** the discussions under Item 8.1 regarding vessel availability and length of the cruise.

The detailed budget for expenditure of Commission funds is provided in IWC (2017b). The Scientific Committee has requester £38,000 for the years 2017 and 2018.

Donovan reiterated the importance of the POWER programme to the Scientific Committee and the Commission.

11. CRUISE PLAN

11.1 Priorities and allocation of research effort

The broad priorities for 2017, most of which are also applicable to 2018 and 2019, are given under Item 9. Taking into account the likely weather in the regions, the Meeting agreed that it was reasonable to plan for the vessel being

[2]After the meeting, the TAG was informed that the Government of Japan decided that:
- *Yusin-Maru No.2* will be engaged for the 2017 (-2019) POWER cruises, with international status;
- for the 2017-2019 cruise plan using Dutch Harbor port, a total of maximum 85 days for the entire cruise from Japan to Japan is available, including 60 days for the research area, as proposed in the planning meeting (Tables 1-3). For only 2017 cruise, vessel will depart from Shimonoseki; and
- for the 2018 or 2019 cruise plan using Petropavlovsk-Kamchatskiy port, a total of maximum 76 days for the entire cruise from Japan to Japan is available, including 60 days for the research area, as proposed in the planning meeting (Table 3, option 2).

able to cover 40 n.miles per day in the research area. Given that decisions have yet to be made regarding the vessel and the length of the survey (see Item 8.1) it is not possible to finalise precise details of transit times and the allocation of the research effort.

In the discussions below, it is assumed that the vessel will be upgraded to be able to enter international ports and the total at sea period will be 85 days (this longer period will only be possible if the vessel used has international clearance as it will allow for refuelling and obtaining new supplies). If this is not the case, the cruise will be limited to 60 days. The Meeting **authorised** the Steering Group is authorised to modify the proposed tracklines and itinerary as necessary by correspondence.

Table 1

Revised proposed itinerary for the 2017 IWC-POWER cruise in the eastern Bering Sea assuming 85 days (see text). For reasons of refuelling and supplies the maximum time in the research area will be about 60 days.

Date	Event
3 July 2017	Vessel departs Shimonoseki
13 July	Vessel arrives Dutch Harbor, Unalaska Island, Alaska, USA
15 July	Pre-cruise meeting
16 July	Vessel leaves Dutch Harbor (60 days in the research area)
18 July	Vessel start the survey in the research area
08 September	Vessel completes the research area
13 September	Vessel arrives Dutch Harbor
15 September	Post-cruise meeting
16 September	Vessel leaves Dutch Harbor
25 September	Vessel arrives Shimonoseki

Table 2

Revised proposed itinerary for the IWC-POWER cruise in the central Bering Sea assuming 85 days (see text). For reasons of refuelling and supplies the maximum time in the research area will be about 60 days.

Date	Event
3 July 2018 or 2019	Vessel departs Shiogama
12 July	Vessel arrives Dutch Harbor, Unalaska Island, Alaska, USA
15 July	Pre-cruise meeting
16 July	Vessel leaves Dutch Harbor (60 days in the research area)
20 July	Vessel start the survey in the research area
07 September	Vessel completes the research area
13 September	Vessel arrives Dutch Harbor
15 September	Post-cruise meeting
16 September	Vessel leaves Dutch Harbor
25 September	Vessel arrives Shiogama

11.2 Itinerary

To minimise transit time, maximise research time and minimise the period of time that researchers have to spend on the vessel (thus maximising the benefit of the budget in terms of activity in the research area), the proposed home port for the eastern (2017) and central (either 2018 or 2019, see below) blocks is Dutch Harbor. For the western block in the waters of the Russian Federation, two options are given related to permitting issues, one using Petropavlovsk-Kamchatskiy on the Kamchatka peninsula and the other using Dutch Harbor (noting the need not to cross US-Russia borders for permitting purposes the former is preferred). The proposed itineraries (see discussion under Item 11.1 for assumptions) are shown in Tables 1-3.

11.3 Research area

The research area proposed for the 2017-19 period and agreed by the Scientific Committee is shown in Fig. 3. After some discussion the meeting **agrees** with the boundaries for the eastern, central and western blocks which were based largely upon practical considerations of EEZs and research coverage.

11.4 Research vessel

As noted in footnote 1, after the meeting it was agreed that *Yushin-Maru No. 2* with international clearance will be available. Specifications are given in Table 4.

11.5 Other matters

There were no matters to discuss under this item.

12. DETAILS OF THE CRUISE

12.1 Cruise track design

The Meeting reviewed a draft proposal for cruise track design for the 2017, 2018 and 2019 surveys developed using program DISTANCE (Ver. 6.2) The lines were reviewed in the light of the guidelines for good track design included in the Requirements and Guidelines for Surveys under the RMP (IWC, 2012), and in particular the need to take into account the distribution of priority species and the objectives of the survey, the need to ensure that lines did not follow features that might result in a bias (e.g. by following a coastline where the density of whales decreased with distance from the coast), as well as practical considerations such as time that would need to be spent on transit. As the initial proposals for each block did not meet these criteria, program DISTANCE was used to provide some alternative options which did.

Table 3

Revised proposed itinerary for the IWC-POWER cruise in the western Bering Sea assuming 85 days (option 1) and 76 days (option 2, see text). For reasons of refuelling and supplies the maximum time in the research area will be about 60 days for both option. Two options are provided for the homeport although the Kamchatka port is preferred will depend on permitting (see text).

Option 1		Option 2	
Date	Event	Date	Event
3 July 2018 or 19	Vessel departs Shiogama	12 July 2018 or 19	Vessel departs Shiogama
12 July	Vessel arrives Dutch Harbor	17 July	Vessel arrives Petropavlovsk-Kamchatskiy
15 July	Pre-cruise meeting	19 July	Pre-cruise meeting
16 July	Vessel departs Dutch Harbor	20 July	Vessel departs Petropavlovsk-Kamchatskiy
20 July	Vessel starts survey in research area	25 July	Vessel starts survey in research area
07 September	Vessel completes the research area	15 September	Vessel completes the research area
13 September	Vessel arrives Dutch Harbor	17 September	Vessel arrives Petropavlovsk-Kamchatskiy
15 September	Post-cruise meeting	19 September	Post-cruise meeting
16 September	Vessel leaves Dutch Harbor	20 September	Vessel leaves Petropavlovsk-Kamchatskiy
25 September	Vessel arrives Shiogama	25 September	Vessel arrives Shiogama

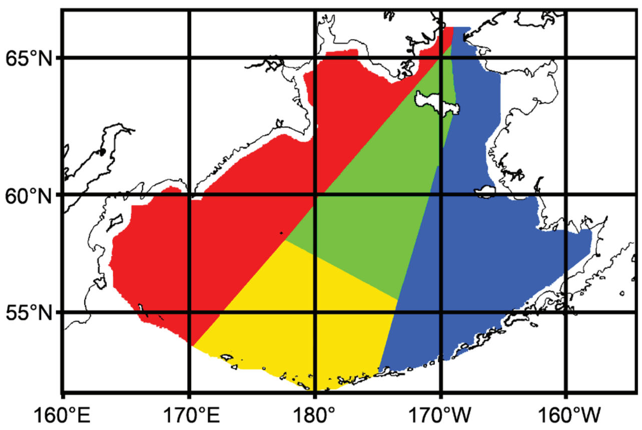


Fig. 3. Survey blocks and strata for the 2017-19 IWC-POWER cruises (Western, Eastern and Central blocks). The Central block was divided into northern and southern strata so that area sizes are as similar as possible. The suggestion is that the Eastern block is covered in 2017, the Central in 2018 and the Western in 2019.

Table 4

Specifications for *Yushin-Maru No. 2.*

Call sign	JPPV
Length overall	69.61m
Gross tonnage	747
Barrel height (m)	19.5m
IO Barrel height	13.5m
Upper bridge height	11.5m
Bow height (m)	6.5m
Engine power	5,280/3,900(PS/kW)

The meeting **agreed** the cruise track designs shown in Fig. 4 for the three blocks assuming that international clearance is obtained (see Items 8.1 and 11.1). It recognised that there may need to be modification of the tracks for the eastern block following review of the initial draft of a formal proposal (see below).

As there is no expected migration of large whales during the survey period, it was **agreed** that the cruise leader will decide on the direction of each survey depending upon weather or other logistics, including minimising transit distance from the home port. For the 2017 eastern survey, a south-to-north survey should be conducted if the weather was favourable at the beginning; if weather is poor, transit to the north followed by a north-to-south survey would be preferable. *Inter alia,* this would offer the best chance to survey North Pacific right whale critical habitat in good weather. For the Central block, the optimum strategy would be to travel north-to-south.

12.2 Survey mode and research hours

Activities are classified into two principal groups: 'on-effort' and 'off-effort'. On-effort activities are times when full search effort is being executed and conditions (such

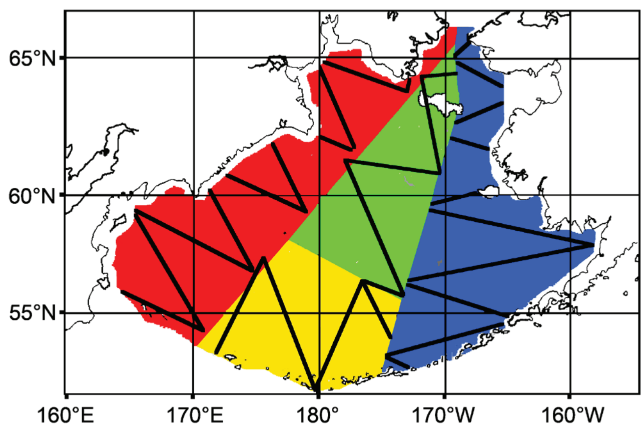


Fig. 4. Proposed tracklines for the three blocks under the assumptions noted in Item 11.1.

as weather and sea conditions) are within acceptable parameters to conduct research. Off-effort activities are all activities that are not on-effort. All sightings recorded while the ship is on-effort are classified as primary sightings. All other sightings are secondary sightings. The meeting re-iterated that if sightings are made outside official research hours (e.g. before sightings effort begins in the morning), then these should be recorded as 'off-effort' sightings as they can contribute useful information on distribution even though they are not suitable for abundance estimation.

For the 2017-19 surveys, following advice from the Scientific Committee and the TAG, the survey will alternate modes between Normal Closing Mode (NSP) and Independent Observer Mode (IO) (*ca* every 50 n.miles). However, in the Bering Sea many high density areas of large whales (e.g. fin, humpback whales) are expected. When the high density of whales in the area causes problems for the observers in discriminating between the same and different schools while conducting IO mode survey, searching mode will be changed to NSP.

Research hours during the cruise will be the same as on previous POWER cruises. This will involve a maximum 12 hours per day between 6:00 and 19:00, including 30 minutes for meal times (lunch and supper) during only IO mode. Days will begin 60 minutes after sunrise and end 60 minutes before sunset. As in the SOWER programme, for biopsy sampling/photo-identification work on priority species (see Item 12.8), there may be occasions when it is beneficial to extend the research activities outside the normal research hours. The basis for any such extension of research hours will involve mutual agreement between the captain and cruise leader and an allocation of equivalent time-off the following morning or evening.

The research day in transits will begin 30 minutes after sunrise and end 30 minutes before sunset, with a maximum of a 12-hour research day. Time-zone changes will be in 30-minute intervals, coming into effect at midnight.

In transit, the research day will begin 30 minutes after sunrise and end 30 minutes before sunset, with a maximum of a 12-hour research day. Time-zone changes will be in 30-minute intervals, coming into effect at midnight.

12.3 Number of crew on effort

As in the previous cruises, two topmen will observe from the barrel at all times in passing mode. Two primary observers will be in the barrel whenever full searching effort using reticle binoculars and angle board is conducted. Two primary observers (Captain and helmsman) will be at the upper bridge with binoculars with reticles, regardless of the research mode. Also present on the upper bridge, whenever the sighting survey is conducted, will normally be the Chief Engineer (or an alternate). With four researchers on board, the Cruise Leader should ensure that the number of researchers searching from the upper bridge is standardised. In IO mode, there would be an additional person in the IO platform (e.g. researcher). The number of researchers to be used is discussed further in Item 13.1 below.

12.4 Navigation and research speeds

As in 2016, 11.5 knots (through the water) will be maintained during research. It was noted that in conditions of heavy swell, searching speed might have to be reduced.

12.5 Acceptable weather conditions

In accord with the recommendation of the 2013 TAG report, the usual guidelines will apply, i.e. visibility (in principle for seeing common minke whales) >2.0 n.miles; wind speed <21 knots; sea state <Beaufort 6. These conditions are not suitable to reliably see common minke whales but are sufficient for the other large whale species.

12.6 Estimated angle and distance experiment

The experiment is designed to calibrate and identify any biases in individual observers' estimation of angle and distance. The experiment should be conducted during weather and sea conditions representative of the conditions encountered during the survey. Following the TAG recommendations, procedure of this experiment was improved from 2015 cruise; (1) use of relatively inexpensive GPS technology (for a waterproof tough model) on the buoy to improve detectability: (a) at greater distances; and (b) in more realistic sea/weather conditions than may be possible using the present radar system; (2) use of two buoys which can: (a) reduce the potential lack of independence with one buoy with the correct experimental protocols; and (b) allow increased efficiency which will assist when having a greater distance range and when including researchers as well as the crew in the experiment (multi-buoy experiments have been successfully conducted in the North Atlantic). With respect to the additional buoy, the TAG suggested that a smaller buoy than the one currently used (to simulate a whale's body rather than the blow) was provided on the vessel in 2015. The detailed protocol was discussed in the planning meeting and found in the Guide for Researchers.

12.7 Data format

The survey will be conducted using data forms modified in accordance with previous recommendations. The exception is that the old acoustics data forms from the SOWER cruises will be reviewed and updated intersessionally with advice from researchers at the Alaska Fisheries Science Center.

It was **agreed** that Donovan and Matsuoka should update the Guidelines for Researchers accordingly.

12.8 Biopsy sampling

12.8.1 Priority of species

The highest priority species for biopsy sampling are the North Pacific right whale, followed by the blue whale and the sei whale; all three are unlikely to be encountered often so when detected every effort should be made to obtain biopsy samples. The right whale population is critically endangered and may number only about 30 animals, and genetic information is urgently required. Blue whales are unlikely to be encountered except rarely, but are of considerable interest given their conservation status and uncertainty regarding population structure. Sei whale samples will contribute to the to the IWC's ongoing in-depth assessment. Also of high priority are gray whale given the IWC's ongoing basin wide assessment. Medium-priority species include sperm, fin and killer whales.

With respect to humpback whales, the priority is to obtain samples from animals encountered north of 60°N; the origin of the animals in this northern portion of the Bering Sea is unclear. In the southern Bering Sea, humpback whales have been sampled in previous years in large numbers; consequently, the species is considered low priority for biopsy in that area, although (as for other large whale species encountered) opportunistic samples are useful.

12.8.2 Equipment and collection

Biological sample collection will be by using biopsy sampling (skin/blubber collected by projectile dart). Projectile biopsies will be collected using either a compound crossbow or the Larsen gun system. During any single encounter, no more than five biopsy sampling attempts per individual will be made. It is rare that an animal would be targeted for biopsy more than twice during one encounter, but conservatively five sample attempts will be allowed as necessary. If signs of harassment such as rapid changes in direction, prolonged diving and other behaviours are observed from an individual or a group, biopsy will be discontinued on that individual or group. The animals to be sampled will either approach the vessel on their own or be approached by the research vessel during normal survey operations. The projectile biopsy sample will be collected from animals within approximately 5 to 30m of the bow of the vessel.

For large cetaceans, small samples (<1g) will be obtained from free-ranging individuals using a biopsy dart with a stainless steel tip measuring approximately 4cm in length with an external diameter of 9mm and fitted with a 2.5cm stop to ensure recoil and prevent deeper penetration (so that only 1.5cm of the tip is available to penetrate the animal). Between sample periods, the biopsy tips are thoroughly cleaned and sterilized with bleach following the established protocol. Biological samples may be collected from adults, juveniles, females with calves and calves. The same size biopsy dart would be used for calves as for adults. No biological samples will be taken from newborn calves. The age of a calf would be determined by the subjective judgment of the biologists who have 20+ years' experience in the field. They would (and would be instructed to) err on the side of caution and not biopsy an animal that appeared too young.

12.8.3 Keeping of samples

As for the 2015 cruise, all samples would be frozen and stored in cryo-vials. For at least the eastern and central blocks, each sample will be split into skin and blubber, the latter not being required for genetic analysis. For at least the eastern and central blocks, if possible under the US-Japan agreement with respect to CITES, the skin sample will be divided at sea with the IWC samples being retained at Dutch Harbor – the Japanese sample can remain onboard for storage by ICR. The blubber sample will be retained whole (i.e. not be split) and held at ICR; analyses of blubber (e.g. for contaminants, hormones, fatty acids) generally require larger amounts of tissue and splitting already small quantities may render such analyses impossible. The meeting **re-iterated** that the question of future analysis of blubber samples, and access to them by researchers, should follow the agreed procedure for accessing IWC samples (see *http://www.iwc.int*).

12.9. Photo-identification studies

As appropriate and decided by the Cruise Leader, research time will be given for photo-identification and /or video taping of large whales, with the priority by species as for biopsy sampling (see above). The estimated daily number of miles to be steamed in searching mode has a built-in allowance for such work. Generally, large whales will be approached within approximately 15-20m. Photo-identification of adult and juveniles will occur. If the opportunity arises, females accompanied by calves may be approached for photo-identification, but efforts will cease immediately if there is any evidence that the activity may be interfering with pair bonding, nursing, reproduction, feeding or other vital functions.

Recommended improvements to the equipment (based upon the 2015 and 2016 cruise reports) will be dependent on the resources available (see below).

12.9.1 Priority of species
The priorities follow those discussed for biopsy sampling agreed above.

12.9.2 Keeping of data
As noted last year, a master set of all photographs taken on the IWC-POWER cruises is kept at the IWC Secretariat within an Adobe Lightroom database; these are copyright of the IWC. Even if a researcher uses their own camera, the photographs remain the property of the IWC.

Photographs that have been examined and catalogued as individuals for identification purposes will also be archived within a set of IWC-POWER Catalogues. As discussed during the TAG meeting, it is important to share such information with other researchers working in the North Pacific through the IWC protocol (*http://www.iwc.int*) to apply for use of the photographs (available from the IWC Secretariat and is available through the IWC-POWER pages on the IWC website as well as via the Scientific Committee Handbook). The final decision on access is made by the IWC-POWER steering group. All researchers wishing to use the photographs must obtain formal permission from the Secretariat.

12.10 Acoustic studies
As recommended by the Scientific Committee, the meeting examined logistics and **agreed** that acoustic work using sonobuoys would be a priority for at least the eastern and central blocks, recognising permitting difficulties for the western block make use of sonobuoys unlikely.

Clapham presented information on the use and logistical requirements for sonobuoys, with the idea of conducting passive acoustic monitoring (PAM) on the 2017 and 2018 surveys. The meeting **endorsed** the Scientific Committee's recommendation to incorporate acoustic detection into the eastern and central surveys (IWC, 2017b), recognising that: (a) sonobuoy deployment does not require the vessel to slow down and so does not interrupt the visual survey; and (b) it can be conducted in all weathers and at night i.e. when visual surveying is impossible.

All necessary equipment will be provided by the Alaska Fisheries Science Center (AFSC), including sonobuoys, laptop computer, antennae, cables, and analytical software. AFSC would also provide a dedicated, experienced acoustic observer to conduct all acoustic monitoring operations on the cruise (see Item 13.2).

It was agreed that the general acoustic schedule will involve deployment of one sonobuoy every 3 hours, as well as one at night, leading to 6 buoys per day under good conditions. When drifting for fog, then no new deployment would be necessary unless the battery runs out. Thus the maximum number of sonobuoys required will be around 360 (6x60 days) but given the likely prevailing conditions, may be somewhat less.

The sonobuoys are shipped in crates of 48 (1.3m^2, 680kg) and thus allowing for possible failures, a maximum of eight crates will be required. In discussion, it was agreed that the crew will investigate the best way to store the sonobuoys on board.

It was **agreed** that Donovan, Matsuoka and Crance will confer to ensure that the Guidelines for Researchers are updated with an acoustics protocol and updated data records (and see Item 12.7). Crance will liaise directly with Japan regarding equipment specifications and practical details of installation including timing. In order to avoid problems with comparability with previous surveys and possible biases, the acoustic observer will not ordinarily transmit information to visual observers, except when high-priority species (right and blue whales) are detected.

Although the preferred position for the acoustic operator is in the bridge, if this is not possible having the equipment in a cabin is acceptable. It was **agreed** that technical details (including when, where and how to wire the vessel and antennae) will be handled by a small group comprising the Cruise Leader, crew and the acoustics expert. In terms of logistics, it is by far the simplest and most cost effective to load the sonobuoys in Dutch Harbor. If international clearance cannot be obtained, then considerable effort (and cost) will be needed to ship them safely to Japan although this is possible as witnessed by the previous experience with SOWER cruises.

12.11 Oceanographic studies
Since sufficient time cannot be devoted to oceanographic studies to collect worthwhile data, the meeting **agreed** with past conclusions that no such studies should be undertaken. Consideration can be given to external requests for simple sampling if considered practicable.

The meeting recalled that last year the TAG had agreed that the use of equipment such as SeaGliders should be considered when designing the medium-term programme. It noted that this will be facilitated by the ability to have a vessel with international clearance.

12.12 Satellite tagging
No activities are planned for the 2017 cruise. The TAG had agreed that the use of such equipment should be considered when designing the medium-term programme.

12.13 Marine debris
The meeting reiterated the importance of observations of marine debris in non-IWC contexts such as modelling the predicted movement of debris from the 2011 tsunami across the Pacific. The protocol adopted for recording such material (15 minutes in every hour) will continue in 2017 to prevent compromising cetacean sightings searching effort.

13. INTERNATIONAL RESEARCHERS AND ALLOCATION RESEARCH PERSONNEL

13.1 Number of researchers
As noted under Item 8.1, the meeting strongly recommended that, if possible, space be made for a fifth observer to allow for an acoustic observer to join the cruise without adversely affecting the workload of the researchers with respect to the line-transect, photo-identification and biopsy sampling components. Cabin-sharing by two researchers is a possible, although not an optimal short-term option. The meeting **agreed** that if five is not possible, one of the four researchers should be an acoustician, recognising that this reduction in the size places additional work upon the remaining researchers.

13.2 Nomination and allocation of researchers
For 2017 the following framework for researcher involvement was **agreed**:

(1) Japan (IWC-POWER range state, vessel provider, Matsuoka appointed Cruise Leader);
(2) USA (IWC-POWER range state, acoustic, Jessica Crance);
(3) IWC (Taylor, UK/USA, Secretariat contractor for photographic catalogue);
(4) Japan (IWC-POWER range state, Yoshimura); and
(5) Russia (IWC-POWER range state, to be confirmed).

14. GENERAL PREPARATIONS FOR THE 2017 CRUISE

14.1 Identification of the home port organiser
It was **agreed** that for Dutch Harbor, Crance would undertake this role. Alternative arrangements will be made by the Steering Group should Shiogama or Petropavlovsk-Kamchatskiy be the home ports.

14.2 Entry and other permits
The meeting noted that the 2017 cruise will be within the US EEZ and Okazoe undertook to file the necessary documents, including the need for biopsy sampling, within the necessary time limit (at least six months prior to the cruise).

A decision on whether or not the 2018 cruise will be in the central (US EEZ and high seas) or the western block (Russian EEZ) will depend on the availability of entry permits. Zharikov provided a valuable summary of the permit process for the Russian Federation (see Annex E).

As this will be the first time an IWC-POWER cruise will apply for permission to enter Russian waters it was agreed that it would be important to work closely with Russian authorities and scientific institutions to obtain advice. It was also agreed to apply for permission to work in both the western and central blocks in 2018; if a problem occurred with the application to work in Russian waters then the central block could be covered and the western block then surveyed in 2019 after re-application for the permit, correcting any errors.

Work to develop a permit application for Russian waters will begin as soon as possible to allow time for consultation (the formal application will be submitted in December 2017). The meeting noted and **strongly endorsed** the Scientific Committee's strong request for the Russian authorities to facilitate the permit process as part of its contribution to IWC-POWER. Zharikov and Donovan will discuss the matter further with the Russian Delegation at the forthcoming IWC Biennial Commission meeting.

A working group comprising Zharikov, Matsuoka, Okazoe, Brownell, Clapham and Donovan was established to begin work to develop entry permit requests for the western and central blocks and to develop the strategies for CITES permits under different scenarios of home ports etc.

14.3 Review of recommendations from the 2016 cruise
It was **agreed** that Donovan and Matsuoka would review the recommended items for purchase and decide what could be met from available funds. It was also noted that work to improve the ship's email system was underway.

15. IN TRANSIT SURVEY

15.1 Home port to research area and back
As for 2016, while recognising the need to move rapidly to and from the research area, the meeting **re-iterated** that should the opportunity arise, biopsy and photo-identification could be undertaken on right, gray and blue whales, in that order of priority for the high seas. It will not be possible for biopsy/photo-identification effort in US waters in transit as no US scientists will be on board. The CITES system for importing/exporting will be dealt with by the appropriate authorities. Standard passing mode will be adopted during transit and this will be noted on the permit application (see Items 12.2 and 12.3).

16. TRANSPORTATION OF DATA, SAMPLES AND EQUIPMENT

16.1 Equipment
Donovan and Matsuoka will arrange for additional Larsen darts to be obtained. Information for researchers will be updated by Matsuoka and Donovan in consultation with Crance.

16.2 Data and samples and necessary permits
Within two months of the end of the cruise, all validated sightings data will be forwarded to IWC by the Cruise Leader (Matsuoka). Matsuoka will also submit all identification photographs/videos and accompanying data to IWC. Crance will ensure that a hard drive of the acoustic data will be shipped to the IWC for archiving purposes. The Cruise Leader will ensure that any borrowed equipment (except IWC cameras and lenses) will be returned to its owners. The Cruise Leader and Crance will ensure that the IWC samples left in Dutch Harbor are sent to SWFSC in La Jolla, California, in accordance with the appropriate CITES provisions. NRIFS will be responsible for sending the IWC portion of any samples collected on the return high seas transit leg to SWFSC.

17. COMMUNICATIONS

17.1 Safety aspects (daily reports)
Daily vessel position reports will be submitted to ICR, NRIFS, the Fisheries Agency and Kyodo Senpaku Co Ltd. There will also be regular contact with the US Coast Guard by the US researcher.

17.2 Between the Cruise Leader and the IWC
As in previous years, weekly reports (every Monday) will be provided to the IWC Secretariat and members of the Steering Group.

The IWC Secretariat will establish a mailing list so that one address can be used for all.

17.3 Fog and sea temperature information
It was **agreed** that fog information will be required and Clapham will liaise with Matsuoka regarding obtaining the latest NOAA information, otherwise the same arrangements as in 2016 will apply.

17.4 Other official communication
Given that there will be operations within the US EEZ, arrangements will be made to comply with any requirements specified in the permit. The US researcher will be responsible for communicating with the US authorities.

17.5 Private communication
Researchers may send and receive private communications, including e-mails, at their own expense. Prepaid cards such as the KDDI card (super world card) can be used for private voice communications.

Table 5

Summary of actions including responsible persons and due dates.

Item	Action point	Responsibility	Due date
6	Develop updated future work plan based on previous TAG report	Kitakado and Donovan	Early 2017
7	Prepare definitive version of the Cruise Report for circulation to the steering group members	Matsuoka and authors	ASAP but certainly by SC/67a
11.1, 12.1	Modify proposed tracklines if necessary	Steering Group	ASAP
12.7; 12.10,	Update information for researchers and data sheets, especially with respect to acoustics	Matsuoka, Donovan and Crance	Spring 2017
13.2	Complete appointments for researchers for 2016 cruise	Kato, Donovan, Bannister, Matsuoka	ASAP, by early new year
12.9, 14.3, 16.1	Review list of recommended purchases from 2016 cruise and decide what could be bought with available funds	Donovan and Matsuoka	By SC/67a
14.2	Apply for US permits for 2017	Okazoe	End of 2016
14.2	Begin process for Russian permits and investigate CITES options	Zharikov, Matsuoka, Okazoe, Brownell, Clapham and Donovan	Begin early 2017
17.2	Establish a mailing list for the weekly reports including the steering group and Secretariat	Donovan/Miller	By early new year
21.2	Update website	Donovan/Wilson	ASAP

17.6 Terms of payment of communication costs

Private accounts must be paid by researchers before departing the home port at the end of the cruise. Payment must be in cash (Japanese yen or US dollars depending upon home port).

18. MEETINGS

18.1 Pre-cruise meeting

A pre-cruise meeting will be held in Dutch Harbor on 14 July 2017. In addition to the researchers and crew, at least all US members of the Steering Group are encouraged to attend.

The Cruise Leader will ensure that the report is circulated to the IWC-POWER Steering Group when completed.

18.2 Post-cruise meeting

The post-cruise meeting will be held at Dutch Harbor when the vessel return to the port.

18.3 Home port arrangements and responsible persons

Crance will co-ordinate the home port arrangements in Dutch Harbor in co-operation with the Cruise Leader. This will include arrangements for hotels and a meeting room. Agents will be organised by Kyodo Senpaku Co. Ltd. who will inform the home port organiser.

19. REPORTS

19.1 Planning meeting report

The agreed report will be tabled at the IWC/SC meeting in 2017.

19.2 2016 Cruise report

The 2016 cruise report was drafted on the return journey of the cruise following the guidelines provided by Donovan last year. As discussed in Item 7, that report will be circulated to the Steering Group before final preparation by the authors; the final version will be sent to the Secretariat for submission to the IWC Scientific Committee as in the past. The 2017 Cruise Report should be handled in the same way.

20. OTHER LOGISTICS

20.1 Press releases

As in 2016, the Cruise Leader in consultation with the IWC and the US will prepare a press release before and after the cruise. The IWC, ICR, US and Japan Fisheries Agency press releases should be released simultaneously. The IWC website will also include a press release pointing to the relevant IWC-POWER cruise web page; consideration will also be given to providing a weekly review of activities on the website as the cruise progresses, and a summary at the end of the cruise.

20.2 Security and safety

Based on previous experience, no security problems are anticipated. The IWC banner will be readily visible.

It was noted that for safety, life vests are to be worn for all activities below the bridge, e.g. during any operations on the foredeck, e.g. during biopsy sampling.

20.3 Accommodation and food costs

The IWC will cover the accommodation and food costs for the scientists involved; the cost (¥2,500 per day) remains unchanged from previous years.

20.4 Other matters

None were raised.

21. OTHER

21.1 Data validation and analysis

21.1.1 Validation

Work on data validation continues at the Secretariat. Where difficulties have arisen, these are being dealt with in cooperation with the Cruise Leader.

21.1.2 Killer whale samples

A request to use the IWC-POWER killer whale samples was approved.

21.2 IWC website

Donovan reported that the IWC-POWER pages will be updated in light of the present meeting and the Scientific Committee meeting.

22. CONCLUDING REMARKS

As last year, Kato noted that the 2016 cruise will complete the first stage of the POWER programme south of the Bering Sea. Future planning will need to take into account operations within the EEZs of both the USA and Russia, although for the latter only in years two and three.

A list of action points arising from the meeting is given as Table 5.

Kato thanked the meeting members for their participation and looked forward to a successful cruise in 2016.

On behalf of the IWC, Donovan thanked all those who had participated in the meeting. The IWC-POWER cruises are a particularly important component of the IWC's work. As the meeting has recognised, they are an excellent example of international collaboration. He stressed the importance of an enthusiastic and efficient crew, without whom the cruises could not succeed. He asked that the meeting's appreciation to the crew be conveyed to them. He thanked the Government of Japan for providing such excellent facilities, and in particular the Chair and the interpreters who had performed their difficult tasks with their customary efficiency and good humour. The meeting had been facilitated by the very good cruise report.

The meeting adopted the report, and concluded its business, at 13:50 hrs, 17 September 2016.

REFERENCES

Barlow, J. 2006a. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Mar. Mamm. Sci.* 22(2): 446-64.

Barlow, J. 2006b. Cruise report of the Pacific Islands Cetacean Ecosystem Assessment Survey (PICEAS 2005) by the NOAA ship McArthur II (Cruise number: AR-05-07), 28 April 2006. National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037, 23pp.

Barlow, J. and Forney, K. 2007. Abundance and population density of cetaceans in the California Current ecosystem. *Fish. Bull.* 105: 509-26.

Bradford, A.L., Forney, K.A., Oleson, E.M. and Barlow, J. 2013. Line-transect abundancxe estimates of cetaceans in the Hawaiian EEZ. PIFSC Working Paper WP-13-004.

International Whaling Commission. 2012. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2017a. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 7-9 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:459-76.

International Whaling Commission. 2017b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

Matsuoka, K., Hakamada, T. and Miyashita, T. 2014. Research plan for a cetacean sighting survey in the western North Pacific in 2014. [Paper available from the office of this Journal].

Matsuoka, K., Yoshimura, I. and Miyashita, T. 2013. Cruise report of the Japanese cetacean sighting survey in the western North Pacific in 2012. Paper SC/65a/O04 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 8pp. [Paper available from the Office of this Journal].

Miyashita, T. 2006. Cruise report of the sighting survey in the waters west of the Kuril Islands and the Kamchatka Peninsula in 2005. Paper SC/58/NPM5 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies. 9pp. [Paper available from the Office of this Journal].

Miyashita, T. and Berzin, A.A. 1991. Report of the whale sighting survey in the Okhotsk Sea and adjacent waters in 1990. Paper SC/43/O5 presented to the IWC Scientific Committee, May 1991 (unpublished). 14pp. [Paper available from the Office of this Journal].

Moore, S.E., Dahlheim, M.E., Stafford, K.M., Fox, C.G., Braham, H.W., MacDonald, M.A. and Thomason, J. 1999. Acoustic and visual detection of large whales in the eastern north Pacific Ocean. *NOAA Tech. Mem. NMFS* NMFS-AFSC-107: 27pp.

Moore, S.E., Waite, J.M., Friday, N.A. and Honkalehto, T. 2002. Cetacean distribution and relative abundance on the central–eastern and the southeastern Bering Sea shelf with reference to oceanographic domains. *Prog. Oceanog.* 55(1-2): 249-61.

Myasnikov, V.G., Vinnikov, A.V., Ryabov, A.A., Tyupeleev, P.A., Gushcherov, P.S., Samanov, V.I. and Miyashita, T. 2016. Cruise report of the cetacean sighting survey in the northern part of the Sea of Okhotsk in 2015. Paper SC/66b/IA17 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 25pp. [Paper available from the Office of this Journal].

Pastene, L.A., Hatanaka, H., Fujise, Y., Kanda, N., Murase, H., Tamura, T., Miyashita, T. and Kato, H. 2009. The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPN II): origin, objectives and research progress made in the period 2002-2007, including scientific considerations for the next research period. *Aquabiology* 33(2): 171-85. [In Japanese. English version available as: Paper SC/J09/JR1 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 73pp. [Paper available from the Office of this Journal].

Rone, B.K., Clapham, P.J., Weller, D.W., Crance, J.L. and Lang, A.R. 2016. North Pacific right whales and blue whales in the Gulf of Alaska: Results from a 2015 visual and acoustic ship survey. Paper SC/66b/BRG01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 11pp. [Paper available from the Office of this Journal].

Zerbini, A.N., Waite, J.M., Durban, J.W., LeDuc, R.G., Dahlheim, M. and Wade, P.R. 2007. Estimating abundance of killer whales in the nearshore waters of Alaska and Aleutian Islands using line transect sampling. *Mar. Biol.* 150(5): 1033-48.

Annex A

List of Participants

Robert Brownell
Southwest Fisheries Science Center
USA

Phillip Clapham
Alaskan Fisheries Science Center
USA

Greg Donovan
Head of Science
International Whaling Commission

Yulia Ivashchenko
Alaskan Fisheries Science Center
USA

Kenichi Hosone
Kyodo Senpaku Co., Ltd., Japan

Takashi Hakamada
Institute of Cetacean Research
Japan

Hidenori Kasai
Captain, Kyodo Senpaku Co., Ltd.
Japan

Hidehiro Kato
Tokyo University of Marine Science and Technology, Japan

Toshihide Kitakado
Tokyo University of Marine Science and Technology, Japan

Yoshimi Katayama
Tokyo University of Marine Science and Technology, Japan

Koji Matsuoka
Institute of Cetacean Research
Japan

Tomio Miyashita
National Research Institute of Far Seas Fisheries, Japan

Masakatsu Mori
Kyodo Senpaku Co., Ltd., Japan

Hiroyuki Morita
Fisheries Agency of Japan
MAFF, Japan

Naohito Okazoe
Fisheries Agency of Japan
MAFF, Japan

Takeshi Semii
Chief Radio Operator
Kyodo Senpaku Co., Ltd.
Japan

Yasunari Tsuda
Chief Radio Operator
Kyodo Senpaku Co., Ltd., Japan

Isamu Yoshimura
Kyodo Senpaku Co., Ltd., Japan

Kirill Zharikov
All Russian Research Institute of Fisheries and Oceanography
Russia

Saemi Baba
Interpreter, Japan

Hiroko Yasokawa
Interpreter, Japan

Annex B

Agenda

1. Opening remarks and welcoming address
2. Appointment of chair and rapporteurs
3. Adoption of agenda
4. Organisation of meeting
5. Review of available documents
6. Review of discussions at IWC/66b and TAG reports
   - 6.1 Progress during intersessional period
   - 6.2 Future work
7. Preliminary results from the 2016 cruise
8. Availability of research vessels
   - 8.1 Research vessel offered by Japan
   - 8.2 Other possibilities
9. Priority for the 2017 and 2018 cruises
10. Review of the budget
11. Cruise plan
    - 11.1 Priorities and allocation of research effort
    - 11.2 Itinerary
    - 11.3 Research area
    - 11.4 Research vessel
    - 11.5 Other matters
12. Details of the 2017 and 2018 cruises
    - 12.1 Cruise track design
    - 12.2 Survey mode and research hours
    - 12.3 Number of crew on effort
    - 12.4 Navigation and research speeds
    - 12.5 Acceptable condition
    - 12.6 Estimated Angle and Distance Experiment
    - 12.7 Data format
    - 12.8 Biopsy sampling
      - 12.8.1 Priority of species
      - 12.8.2 Equipment
      - 12.8.3 Keeping of samples
    - 12.9 Photo-id studies
      - 12.9.1 Priority of species
      - 12.9.2 Equipment
      - 12.9.3 Keeping of data
    - 12.10 Acoustic studies
    - 12.11 Oceanographic studies
    - 12.12 Satellite tagging studies
    - 12.13 Other matters
13. International researchers and allocation of research personnel
    - 13.1 Number of researchers
    - 13.2. Nomination and allocation of researchers
14. General preparations for the 2017 cruise
    - 14.1 Identification of home port organiser
    - 14.2 Entry and other permits
    - 14.3 Review of recommendations from 2016 cruise
15. In transit survey
    - 15.1 Home port to research area and back
16. Transportation of data, samples and equipment
    - 16.1 Equipment
    - 16.2 Data and samples and necessary Permits
    - 16.3 Responsible persons
17. Communications
    - 17.1. Safety aspects (daily report etc.)
    - 17.2 Between Cruise leader and IWC
    - 17.3 Weather and sea temperature information
    - 17.4 Other official communication
    - 17.5 Private communications
    - 17.6 Terms of payment of communication cost
18. Meetings
    - 18.1 Pre-cruise meeting
    - 18.2 Post-cruise meeting
    - 18.3 Home Port arrangements
    - 18.4 Responsible persons
19. Reports
    - 19.1 Planning meeting report
    - 19.2 Cruise report
20. Other logistics
    - 20.1 Press release
    - 20.2 Security
    - 20.3 Accommodation and food costs
    - 20.4 Other matters
21. Other
    - 21.1 Data validation and analysis
    - 21.2 IWC website
22. Conclusion remarks

Annex C

List of Available Documents

1. International Whaling Commission. 2017. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 7-9 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:459-76.
2. International Whaling Commission. 2017. Report of the Planning Meeting for the 2016 IWC-POWER Cruise in the North Pacific, 9-10 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:477-87.
3. International Whaling Commission. 2017. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109 (extracts).
4. International Whaling Commission. 2017. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 18:203-29 (extracts).
5. Berchok, C., Crance, J. and Clapham, P. 2016. Inclusion of passive acoustic monitoring in IWC POWER surveys. Paper SC/66b/O01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 5pp. [Paper available from the Office of this Journal].
6. Draft Cruise Report of the 2016 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER).
7. Summary of IWC-POWER surveys (2010-16).
8. Proposal for 2017-19 IWC-POWER in the Bering Sea.
9. IWC-POWER 2017 required equipment.
10. Data analysis for distance and angle experiment.
11. Necessary permits to conduct POWER cruise in EEZ of Russian Federation.
12. Candidate cruise track design by strata.

Annex D

Summary of IWC-POWER Results 2010-16

Table 1

Some key characteristics of the two vessels used thus far.

Vessel	*Kaiko-Maru* (2010)	*Yushin-Maru No.3* (2011-16)
Call sign	JGDW	7JCH
Length overall [m]	61.9	69.61
Molded breadth [m]	11.0	10.8
Gross tonnage (GT)	860.25	742
Barrel height [m]	19.5	19.5
Upper bridge height [m]	9.0	11.5
Bow height [m]	6.5	6.5
Engine power [PS/kW]	1471	5,280/3,900

Table 2

Summary of sightings.

Year	2010		2011		2012		2013		2014		2015		2016			
Vessel	*Kaiko-Maru*		*Yushin-Maru No.3*		*Yushin-Maru No.3*		*Yushin-Maru No.3*		*Yushin-Maru No.3*		*Yushin-Maru No.3*		*Yushin-Maru No.3*		Total	
Searching effort (n.miles)	1,816.2		2,397.8		2,126.1		3,035.9		3,233.0		3,248.5		2,237.5		18,095.0	
Species	sch	ind	sch	ind	sch	ind	sch	ind	sch	ind	sch	ind	sch	ind	sch	ind
Blue whale	3	3	9	9	4	4	0	0	1	1	0	0	0	0	17	17
Fin whale	23	48	80	139	114	169	1	1	0	0	0	0	0	0	218	357
Sei whale	53	31	38	73	81	151	0	0	1	1	0	0	0	0	173	256
Bryde’s whale	0	0	0	0	0	0	6	6	88	98	27	32	1	1	122	137
Like Bryde’s	-	-	-	-	-	-	-	-	3	3	2	2	0	0	5	5
Common minke whale	8	8	2	2	2	2	0	0	0	0	0	0	0	0	12	12
Like minke	1	1	2	2	0	0	0	0	0	0	0	0	0	0	3	3
Humpback whale	5	8	76	133	7	7	0	0	0	0	0	0	0	0	88	148
North Pacific right whale	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Sperm whale	67	84	57	74	45	52	33	50	65	137	11	50	6	30	284	477
Baird's beaked whale	1	20	0	0	0	0	0	0	0	0	0	0	0	0	1	20
Cuvier’s beaked whale	0	0	0	0	0	0	2	6	5	8	3	6	2	5	12	25
Longman's beaked whale	0	0	0	0	0	0	0	0	0	0	1	110	0	0	1	110
Stejneger’s beaked whale	0	0	0	0	0	0	1	4	0	0	0	0	0	0	1	4
Mesoplodon spp.	3	6	6	22	3	9	8	20	7	13	1	2	2	3	30	75
Zhiphiidae	4	9	12	20	22	42	28	51	35	73	4	4	2	2	107	201
Killer whale	6	53	6	66	12	42	0	0	1	3	1	4	0	0	26	168
Unid. large whale	27	43	59	95	44	70	8	8	9	9	3	3	0	0	150	228

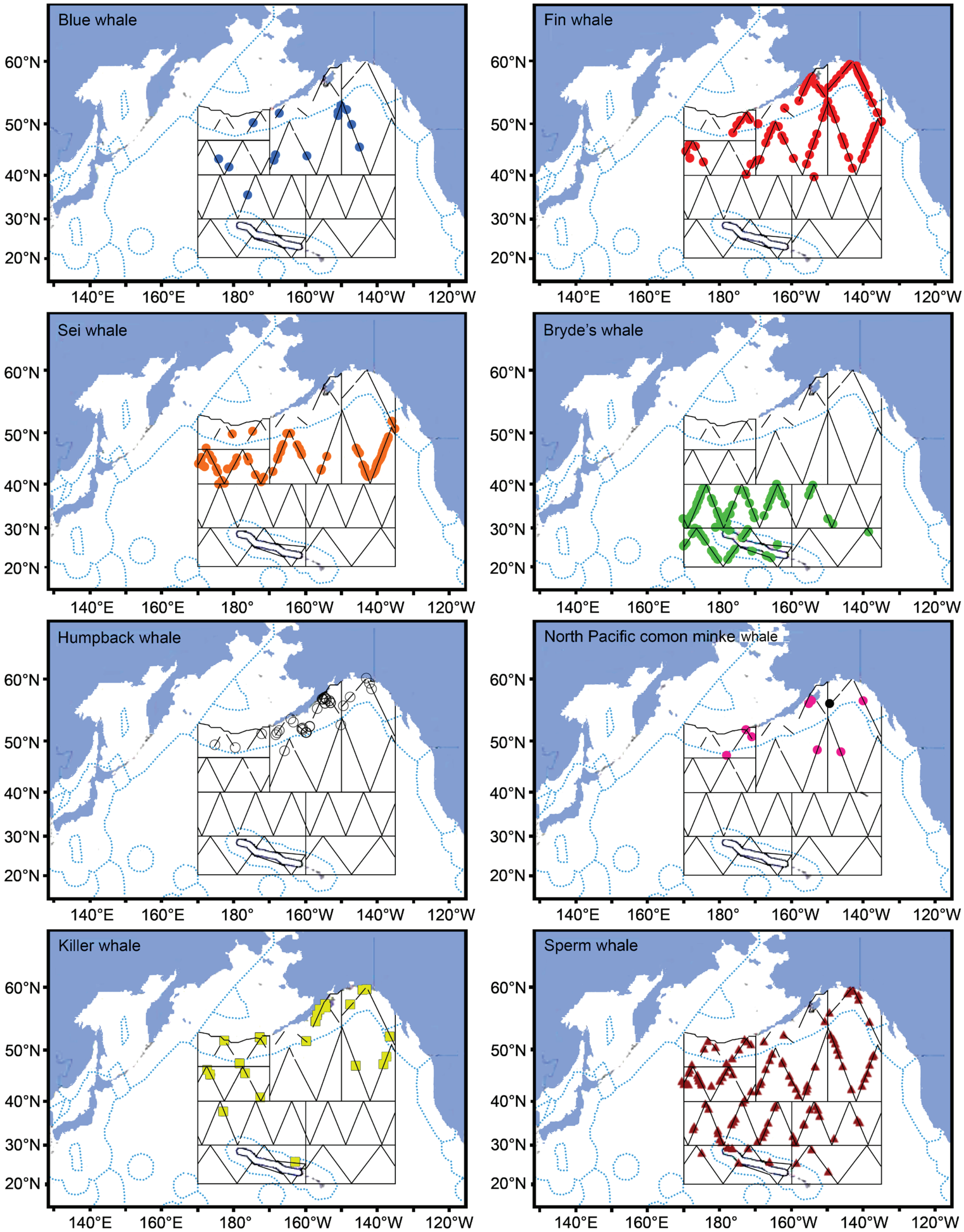
Table 3

Summary of angle and distance experiments undertaken.

Year	2010	2011	2012	2013	2014	2015	2016	Total
Barrel distance	36	42	42	42	36	60	72	330
Barrel angle	36	42	42	42	36	60	72	330
IOP distance	-	-	-	-	-	60	72	132
IOP angle	-	-	-	-	-	60	72	132
Upper distance	36	24	37	37	24	40	60	258
Upper angle	36	24	37	37	24	40	60	258
Total	144	132	158	158	120	320	408	1,440

Sighting maps

Figures summarising the sightings of the major species seen during the IWC POWER cruises thus far (2010-16). In the figure showing both North Pacific right whales and common minke whales, the former is indicated by a black circle and the latter by pink circles. Note that the small number of common minke whale sightings is a reflection of the fact that the survey continues in sea state conditions sub-optimal for common minke whales.



Annex E

Permits to Conduct an IWC-POWER Cruise in the EEZ of the Russian Federation

According to 2017-19 POWER cruise plan it is supposed to conduct a sighting survey, including sighting experiments, biopsy sampling and photo-ID studies in Russian EEZ. There will be needed two permits from appropriate Russian authorities. The first one is a permit to conduct marine bioresource research in Russian waters (including biopsy sampling), the second is CITES export permission.

Permit to enter Russian EEZ and to conduct studies

The cruise plan should include EEZ and exclude territorial waters of Russian Federation. They are defined by domestic and international laws as 12 n.mile zone off the coastal line (including islands), and outer border of these waters is considered as a state border of Russia. In case of gulfs, sounds, straits, river estuaries, etc. which mouths are less than 24 n.mile width, basically the territorial waters are measured from line, connecting the furthermost points of the mouth facing to open sea in the lowest tide.

The list of actual points and lines from which the 12 mile territorial waters are measured is adopted by the Government of Russia and available through the Internet[3].

Whale sighting surveys like POWER cruise are considered as marine bioresources studies in Russian legislation. In this case the deadline for submission of cruise plan through the diplomatic channel is 6 months. However it seems reasonable to start preparation of the draft well before in order to meet all requirements. The main data required for submission are listed below.

(1) The name of research program.
(2) Information about program developers and participants (full name of organization, state, address, phone, fax, e-mail).
(3) Goals and purposes of the program, information on the matter of study.
(4) Brief characteristics of methods and processing of acquired data.
(5) Planned dates of start and ending of the research.
(6) Area of study (fishery zone, including maps, waypoints, etc.).
(7) Species planned for studies.
(8) Information about research vessel and equipment intended to use during studies.
(9) Information on taking/sampling animals.
(10) Other information.
(11) Some extra data may also be required in the process of consideration.

The permit for conducting sighting survey might be issued with correction of initial waypoints and tracklines according to requirements of Russian authorities and inner regulations. Sampling option in Russian EEZ is included in this permit, but export of samples will be discussed separately below. Also the obligatory condition of issuing the permit is presence of Russian representative onboard the vessel and sharing all acquired data.

Permit to export biopsy samples (CITES) from Russian EEZ

Essential point in the process of CITES permit is a memorandum on cooperation or any kind of agreement with appropriate Russian scientific institute (exporter). Basing on such a memorandum or agreement Russian or corporate foreign institute (importer) will submit a request to export samples.

The submission must include Japanese (owner of the vessel) import permit and it is a crucial item. Appropriate records in IWC SC report could be very helpful. Main items of submission are as follows:

(1) purpose of import/export;
(1) species;
(2) sample description;
(3) number of samples;
(4) sample origin;
(5) transportation and storage issues;
(6) postal addresses of exporter and importer and contact phones;
(7) recommendation of Scientific CITES body in Russia;
(8) legal basis for import/export (Memorandum or agreement between research institutes);
(9) documents confirming legal sampling (permit #1); and
(10) fees receipt

The timing of consideration by Russian CITES body is 20 days after submission (if no additional information is required, in that case timing may be prolonged up to 20 days more). The CITES export permit expiry time is 6 months.

The CITES export permits are issued separately for each species. Therefore, it is reasonable to estimate preliminary the maximum number of samples which could be possibly taken from each whale species.

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[3]*http://structure.mil.ru/structure/forces/HYDROGRAPHIC/ESIM.htm.*

Report of the Workshop on Southern Hemisphere Blue, Fin and Humpback Whale Photo-identification Catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula

Report of the Workshop on Southern Hemisphere Blue, Fin and Humpback Whale Photo-identification Catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula[1]

1. INTRODUCTORY ITEMS

1.1 Introductory remarks and goals of the Workshop

The 'Workshop on Southern Hemisphere blue, fin and humpback whale catalogues from the Central and Eastern South Pacific and the Antarctic Peninsula' was held on 2 December 2016 at the Centro Cultural in Valparaíso, Chile, immediately following the biennial meeting of the Society of Aquatic Mammal Experts of Latin America (SOLAMAC). The Agenda of the meeting is given in Annex A.

Zerbini welcomed the participants (listed in Annex B) and thanked the other members of the Steering E-Mail Group (Brownell, Galletti, Jackson, Olson, Palacios, and Torres-Florez) for their guidance in planning the agenda for the Workshop. He went over the Workshop's agenda and the day's schedule, and then described the meeting's goal and objectives: to agree a strategy for combining photo-identification catalogues to support mark-resight measurement of abundance and population connectivity of blue, fin and humpback whale populations from the Central and Eastern South Pacific and the Antarctic Peninsula with emphasis on the assessments conducted by the International Whaling Commission (IWC) Scientific Committee (SC).

1.2 Appointment of Chair and Rapporteurs

Zerbini, Jackson, and Olson were to co-Chair the Workshop. Palacios was appointed as rapporteur, with Olavarría assisting with rapporteuring during the small-group sessions.

2. BACKGROUND ON THE IWC ASSESSMENTS OF SOUTHERN HEMISPHERE WHALES

Jackson gave a presentation on the IWC's rationale for conducting the assessments of Southern Hemisphere humpback and blue whale populations, including data requirements and progress on this topic to date. In regards to humpback whales, she noted that the previous population assessment of humpback wintering off the west coast of Central and South America (Breeding Stock G, BSG) was concluded in 2006, with a minor revision in 2011 following peer-reviewed publication of an abundance estimate for this region (Félix *et al.*, 2011; Johnston *et al.*, 2011). More recent population assessments from other regions took population sub-structure into account, for example on breeding grounds (e.g. off east and west Africa and Oceania) and where multiple feeding areas are known (e.g. west of South Africa, Antarctic Area III). The assessment of Breeding Stock B (western Africa) was particularly highlighted as this breeding area may have sub-structure potentially analogous to that seen in BSG, with a feeding area found at the highest latitudes of the continent (the southwest corner of Africa) and some genetic structuring seen on the breeding grounds (IWC, 2012). In regard to blue whales, Jackson highlighted that assessment of the Chile/Peru blue whale population is currently of highest priority for the IWC (IWC, 2016), with the next planned assessment being for Australia/Indonesia. Progress on abundance estimation is anticipated to be made primarily through catalogue reconciliation within the Southern Hemisphere blue whale catalogue.

[1]Presented to the Scientific Committee as SC/67a/Rep03rev1.

Following the presentation, it was noted that substructure has been detected across the humpback whale breeding grounds, with Colombia and Ecuador showing some genetic differences (Félix *et al.*, 2012). Also, in addition to the two well-known feeding areas in the Antarctic Peninsula and the Magellan Strait, Chiloe Island and the Gulf of Corcovado in Chile may represent a third feeding area (Haro, 2009; Hucke-Gaete *et al.*, 2006; 2013; Vernazzani *et al.*, 2008).

In regard to blue whales, it was asked if there is new information available on the whales seen at the Costa Rica Dome (CRD), noting a recent match between Galápagos and the CRD (Douglas *et al.*, 2015). Olson indicated that linkages have been made between the Galápagos Islands and Chile (Hucke-Gaete *et al.*, 2016; Torres-Florez *et al.*, 2015), as well as the match to the CRD, suggesting the possibility of a linkage between the Southern Hemisphere and the CRD. The population identity of blue whales at the CRD requires further investigation because this area is likely used by both Northern and Southern Hemisphere populations and potentially includes a resident population (Capella *et al.*, 1998; Leduc *et al.*, 2017; Reilly and Thayer, 1990).

3. IWC PHOTO-IDENTIFICATION CATALOGUE SHARING GUIDELINES

Olson presented data sharing guidelines with regard to photo-identification data prepared by the IWC's Data Sharing Working Group. She remarked that there are great benefits from combining catalogues for achieving a more thorough understanding of population structure and producing region-wide abundance estimates. It was highlighted that the comparison of catalogues between regions is important in order to accomplish these goals successfully.

Following the presentation, in response to a question, Olson explained that the photo-identification guidelines will eventually be available online at the IWC website (*http://www.iwc.int*), and that anyone involved with photo-identification cataloguing for IWC assessments would receive a copy of the guidelines. The participants of the Workshop felt that these guidelines should be made available to the wider community to maximise the benefit of developing a 'best practice' approach.

While it is clear that these guidelines are aimed at the research community, it was asked if there are guidelines being considered for opportunistic photographs. Olson stated that such photos are best submitted to existing research groups or open access catalogue holders rather than to the IWC, noting that such photos represent a great opportunity for citizen science.

Workshop participants also inquired about the differentiation between the Antarctic Humpback Whale Catalogue (AHWC) curated by the College of the Atlantic (COA) and that of Happywhale. Olson answered that the AHWC has a research basis, accepting and incorporating photographs from research groups as well as those collected opportunistically. Happywhale focuses exclusively on citizen science and public outreach, gathering and sharing photographs acquired during tourism activities. It was also clarified that AHWC receives funding support from the IWC to support photograph matching, and as part of this agreement is required to share its findings with the IWC.

4. IMPORTANCE OF COLLABORATIVE WORK AND SHARING OF CATALOGUES FOR ASSESSMENT OF WHALE POPULATIONS: THE SPLASH PROJECT

Urbán gave a presentation describing the experience of the SPLASH (Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific) project in the North Pacific, as its large-scale research objectives and multi-group collaboration were related to objectives of this Workshop. The project SPLASH was a coordinated research effort to study humpback whales in the entire North Pacific; with the involvement of scientists along the US West Coast, Hawaii, and Alaska, Japan, Russia, Philippines, Mexico, and Canada; the field work was from 2004 to 2006; and funding came from governments of the US (NOAA/NMFS, National Marine Sanctuaries), Canada, and Mexico and private foundations including National Fish and Wildlife Foundation, Pacific Life Foundation, and Marisla Foundation. The general results have been made available in a comprehensive report with the agreement of the Steering Committee members, estimating 20,000 individuals (2004), revealing very complex population structure and indicating that there appears to be a 'missing' breeding ground not yet studied in the North Pacific (Calambokidis *et al.*, 2008).

Following the presentation, participants inquired about how the process of implementation of the SPLASH project worked from the beginning. Urbán indicated that there were several meetings pre-SPLASH, taking advantage of larger scientific meetings like the IWC/SC and others. Urbán also remarked previous experience of some of the project members (e.g. David Mattila) with the YONAH (Year of the North Atlantic Humpback Whale) project were key to the success of SPLASH. Regional leaders (8-10 people) were identified to work as a Steering Committee. Despite the large region and number of research groups, most of the process relied on informal verbal agreement (rather than on signed memoranda of understanding or other inter-institutional agreements), although detailed minutes with these commitments were documented in meeting reports. Details about authorship in publications were described in these reports, and specific publications and their respective leads were identified as part of the product's outcomes. This process generated trust among researchers and led to excellent results. In addition, it left no feelings of dissatisfaction or disappointment; only the sense that much more could be done with the large data set collected for many years to come. Another key to the success of SPLASH was the funding, which was in large part contributed by NOAA. Funding was allocated to each group based on their request and proportional to their targets in terms of the number of photo-identifications and biopsies they expected to obtain. The commitment by each group to reach these targets was very important to achieve the project's goals.

5. HUMPBACK WHALES

5.1 South/Central Pacific and Antarctic Peninsula reconciled catalogue

Acevedo presented a compilation of existing photo-identification data as part of an initiative to investigate connectivity among various areas in both breeding and feeding grounds of BSG. For the purpose of this report, this initiative will be referred to as the 'Central-South America and Antarctic Peninsula Humpback Whale Catalogue Sharing Initiative' (abbreviated as HWCSI). Throughout the extensive geographic range of this stock, 16 independent photo-identification catalogues containing data from 1986 to 2016 are being compiled. There are 11 catalogues from the breeding grounds (Costa Rica, Panamá, Colombia, Ecuador [including the Galápagos Islands], and Peru; with at least 8,429 identified whales) and five catalogues from the feeding grounds (the Antarctic Peninsula, the Magellan Strait and Golfo Corcovado; with 1,374 identified whales, Table 1). This compilation includes 3,180 individuals that are concurrently present (i.e. as duplicates) in the AHWC, because photographs have been previously submitted to this catalogue by HWCSI collaborators. All HWCSI photos are stored digitally and the sighting information for each whale is stored in an electronic database. Preliminary matching (12 catalogues for the period 1991-2015) revealed 41 matches within low latitudes (breeding grounds), 141 matches between breeding and feeding grounds, and no matches among the three feeding grounds. Matches were also found between BSG and other breeding stocks: four with Brazil (Breeding Stock A) and two with French Polynesia (Breeding Stock F). Previous independent (outside HWCSI) catalogue comparisons had been performed across: (i) Peru, southern Ecuador and northern Panama; (ii) Gulf of Corcovado, Peru and southern Ecuador; and (iii) the Antarctic Peninsula, the Magellan Strait and all regions within the breeding ground. These three independent comparisons revealed 404 re-sightings of 356 whales within the breeding grounds and 399 re-sightings of 282 individuals between breeding and feeding grounds. Once again, no matches were found among the three feeding areas. A summary of abundance estimates computed from photo-identification data for multiple regions within the range of BSG between 1998 and 2016 was also provided. These estimates pertained to five localities in the breeding grounds (Rasmussen *et al.*, unpublished data, (Capella *et al.*, 1998; Félix *et al.*, 2011; Guzman *et al.*, 2014), one for the Antarctic Peninsula (Stevick *et al.*, 2006) and two for the Magellan Strait (Capella *et al.*, 2012; Gende *et al.*, 2014). One of these estimates (N=6,504, CV=0.21; (Félix *et al.*, 2011) was endorsed by the IWC for use in the assessment of BSG.

In response to a question, Acevedo clarified that the initiative started by Fernando Félix at the 2014 SOLAMAC meeting in Cartagena, Colombia, to produce new population estimates for BSG and the one he presented and discussed at the Workshop (the HWCSI) were the same. Castro added that the previous effort to estimate abundance for this population was based on data for Ecuador that combined data sets by Félix and Castro (Félix *et al.*, 2011). She emphasised that only photos systematically collected by the researchers were used and that photos contributed by tourists to the catalogue had to be excluded from the data before the final abundance was computed. In this regard, Urbán noted that for the SPLASH project a large number of photos were eliminated from regional catalogues in an initial step to use only the best ones; following that, Cascadia Research Collective implemented a second, even more stringent quality control process to further select the photos used for the abundance estimate. This emphasises that the comparison/reconciliation of a global catalogue should ideally be implemented by one group (1-2 persons) to ensure consistency, and that the new layer of quality control will lead to a reduction in the number of photos used for the final catalogue due to the elimination of low-quality photos.

Urbán also noted that an initial step toward a population abundance estimate will require an evaluation of what data are extant. SPLASH did not use previous photos, but the historical data were used to determine the sampling strategy for the new three-year field effort. While new, systematic

Table 1

Summary of the humpback whale photo-identified individuals contributed to the HWCSI by catalogue and region.

Catalogue	Locality (BSG)	Country	Years																									
			91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total
PAO	Los Organos	Perú	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	33	16	105	119	89	141	174	690
PWF	Machalilla	Ecuador	-	-	-	-	-	19	7	24	22	11	53	84	111	234	256	176	190	265	290	182	212	172	169	209	207	P	2,893
PWF	Salinas	Ecuador	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	1	-	-	-	-	-	-	-	3	-	10
PWF	Galapagos Islands	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	2	1	-	-	-	2	-	8
PWF	El Pelado Island	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	14
PWF	Bahía Caraq	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
MBS	Machalilla	Ecuador	8	13	1	15	29	79	70	-	-	-	-	3	-	-	1	3	-	1	-	-	-	-	2	1	-	-	226
MBS	Salinas	Ecuador	-	-	-	-	-	-	-	-	-	3	-	66	88	132	181	263	284	250	158	332	36	49	63	54	39	P	1,998
MBS	Isla Sta. Clara	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
USFQ	Machalilla	Ecuador	-	-	-	-	-	22	2	8	13	11	73	97	64	159	78	-	-	-	-	-	-	2	1	1	-	-	531
USFQ	Esmeraldas	Ecuador	-	-	-	-	-	-	-	-	-	3	38	35	72	72	11	4	-	16	10	6	9	38	6	22	43	-	385
USFQ	Galapagos Islands	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	1	-	-	-	-	-	4
USFQ	Golfo de Guayaguil	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
USFQ	Salinas	Ecuador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3
Sentir	Coqui Cove	Colombia	-	-	-	-	-	-	-	-	-	13	1	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32
Macuaticos	Tribuga Gulf	Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	127	100	66	P	309
Panacetacea	Gulf of Chiriqui	Panama	-	-	-	-	-	-	-	-	-	-	-	4	9	6	-	4	34	31	40	12	40	87	129	160	110	-	666
Others	Panama Gulf	Panama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	18
Panacetacea	South CRb	CR[b]	-	-	1	-	1	-	-	-	3	-	9	11	-	1	-	-	16[a]	-	-	-	-	-	-	-	-	-	42
Panacetacea	North CRb	CR[b]	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CEIC	Dulce Gulf	CR[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	2	13	1	1	4	31
Vida	Costa Rica	CR[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	23
Sub-total			**8**	**13**	**2**	**15**	**30**	**120**	**79**	**32**	**38**	**41**	**181**	**318**	**345**	**605**	**531**	**451**	**526**	**588**	**511**	**592**	**316**	**473**	**643**	**637**	**615**	**178**	**7,888**
	Feeding areas																												
CEQUA	Magellan Strait	Chile	-	-	-	-	-	-	-	-	-	-	-	-	11	27	28	15	10	-	3	9	10	24	-	2	21	15	175
Whalesound	Magellan Strait	Chile	-	-	-	-	-	-	-	-	18	3	6	7	12	10	7	12	17	10	8	10	7	11	9	5	14	12	178
INACH	Antarctic	Antarctic	-	-	-	23	-	40	46	21	38	-	-	-	-	-	-	56	9	43	-	-	-	-	-	-	-	-	276
CEQUA	Antarctic	Antarctic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	-	-	-	-	-	-	38
PROANTAR	Antarctic	Antarctic	-	-	-	2	-	-	-	49	58	21	65	106	51	18	22	13	21	1	53	18	26	-	57	54	P	P	635
Others	Antarctic	Antarctic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	29	11	-	-	55	-	-	2	105
Sub-total			**0**	**0**	**0**	**25**	**0**	**40**	**46**	**70**	**114**	**24**	**71**	**113**	**74**	**55**	**57**	**96**	**65**	**54**	**93**	**86**	**43**	**35**	**121**	**61**	**35**	**29**	**1,407**
Total			**8**	**13**	**2**	**40**	**30**	**160**	**125**	**102**	**152**	**65**	**252**	**431**	**419**	**660**	**588**	**547**	**591**	**642**	**604**	**678**	**359**	**508**	**764**	**698**	**650**	**207**	**9,295**

PAO: Pacifico Adventures (Los Organos, Peru); PWF: Pacific Whale Foundation Ecuador; MBS: Museo Ballenas Salinas; UFSQ: Universidad San Francisco de Quito; CEIC: Centro de Investigación de Cetáceos; CEQUA: Centro de Estudios del Cuaternario Fuego-Patagonia y Antárctica; INACH: Instituto Nacional Antártico Chileno, Chile; PROANTAR: Programa Antártico Brasileiro, Universidade Federal do Rio Grande - FURG, Brazil. 'P' refers to data undergoing processing and thus not yet received. [a]Contributed by Frank Garita (Vida catalogue). [b]CR refers to Costa Rica.

sampling in all localities comprising the range of BSG would be desirable, budget limitations are such that it is unlikely the substantial funding needed for such sampling would be made available. For this reason, Workshop participants were encouraged to work with the data they have available now. Further discussion on this topic ensued, and participants agreed that new abundance estimates would likely not be based on a new synoptic sampling effort, but on the existing data sets or on new data collected by individual research groups as part of on-going efforts.

It was asked if the data and photos from AWHC should be fully integrated with the other regional data sets/catalogues compiled by Acevedo, or whether they should be considered a separate effort. It was **agreed** that this would be a topic for the future. Similarly, participants were aware that there are several additional groups working in the Antarctic Peninsula and elsewhere, and their inclusion in a combined assessment also needs to be considered.

Participants discussed whether only flukes or flukes and dorsal fins photos should be used to compute new abundance estimates. Acevedo noted that data in his presentation was based only on flukes, as this was the most widely used type of photo across regional catalogues. However, participants were keenly aware of the fact that mother/calf pairs rarely fluke in the breeding grounds, so if dorsal fin photos are not to be considered for the assessment, there will be a bias in the data toward other group types. It was noted that the AHWC includes both flukes and dorsal fins, and that both can be useful for different purposes.

Participants recognised that careful consideration would be needed in regards to spatial and temporal data coverage, considering that the various catalogues consist of different years and different regions. This was to be discussed in the future in regard to new estimates of abundance, but participants acknowledged that all photos in a catalogue may be useful to explore some population structure and connectivity scenarios. An inspection of the available data is needed before proceeding with exploring analytical options, in order to determine if comparisons between breeding and feeding grounds (or only within them) are feasible, and what sample sizes are needed for a quantitative analysis within, for example, a multi-strata mark-resight framework.

Additionally modern analytical techniques (e.g. Bayesian frameworks, models such as Hidden Markov Models) could potentially be used to maximise the number of contributing catalogues and minimise data loss if some years are missing; expert advice can be sought to explore these analytical avenues.

5.2 Other humpback whale catalogues

Pérez-Alvarez gave a presentation on opportunistic efforts from Centro de Investigación Eutropia (CIE) to collect humpback whale photo-identification data over the period 2007-15 at Reserva Marina Isla Chañaral/Is. Choros- Damas off northern Chile (29°09’67”S, 71°28’07”W). At least 15 humpback whales from this area have been identified. Feeding behavior was also observed there, and genetic samples from six individuals have been collected. The Consortium Whalesound-Pantalassa also has a catalogue with 24 humpback whales from Chañaral-Choros area for the period 2005-15.

In discussion, Haro reported that she has collected an additional 9 fluke IDs from the same area between 2011 and 2015 (Haro, personal catalogue) and that comparisons of these data with those from the Magellan Strait and the Gulf of Corcovado revealed no matches.

The Centro Conservación Cetacea (CCC) catalogue of humpback whales for the period 2004-14 includes fluke, left and right dorsal fin photographs collected mainly off northwestern Isla de Chiloé, but also off Isla de Chañaral, Gulf of Corcovado, and opportunistic sightings off central Chile. Currently the catalogue is composed of 69 individuals but 70 additional photo-identifications of individuals have been collected during the 2016 field season off west Isla de Chiloé that need to be internally reconciled. Galletti remarked that her group had found a single match between the Magellan Strait and northwestern Isla de Chiloé (Capella *et al.*, 2008; Vernazzani *et al.*, 2008).

Reconciliation of catalogues by Whalesound-Pantalassa is already underway for the Strait of Magellan, Chiloé and Melimoyu (Aysén), and a single match has been identified between the Magellan Strait and Chiloé and between the Magellan Strait and Melimoyu. Participants **agreed** that it would be desirable to create a combined catalogue, which could be reconciled with the existing catalogues in order to understand connections among these three regions in southern Chile.

5.3 Small-group discussion on humpback whales

After the primary presentations, a small group was formed to continue more targeted discussion on how to move forward toward computing new abundance estimates for BSG based on the integrated photo-identification dataset developed by the HWCSI. This group was composed of Acevedo, Angel-Romero, Benitez, Botero-Acosta, Capella, Carnero-Huamán, Castro, Dalla Rosa, Denkinger, Haro, Kaufman, Morais, Olavarría (rapporteur), Pacheco, Pávez, Pérez-Alvarez, Rasmussen, Reyes, Santos, Toro, Urbán, Young, and Zerbini (Chair).

The following items were identified as priorities to initiate the discussion:

- inclusion of other groups to this collaborative initiative;
- data quality control;
- dividing the data between opportunistic and dedicated surveys;
- integrating the College of the Atlantic’s Antarctic Humpback Whale Catalogue; and
- how to coordinate an effort to compute new abundance estimates for BSG in the future.

Early in the discussion, data-holders **agreed** that they were willing to collaborate on a population-wide abundance estimate based on their photo-identification data, but that this would require the development of a written agreement or memorandum of understanding (see Item 5.3.5 below). The participants also **agreed** that this document would be developed under the leadership of Jorge Acevedo and Fernando Félix.

5.3.1 Inclusion of other research groups to the HWCSI

In addition to the Workshop participants or those already contributing to the HWCSI, the following holders of humpback photo-identification data relevant for computing new estimates of abundance for BSG were identified:

(1) Lilián Flórez-González – data from Colombia;
(2) Ari Friedlaender – data from the Antarctic Peninsula; and
(3) Luis Santillán - data from Bahia Sechura, Peru.

It was **agreed** that Acevedo and Félix, with help from the Workshop organisers, would approach these researchers with an invitation to collaborate in the HWCSI.

It was noted that the Flórez-González catalogue from Colombia includes a large amount of data collected since 1986 (Flórez-González, 1991), which was used to calculate an initial population abundance for the Colombian region

(Capella *et al.*, 1998). Support would be needed for completing the organisation of the catalogue, as part of it is not in electronic format. It was recognised that this is one of the early catalogues, it covers an important portion of the breeding ground, and it has not been considered in recent population estimates.

5.3.2 Data quality control

The Workshop participants recognised the need to apply strict quality control criteria to select photographs that will be used to develop abundance estimates. It was suggested that procedures similar to those developed under the SPLASH Project would be useful in this context. It was also noted that software is available to match photographs, e.g. Match My Whale (Stack *et al.*, 2015) and that attempts will be made to automate matching for producing new abundance estimates of BSG. Because there was insufficient time to discuss photograph quality control in detail, Workshop participants **agreed** this would be done under the coordination of Acevedo and Félix.

5.3.3 Dividing the data between opportunistic and dedicated surveys

The small group did not have time to discuss this topic, but **agreed** this deserves future consideration.

5.3.4 Integrating the Antarctic Humpback Whale Catalogue by the College of Atlantic

Workshop participants **agreed** that given the current capabilities among the regional researchers, the submission of their catalogues to the AHWC/COA was not required for the purpose of developing new abundance estimates of BSG. However, participants recognised the AHWC is an important repository of humpback whale photographs and that contribution of photo-identified whales should continue (e.g. for matching of photographs from western Central and South America or the Antarctic Peninsula with other areas).

5.3.5 Coordination to compute new BSG abundance estimates

Workshop participants indicated that while collection of new data through a coordinated field research program would be useful, it is more practical at present to analyse the extensive existing dataset given budgetary constraints. They also recognised that an analytical framework for estimating abundance is needed and could be developed with support from the IWC if possible.

Workshop participants noted that in some cases there are multiple catalogues for a single region (e.g. coast of Chile and the Antarctic Peninsula). It was suggested that the establishment of 'regional coordination' could facilitate the reconciliation of these catalogues in preparation to compute new abundance estimates.

It was noted that a similar collaboration agreement to that used for the Southern Hemisphere Blue Whale Catalogue could be used. However, the formal agreement already in place for the current regional collaboration on assessing migratory connectivity of BSG whales could also be extended toward developing new abundance estimates. It was **agreed** that further discussion on the implementation of a formal agreement to compute these estimates would be conducted under Acevedo and Félix.

5.3.6 Final statement by the small group

All participants in the small group **agreed** to collaborate on developing new population estimates for BSG humpback whales. They also **agreed** that a process to move forward towards computing these estimates would be led by Jorge Acevedo and Fernando Félix in consultation with all other contributors. This process would include:

(1) development of a data sharing agreement;
(2) reconciliation of regional catalogues;
(3) matching of photo-identification data (e.g. use of existing software);
(4) description of quality control procedures; and
(5) development of a framework to compute new abundance estimates.

6. BLUE WHALES

6.1 Southern Hemisphere Blue Whale Catalogue (SHBWC)

Galletti gave an overview of the SHBWC. Thirteen research institutions that work on blue whales in Southern Hemisphere and in the Indian Ocean actively contribute to the catalogue. The SHBWC is an online collaborative platform to share photo-identification catalogues that is being supported by the IWC since 2008. Data sharing agreements and protocols are in place and contributions of blue whale photographs from groups or individuals are welcome. Today, the SHBWC holds 1,022, 1,006 and 46 photo-identifications for left sides, right sides and flukes, respectively from the Southern Ocean, Southeast Pacific, ETP, Australia, New Zealand and Sri Lanka. Nearly all of these are likely to be unique individuals. Comparisons among sub-catalogues are performed regularly. Until 2016, one long-term re-sighting over 10 years has been found for Chile (Vernazzani and Cabrera, 2011) and five re- sightings among all Australian catalogues (Galletti Vernazzani *et al.*, 2016). No further matches have been found to date within or across the other areas. Local efforts to compute abundance estimates have been undertaken using mark-recapture techniques off Isla de Chiloé, southern Chile and off Perth Canyon, western Australia (Galletti Vernazzani *et al.*, In review; Jenner *et al.*, 2008).

In describing the genesis of the catalogue, Galletti explained that the SHBWC originated from a group of blue whale researchers who met at the 2007 conference of the Society for Marine Mammalogy and agreed to develop this initiative. They approached the IWC, who agreed to fund it and has continued to support it. The initial funding was for software development, and now the IWC also funds experienced whale matchers to assist regional researchers as required and to match photographs between regions. The bulk of the work relies on individual research groups to upload and populate the database on their time and funding. Regarding the data sharing agreement, the guidelines developed for the SHBWC are now being used by Olson as a base for developing IWC guidelines more broadly, and these are continuously updated and revised.

In response to a question regarding catalogue accessibility, it was noted that the SHBWC is not available to the public as it is a tool for researchers. Opportunistic contributions from the general public are acknowledged when they are contributed as part of regional catalogues.

It was noted that in some regions such as Perth Canyon the proportion of fluke IDs appear to be much higher than in other regions, and it was asked if this occurs because whales are approached differently. It was noted that some groups opt to collect a fluke photo (rather than lateral photos) because it can be easier and faster, but blue whales in many locations do not fluke. Hence the SHBWC primarily focuses on left and right sides. All research groups contributing to this catalogue are encouraged to collect the same information (photos of both sides as priority, and flukes if available) for consistency. It was clarified that sex and other auxiliary information is recorded in the catalogue, as there are fields for entering this information in the form (the presence of calves can only be entered under comments). The sex field does not distinguish how sex was determined, but in most cases it has come from biopsies.

In response to a question to whether the catalogue can be used for other outputs not related to individual identification, it was noted that it is possible, for example, to analyse whale skin lesions in the catalogue. For any scientific use of the catalogue, the respective owners must be contacted to agree with publication of the outputs.

6.2 Other blue whale catalogues

Galletti gave a presentation on Projecto Alfaguara. The Alfaguara (blue whale) Project has been conducted by CCC off Isla de Chiloé from 2004 to 2016 and off Isla Chañaral during 2012 and 2013. Their photo-identification catalogue has been reconciled until 2012 with a total of 420 individuals (between 20-100 unique individuals per year). Approximately 30% of individuals have been observed on different seasons and several long-term movements have been found including matches from northwestern Isla de Chiloé with Isla de Chañaral (29°S), with Gulf of Corcovado, with northern Los Lagos, and with inlets east of Isla de Chiloé (Galletti Vernazzani *et al.*, 2012). Furthermore one recapture with a ten-year time span was found 200km apart from south Araucanía to northwestern Isla de Chiloé (result from SHBWC, CCC compared to IWC-SOWER, Vernazzani and Cabrera, 2011). Collaboration and matching has been undertaken with all catalogues within the SHBWC and locally with catalogues from MERI, Huinay and Pantalassa (covering southern and northern Chile). In addition mark-recapture open population models with photo-identification data from 2004-12 from Isla de Chiloé has revealed that approximately 570-760 whales are feeding seasonally in this region (Galletti Vernazzani *et al.*, In review).

Given recommendation from the IWC (IWC, 2017) to determine blue whale connectivity with the Atacama/Chañaral Island area, Pérez-Alvarez and Sepúlveda indicated that they would be willing to contribute photographs from 15 individuals they obtained in this region, some of which have also been sampled genetically.

Bedriñana-Romano presented a summary of the Centro Ballena Azul (CBA) photo-identification efforts in the Gulf of Corcovado (extending towards Valdívia and Chiloé), which spanned the period 2003 to 2016 and notably has resulted in one photo-identification and genetic match with Galápagos (Torres-Florez *et al.*, 2015). CBA's catalogue includes 197 unique identifications up to 2014. No mark-recapture analysis with data from this catalogue has been done to date.

In response to a question, it was noted that effort to collect photo-identification data has varied substantially by year, as the group's work was mostly land-based in early years with just a few days on the water. In other years, however, boat surveys (e.g. line-transect) were more frequent and covered different areas, facilitating the collection of photographs.

Galletti gave a presentation on behalf of Chiang about Fundación MERI's efforts in the Gulf of Corcovado. MERI has been conducting photo-identification data of blue whales and other cetaceans since 2014 for 2-3 weeks in February. A total of 57 and 73 individuals were identified in 2014-15 and 2016, respectively. However the 2016 identifications have not yet been inter-matched to those from previous years.

Olson gave a presentation on NOAA's SWFSC photo-identification efforts in the Eastern Tropical Pacific (ETP), where blue whales are found in three discrete locations: off Baja California, México, at the Costa Rica Dome (CRD), and adjacent to the Galápagos Islands and Perú. Photographs of blue whales were collected during line transect surveys in the ETP conducted by the SWFSC 1986-2006. The SWFSC catalogue contains 90 individual blue whales from the CRD and Galápagos/Perú areas, including those photographed during the SWFSC cruises (81) and 9 additional ID's contributed by Daniel Palacios (Palacios, 1999), Judith Denkinger and Julia O'Hern. There are no internal matches within the catalogue, but photographs in the catalogue have been matched to other regions. Three whales photographed at the Costa Rica Dome in late Autumn were matched to the North American population of whales that summer off the US and México (Ugalde de la Cruz unpub., Capella *et al.* (1998)), supporting findings by Bailey *et al.* (2009) that the CRD is a wintering region for the North American population. However, blue whales occur at the CRD year-round and the population identity of the CRD summer whales is unknown. Two blue whales photographed near the Galápagos Islands matched one each to the CRD (Douglas *et al.*, 2015) and to Chile (Torres-Florez *et al.*, 2015). These matches suggest that Galápagos region is host to both Northern and Southern Hemisphere populations (Palacios, 1999). The SWFSC catalogue has been incorporated into the SHBWC.

In discussion, it was noted that currently not all research groups working Chile have photographs in the SHBWC. Achieving this would greatly enhance the possibilities further matches with the Galápagos region, which appears to be the primary wintering ground for Chilean blue whales (Hucke-Gaete *et al.*, 2016; Torres-Florez *et al.*, 2015).

It was noted that if regional humpback whale researchers collect opportunistic blue whale photos, they can be sent to Olson (for the ETP catalogue) or to Galletti for inclusion in the SHBWC. Submissions would be subject to the same data sharing agreements for both catalogues, and after regional internal matching all ETP catalogue contributions would ultimately be submitted to the SHBWC.

6.3 Small-group discussion

After the primary presentations, a small group was formed to further discuss blue whale photo-identification data sharing among researchers working in South America. The group was composed by: Bedriñana-Romano, Galletti, Jackson (Chair), Olson, Palacios (rapporteur), Santos, Sepúlveda, Torres-Florez and Ulloa.

The discussion primarily concerned progress on catalogue sharing, data availability agreements, the size of the various data sets, and whether these catalogues have been internally reconciled between years. The group **agreed** that effort has been highest in the Gulf of Corcovado and Chiloé Island region, while Chañaral Island in the north has received more opportunistic effort, and that for the purposes of an assessment it would be useful to include and reconcile the data collected from both regions.

All research groups **agreed** to collaborate and to contribute their catalogues toward an assessment. Some of the initial discussion concerned getting clarity on how to establish institutional accounts and contribute the data through the SHBWC. A decision needs to be made by SHBWC regarding developing consistent criteria to establish users as a new catalogue within SHBWC versus designating contributors as opportunistic. One consideration is if the sample is small and the group needs matching expertise, it would be best to consider these users as opportunistic. The initial decision was to base it on number of years contributed (>3 years) or number of photos (~30 total) to be considered a new catalogue. It was noted that user category in the SHBWC can be changed at any time if the nature of the contributions change from opportunistic to more systematic.

In terms of sizes of the catalogues, Galletti indicated that CCC has 28 IDs from Chañaral from recent efforts, with no matches to Chiloé (only one match exists from earlier efforts in 2006 and 2007). Sepúlveda and Pérez-Alvarez stated that their catalogue has not been organised or reconciled to evaluate if matches exist, since their sightings are opportunistic (started in 2003) and blue whales are only occasionally seen at Chañaral. They have plans to continue their work and would be willing to join the SHBWC, but they will need to reconcile their own photos first. Galletti indicated the SHBWC would be willing to do this work on Sepúlveda's behalf. Pantalassa is another group that has opportunistically collected blue whale photos in Chañaral (in 2012 and 2013) and they have some IDs.

Bedriñana-Romano and Torres-Flórez indicated that CBA is willing to contribute their Gulf of Corcovado data to the assessment through the SHBWC. They would like to see the protocol and data sharing agreement prior to proceeding. At this point it was emphasised that the main thrust is the IWC assessment, and that other papers are up to subgroups of contributing researchers to pursue based on their goals. These participants were reassured that the IWC has extensive experience with addressing challenging collaborations and agreements with multiple researchers, and that the protocols work well for fostering reciprocal good will. Also, the IWC assessments do not name specific data, just the sources, and are intended for management purposes so they stay as reports; they are not a publication. As such, the assessments can be considered an intermediate step, and contributors can pursue a published paper as their ultimate goal if they choose. Contributors can also withdraw their data from a publication. The assessment process can also consider what would happen with the results if a specific data set is included or not in the analysis.

In conclusion, the small group determined that the Gulf of Corcovado/Chiloé area during the time period 2006 to 2009 would be the focus for a catalogue inter-comparison (CCC and CBA) before the next IWC/SC meeting in May 2017.

7. FIN WHALES

The IWC is considering a future assessment of Southern Hemisphere fin whales as there are no agreed abundance estimates. It would be helpful to gather information on existing research efforts in the region, including photo-identification catalogues and other data sets that could contribute to this initiative in about five years. In this context, Pérez-Alvarez gave a presentation on CIE's fin whale catalogue for the Chañaral/Choros-Damas region. Between 2004 and 2016, at least 81 fin whales have been identified within the Marine Reserves Isla Chañaral and Isla Choros-Damas, north-central coast of Chile. From these, at least 11 individuals have been re-sighted between and within years in that region, including whales seen in 2005-07-10, 2005-10, and 2007-10. Feeding is the most frequent behaviour observed for fin whales within the area. Additionally, CIE has collected at least 21 fin whale genetic samples, as part of an ongoing project focusing on: (1) fin whale population identity and genetic population structure; and (2) genetic relationships between individuals and patterns of parentage.

In discussion, Capella noted that their (WhaleSounds/Panthalassa) catalogue for the same area has 27 identified whales. Pacheco added that he has around six unique individuals from the Mejillones area (*ca*. 23°S) of northern Chile, that he could contribute to CIE's catalogue. Participants were encouraged to initiate a unified catalogue and it was **agreed** that Pérez-Alvarez would coordinate these efforts.

For the Antarctic Peninsula region, Reyes indicated that Fundación Cethus has photographed about 39 whales from the Scotia Sea and Bransfield Strait for the period 2013-16. Similarly, Dalla Rosa noted that Projeto Baleias-FURG/PROANTAR has photographed about 50-100 whales and collected 25 biopsies for the period 2013-16 from the Bransfield Strait to the western Weddell Sea. Both participants indicated that data organisation is pending, but that Reyes and Dalla Rosa were willing to share their data. Participants noted that other researchers working in Antarctica may have additional photo-identification data, possibly including Helena Herr, Ken Findlay, Ari Friedlaender, as well as the IWC from the SOWER cruises carried out in the IWC management areas III, IV and V in 2005, 2006, 2007, and 2008. It was noted that at present there is not a standardised set of protocols for fin whale photo-identification adopted by all researchers with Southern Hemisphere photos. Consistent protocols would be useful to assist with developing South American and Southern Ocean catalogues for this species.

Participants inquired about the possibility of requesting funding from the IWC toward development of fin whale catalogues. Jackson replied that the top priority for the SH sub-committee is the assessment of the pygmy blue whale, so support for fin whales is not likely at this point. However, she noted that if the IWC/SC decide to move towards an assessment of fin whales, funding could be possible. She reminded participants that IWC's best use is in providing leverage in terms of recommendations and endorsements for finding sources of funding elsewhere.

In concluding, Jackson noted that an e-mail group was established at the last IWC/SC meeting to discuss data requirements for a potential Southern Hemisphere fin whale assessment, and that if people want to be involved they should join the e-mail group. Fin whales are in a data-gathering phase and people are encouraged to submit data reports to the IWC, ideally combining data from multiple research groups rather than as individual reports.

8. OTHER

While the focus of the Workshop was on photo-identification data, genetic and acoustic data are also important to potentially complement abundance estimation, as these data may provide additional resolution for all species addressed during the meeting. Discussion of these data types were beyond the scope of the Workshop because of time constraints, because genetic samples require more complex considerations and potentially a broader group of collaborators, and because few research groups in the region are using acoustics. The Workshop **agreed** that integration of these types of data with photo-identification is valuable and should be considered in the future.

Some participants commented that in addition to the primary species subject of this Workshop, they have opportunistically collected photographs and observations of Bryde's whales (*B. edeni, B. brydei*), and suggested that this information be compiled for use toward a future assessment. Castro has collected information from Ecuador, Palacios and Denkinger from Galápagos, Rasmussen from Panama and

Pacheco and Carnero-Huaman from northern Peru. Olson indicated there are also Bryde's whale data and photos from NOAA/SWFSC's surveys in the ETP. These participants **agreed** they would continue in communication to determine how to best compile these data, with Castro serving as lead.

9. CONCLUDING REMARKS

The Workshop organisers indicated that e-mail communications would be initiated in preparation for the next IWC/SC meeting (e.g. blue whales) or to assist in the development of a framework to compute new abundance estimates of humpback whales.

The Workshop organisers acknowledge the efforts of the local scientists (Pavez, Pérez-Alvarez, Santos, Sepúlveda) who assisted with the logistical organisation of the Workshop. They also thanked the participants for their contributions to the IWC assessment process, for joining regional data sharing initiatives, and for contributing with priorities identified during the Workshop for each species. Panacetacea was acknowledged for providing funding support to Daniel Palacios to attend and act as rapporteur of the Workshop.

The Workshop adjourned at 17:30.

REFERENCES

Bailey, H., Mate, B.R., Palacios, D.M., Irvine, L.M., Bograd, S.J. and Costa, D.P. 2009. Behavioural estimation of blue whale movements in the northeast Pacific from state-space model analysis of satellite tracks. *Endang. Spec. Res.* 10: 93-106.

Calambokidis, J., Falcone, E.A., Quinn, T.J., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urban R, J., Weller, D., Witteveen, B.H., Yamaguchi, M., Bendlin, A., Camacho, D., Flynn, K., Havron, A., Huggins, J. and Maloney, N. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. Final report for Contract AB133F-03-RP-00078, US Department of Commerce Western Administrative Center, Seattle, Washington. [Available at *http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-report-May08.pdf*].

Capella, J., Flórez-González, L., Falk, P. and Celis, G.A. 1998. Population size of southeastern Pacific humpback whale stock. Is it recovering? pp.23. *Abstracts of the World Marine Mammal Science Conference, Monaco, 20-24 January 1998*. 159pp.

Capella, J., Galletti Vernazzani, B., Gibbons, J. and Cabrera, E. 2008. Coastal migratory connections of humpback whales *Megaptera novaeangliae* Borowski, 1781, in southern Chile. *Anales Instituto Patagonia, Serie Cs Nat. (Chile)* 36(2): 13-18.

Capella, J., Gibbons, J., Vilina, Y., Florez-Gonzales, L., Sabaj, V. and Valladares, C. 2012. Abundance, population structure and fidelity of humpback whale in the strait of Magellan, Chile. 10pp.

Douglas, A., Sears, R., Denkinger, J., Dobson, E., Olson, P., Gerrodette, T. and Calambokidis, J. 2015. Movement of a blue whale (*Balaenoptera musculus*) between the Costa Rica Dome and the Galapagos: management implications of the first documented cross-equatorial movement. Abstract presented to the 21st Bienniel Conference on the Biology of Marine Mammals. San Francisco, CA.

Félix, F., Caballero, S. and Olavarría, C. 2012. Genetic diversity and population structure of humpback whales (*Megaptera novaeangliae*) from Ecuador based on mitochondrial DNA analyses. *J. Cetacean Res. Manage* 12(1): 71-77.

Félix, F., Castro, C., Laake, J.L., Haase, B. and Scheidat, M. 2011. Abundance and survival estimates of the southeastern Pacific humpback whale stock from 1991-2006 photo-identification surveys in Ecuador. *J. Cetacean Res. Manage. (special issue 3)*: 301-08.

Flórez-González, L. 1991. Humpback whales, *Megaptera novaeangliae* in the Gorgona Island, Colombian Pacific breeding waters: population and pod characteristics. *Mem. Qld Mus.* 30(2): 291-95.

Galletti Vernazzani, B., Burton, C., Double, M., Gill, P., Jenner, C., Jenner, M., Olson, P. and Salgado-Kent, C. 2016. Comparisons among Southern Hemisphere Blue Whale Catalogue off Australia and New Zealand. Paper SC/66b/SH27 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].

Galletti Vernazzani, B., Carlson, C.A., Cabrera, E. and Brownell, J.R. 2012. Chilean blue whales off Isla Grande de Chiloe, 2004-2012: distribution, site-fidelity and behaviour. *J. Cetacean Res. Manage* 12(3): 353-60.

Galletti Vernazzani, B., Jackson, J.A., Cabrera, E., Carlson, C.A. and Brownell Jr, R.L. In review. Estimates of Abundance and Trend of Chilean blue whales off Isla de Chiloe, Chile. 46pp.

Gende, S.M., Hendrix, A.N., Acevedo, J. and Cornejo, S. 2014. The humpback whale population at risk of ship strikes in the Strait of Magellan, Chile. Paper SC/65b/SH18 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Guzman, H.M., Condit, R., Perez-Ortega, B., Capella, J.J. and Stevick, P.T. 2014. Population size and migratory connectivity of humpback whales wintering in Las Perlas Archipelago, Panama. *Mar. Mamm. Sci.* 31(90-105).

Haro, D. 2009. Individual identification of humpback whales *Megaptera novaeangliae* (Borowski, 1781) in the Gulf of Corcovado, northern Patagonia, Chile: 2003-2009. MsC thesis, Universidad Asutral de Chile.

Hucke-Gaete, R., Haro, D., Torres-Florez, J.P., Montecinos, Y., Viddi, F., Bedriñana-Romano, L., Nery, M.F. and Ruiz, J. 2013. A historical feeding ground for humpback whales in the eastern South Pacific revisited: the case of northern Patagonia, Chile. *Aquatic Conservation: Marine and Freshwater Ecosystems* 2013: DOI: 10/1002/aqc.2343.

Hucke-Gaete, R., Torres, J.P., Montecinos, Y., Cuellar, S., Ruiz, J. and Viddi, F.A. 2006. A new humpback whale (*Megaptera novaeangliae*) summer feeding ground off Chiloe and the Corcovado Gulf, southern Chile, as suggested by dedicated and opportunistic surveys (2001-2006). Paper SC/58/SH10 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). [Paper available from the Office of this Journal].

Hucke-Gaete, R., Viddi, F.A., Bedriñana-Romano, L. and Zerbini, A. 2016. Satellite tracking of blue whales (*Balaenoptera musculus*) from Patagonia (Chile) to Galapagos (Ecuador): novel insights into migratory pathways along the Eastern South Pacific. Paper SC/66b/SH16 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 11pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2012. Final report on the assessment of the Southern Hemisphere humpback whale breeding stock B. *J. Cetacean Res. Manage. (Suppl.)* 13:393-410.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 17:250-82.

International Whaling Commission. 2017. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

Jenner, C., Jenner, M., Burton, C., Sturrock, V., Salgado Kent, C., Morrice, M., Attard, C., Möller, L. and Double, M.C. 2008. Mark recapture analysis of pygmy blue whales from the Perth Canyon, Western Australia 2000-2005. Paper SC/60/SH16 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 9pp. [Paper available from the Office of this Journal].

Johnston, S.E., Zerbini, A.N. and Butterworth, D.S. 2011. A Bayesian approach to assess the status of Southern Hemisphere humpback whales (*Megaptera novaeangliae*) with an application to breeding stock G. *J. Cetacean Res. Manage. (special issue 3)*: 309-18.

Leduc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., van Waerebeek, K., Brownell, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern pacific: implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26: 740-51. [Available at: doi:10.1111/mec.13940].

Palacios, D.M. 1999. Blue whale (*Balaenoptera musculus*) occurence off the Galapagos Islands, 1978-1995. *J. Cetacean Res. Manage.* 1(1): 41-51.

Reilly, S.B. and Thayer, V.G. 1990. Blue whale (*Balaenoptera musculus*) distribution in the eastern tropical Pacific. *Mar. Mamm. Sci.* 6(4): 265-77.

Stack, S.H., Currie, J.C., Swabb, M.H., Kaufman, G.D. and Martinez, E. 2015. Evaluating citizen scientist efficacy at cataloguing humpback whales (*Megaptera novaeangliae*) using the crowdsourcing web application Match My Whale. Paper SC/66a/SH01 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 37pp. [Paper available from the Office of this Journal].

Stevick, P.T., Aguayo-Lobo, A., Allen, J.M., Chater, K., Dalla Rosa, L., Olavarria, C. and Secchi, E. 2006. Mark-recapture abundance estimates for humpback whales in the Antarctic Peninsula. Paper SC/A06/HW54 presented to the IWC Workshop on Comprehensive Assessment of Southern Hemisphere Humpback Whales, Hobart, Tasmania, 3-7 April 2006 (unpublished). 4pp. [Paper available from the Office of this Journal].

Torres-Florez, J.P., Olson, P.A., Bedriñana-Romano, L., Rosenbaum, H.C., Ruiz, J., LeDuc, R. and Hucke-Gaete, R. 2015. First documented migratory destination for eastern South Pacific blue whales. *Mar. Mamm. Sci.* 31(4): 1580-86.

Vernazzani, B.G. and Cabrera, E. 2011. Long term mark-recapture of blue whales in Chilean waters. Paper SC/63/SH8 presented to the IWC Scientific Committee, June 2011, Tromsø, Norway (unpublished). 10pp. [Paper available form the Office of this Journal].

Vernazzani, B.G., Carlson, C.A., Cabrera, E., Capella, J. and Brownell, R.L. 2008. Recent humpback whale sightings off Isla de Chiloe, 2006-2008. Paper SC/60/SH26 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 4pp. [Paper available from the Office of this Journal].

Annex A

Agenda

1. Introductory remarks and goals of the Workshop
2. Appointment of a Chair and Rapporteur(s)
3. Background on the IWC assessments of Southern Hemisphere whales
4. IWC photo-identification catalogue sharing guidelines
5. Importance of collaborative work and sharing of catalogues for assessment of whale populations: the SPLASH Project
6. Humpback whales
   - 6.1 South/Central Pacific and Antarctic Peninsula reconciled catalogue
   - 6.2 Other humpback whale catalogues
7. Blue whales
   - 7.1 Southern Hemisphere Blue Whale Catalogue
   - 7.2 Other blue whale catalogues
8. Fin whales
9. Other
10. Concluding remarks

Annex B

List of Participants

Jorge Acevedo
Laboratorio de Mamíferos Marinos, Dept. de Ecología de Ecosistemas Acuáticos, Fundación CEQUA, Avenida España 184, Punta Arenas, CHILE
E-mail: *jorge.acevedo@live.cl*

Paula Angel
Laboratorio de Ecología Molecular de Vertebrados Acuáticos, Universidad de Los Andes, Bogotá, COLOMBIA
E-mail: *pa.angel10@uniandes.edu.co*

Luis Bedriñana-Romano
Universidad Austral de Chile, Valdivia, Chile and Centro Ballena Azul, Valdivia, CHILE
E- mail: *orcahuel@gmail.com*

Laura Benitez
Fundacion Yubarta and Grupo de Investigación en Ecología Animal, Universidad del Valle, COLOMBIA
E-mail: *laudabe77@gmail.com*

Natalia Botero-Acosta
Fundación Macuáticos Colombia, Calle 27#79-167. Medellín, COLOMBIA and Marine Mammal Behavior and Cognition Lab., The University of Southern Mississippi, 118 College Drive, Hattiesburg, Mississippi, 39402, USA
E-mail: *natalia.botero@usm.edu*

Juan Capella
Whalesound Limitada, Lautaro Navarro, 1163, Punta Arenas, CHILE
E-mail: *jjcapella@yahoo.com*

Romina Carnero-Huaman
Pacifico Adventures, Los Organos, PERU
E-mail: *orca.romina@gmail.com*

Cristina Castro
Pacific Whale Foundation, Puerto López, ECUADOR
E-mail: *cristinacastro@pacificwhale.org*

Gustavo Chiang
Fundacion MERI, Av. Presidente Kennedy 5682, Vitacura, Santiago, CHILE
E-mail: *gchiang@fundacionmeri.cl*

Luciano Dalla Rosa
Laboratório de Ecologia e Conservação da Megafauna Marinha, Instituto de Oceanografia, Universidade Federal do Rio Grande, Av. Italia, Km 8, Rio Grande, RS, 96200-000, BRAZIL
E-mail: *l.dalla@furg.br*

Judith Denkinger
Colegio de Ciencias Biológicas y Ambientales, Universidad San Francisco de Quito, Quito, ECUADOR
E-mail: *jdenkinger@usfq.edu.ec*

Barbara Galletti
Centro de Conservacion Cetacea, Casilla 19178, Correo Lo Castillo, Vitacura, Santiago, CHILE
E-mail: *barbara@ccc-chile.org*

Daniela Haro
Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, Santiago, CHILE
E-mail: *daniela.haro.diaz@gmail.com*

Jennifer Jackson
British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK
E-mail: *jeck@bas.ac.uk*

Greg Kaufman
Pacific Whale Foundation, Puerto López, ECUADOR
E-mail: *greg@pacificwhale.org*

Marcel V. Morais
Pacific Whale Foundation, Puerto López, ECUADOR
E-mail: *marceldemorais@yahoo.com.br*

Carlos Olavarría
Centro de Estudos Avanzados en Zonas Aridas (CEAZA), Raúl Bitrán 1305, La Serena, CHILE
E-mail: *carlos.olavarria@ceaza.cl*

Paula Olson
Southewest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Dr., La Jolla, CA, 92037, USA
E-mail: *Paula.Olson@noaa.gov*

Aldo Pacheco
Instituto de Ciencias Naturales Alexander von Humboldt, Universidad de Antofagasta, Antofagasta, CHILE and Pacifico Adventures, Los Organos, PERU
E-mail: *babuchapv@yahoo.com*

Daniel Palacios
Marine Mammal Institute, Oregon State University, Hatfield Marine Science Center, 2030 SE Marine Science Drive, Newport, OR, 97365, USA
E-mail: *daniel.palacios@oregonstate.edu*

Guido Pavez
Instituto de Biología, Facultad de Ciências, Universidad de Valparaíso, and Centro de Investigación Eutropia, CHILE
E-mail: *guido.pavezd@gmail.com*

Maria José Peréz-Alvarez
Laboratorio de Ecología Molecular, Instituto de Ecología y Biodiversidad, Facultad de Ciencias, Universidad de Chile and, Centro de Investigación EUTROPIA, CHILE
E-mail: *mjose.perez@eutropia.cl*

Kristin Rasmussen
Panacetacea, 376 Ramsey St, St. Paul, MN, 55102, USA
E-mail: *krill@aol.com*

Vanesa Reyes
Fundacion Cethus, Buenos Aires, ARGENTINA
E-mail: *vanesa.reyes@cethus.org*

Macarena Santos
Centro de Investigación Eutropia, CHILE
E-mail: *macuits@gmail.com*

Maritza Sepulveda
Laboratorio de Ecología Aplicada, Instituto de Biologia, Centro de Investigación y Gestión de Recursos Naturales, Universidad de Valparaíso, Avenida Gran Bretaña 1111, 9o Piso, Playa Ancha, Valparaíso, CHILE
E-mail: *maritza.sepulveda@uv.cl*

Frederick Toro
Whalesound Limitada, Lautaro Navarro, 1163, Punta Arenas, CHILE
E-mail: *frederick.toro.c@gmail.com*

Juan Pablo Torres-Flores
Departamento de Genética e Evolução, Universidade Federal de São Carlos, São Carlos, S, and Centro Ballena Azul, Valdívia, CHILE
E-mail: *jptorresflorez@gmail.com*

Mauricio Ulloa
Unidad de Rescate y Conservación de Espécies Acuáticas Protegidas, Servicio Nacional de Pesca y Acuicultura (SERNAPESCA), Santiago, CHILE
E-mail: *mulloa@sernapesca.cl*

Jorge Urbán
Universidad Autonoma de Baja California Sur, Carretera al Sur Km 5.5, La Paz, Baja California Sur, CP 23080, MEXICO
E-mail: *jurban@uabcs.mx*

Clara Umaran Young
Trinity College, Dublin, IRELAND
E-mail: *ana.young@oikoschile.cl*

Alexandre Zerbini
Marine Mammal Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 7600 Sand Point Way NE, Seattle, WA, 98115-6349 and Cascadia Research Collective, 218 1/2 4th Ave, Olympia, WA, 98501, USA
E-mail: *alex.zerbini@noaa.gov*

Report of the Fourth Rangewide Workshop on the Status of North Pacific Gray Whales

Report of the Fourth Rangewide Workshop on the Status of North Pacific Gray Whales[1]

The Workshop was held at the Southwest Fisheries Science Center (SWFSC), La Jolla, California from 27-29 April 2017. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Punt (co-Convenor) welcomed the participants to the Workshop and explained that the other co-Convenor (Donovan) was unable to attend the first part of the meeting. He thanked Weller and the SWFSC for yet again hosting this meeting, the fourth in the series. He noted that the Workshop would focus on new information during days 1 and 2 whilst day 3 will focus on modelling.

1.2 Election of Chair

Punt was elected Chair for the first two days of the Workshop, with Donovan chairing the final sessions.

1.3 Appointment of rapporteurs

Brandon, Lang, Punt, Scordino, and Weller were appointed rapporteurs with assistance from the Chairs. Donovan finalised the report on the day after the meeting.

1.4 Adoption of Agenda

The adopted Agenda is given as Annex B.

1.5 Documents and data available

The list of documents is given as Annex C.

1.6 Terminology

The terminology used in this report relating to stock structure hypotheses including the geographical areas is given in Annex D.

2. PROGRESS ON 'NON-MODELLING' RECOMMENDATIONS AND NEW DATA

2.1 Updated information from the co-operative genetics study

Table 1 updates a table developed during the first rangewide Workshop (IWC, 2015) and summarises the samples available for genetic analyses of gray whales in the North Pacific.

Bickham reported that an updated version of DeWoody *et al.* (2016), that summarises the generation and initial analyses of whole genome sequences from three gray whales (two samples from Sakhalin Island, Russian Federation and one from Barrow, Alaska, USA), is provisionally accepted for publication in *Biological Bulletin.* Once published, the genome sequences will be made publicly available through the National Center for Biotechnology Information. A panel of 96 SNP loci linked to functional genes was developed from the genome sequences and used to genotype 36 biopsies representing 29 gray whales sampled off Sakhalin. Ongoing work is focused on using this 96 loci panel to genotype additional samples collected from whales off Sakhalin Island and from the three primary wintering lagoons in Baja Mexico. This latter subset of samples will be obtained from an existing collection in collaboration with Urban and colleagues, and is anticipated to result in ~200 biopsies with accompanying photo-identification data. The genotype data generated will be used to examine gray whale stock structure in the North Pacific as well as to evaluate relatedness between individuals.

Bickham and DeWoody will also present the results of work to reconstruct the historical demography of gray whales in the North Pacific using the three available genome sequences to the Scientific Committee meeting in May 2017. It is expected that these results will inform our understanding of whether patterns of historical diversity are similar for the whales currently feeding off Sakhalin and those using the northern feeding ground. The authors intend to expand the study to include full genome sequences from a broader set of samples collected from whales off Sakhalin Island as well as those overwintering in Mexican lagoons.

The Workshop thanked Bickham for providing these updates and looked forward to the presentation of both papers at SC/67a. In discussion, it was noted that the fossil history of gray whales in the North Pacific suggests that they originated in the western North Pacific and then expanded into the eastern North Pacific (Tsai and Boessenecker, 2015).

Bickham noted that a request to the government of Japan to use samples collected from gray whales off Japan in genetic analyses will be submitted through the IWC Data Availability Group under Procedure B. The objective of the study will be to integrate full genome data and/or SNP data generated from these samples to provide additional insight into the historical demography of the species. The Workshop noted that this request was relevant to the Memorandum of Co-Operation on western gray whale conservation signed by Japan, Korea, Mexico, Russian Federation and the USA and **agreed** that the results of such an analysis should provide a valuable insight into our understanding of the historical demography of North Pacific gray whales.

Lang provided a brief update on work being conducted at Southwest Fisheries Science Center that is using a genotyping-by-sequencing approach to simultaneously discover and genotype SNP loci in gray whales (n=190). This work, which includes analysis of samples from Sakhalin Island, the PCFG, and northern feeding whales, is expected to result in genotypes for hundreds to thousands of SNPs. The sequence data for this project have been generated and are currently being analysed; Lang expects to report on the results at SC/67b. The Workshop **welcomes** this work and looks forward to receiving the results at the 2018 Scientific Committee meeting.

2.2 Updated information from photo-identification studies

SC/A17/GW02 found that PCFG whales often migrated together based on a review of identification photographs of migrating gray whales encountered by whale watch naturalists in Southern California (2013-15). The authors matched all whales associated in a group containing a suspected PCFG whale to a catalogue maintained by Cascadia Research Collective. Confirmed PCFG whales were identified on 21 occasions (from 22 November to 18 March). In 15 of these cases, multiple animals were reported to be in the group and in nine of these, multiple PCFG whales

[1]Presented to the Scientific Committee as SC/67a/Rep04.

Table 1

Summary of available samples of gray whales (not all have been analysed and there may be some overlap between studies included here). When known, the number of individuals (*I*) sampled is included in parentheses after the total number of whales sampled.

Region	Reference	*N (I)*	Years	Months
Mexico (M)				
Baja California, Bahía Ballenas	Goerlitz *et al.* (2003)	2	1996	Mar.
Baja California, Bahía Magdalena	Alter *et al.* (2009)	34 (32)	2001-02, 2005-06	Feb.-Mar.
Baja California, Bahía Magdalena	Martinez (pers. comm.)	119	2012-14	-
Baja California, offshore, San Jose del Cabo	Goerlitz *et al.* (2003)	1	1996	Mar.
Baja California, Ojo de Liebre lagoon	Alter *et al.* (2009)	24	2001-02, 2005-06	Feb.-Mar.
Baja California, Ojo de Liebre lagoon	Goerlitz *et al.* (2003)	14	1997	Feb.-Mar.
Baja California, Ojo de Liebre lagoon	Martinez (pers. comm.)	85	2012-14	-
Baja California, San Ignacio lagoon	Alter *et al.* (2009)	57 (56)	2001-02, 2005-06	Feb.-Mar.
Baja California, San Ignacio lagoon	Goerlitz *et al.* (2003)	66	1996, 1997	Feb.-Mar.
Baja California, San Ignacio lagoon	Martinez (pers. comm.)	97	2012-14	-
Baja California, San Ignacio lagoon	D'Intino *et al.* (2013)	51 (40)	1996-97	-
Baja California, San Ignacio lagoon	Durban (pers. comm.)	16	2012	Mar.
ENP (not specified)	Alter *et al.* (2007)	42	-	-
Migration				
CA/OR/WA (89), AK (9), Chukotka (5)	LeDuc *et al.* (2002)	104	1979-2000	All
PCFG/South				
Pacific northwest, (not identified as PCFG)	Lang *et al.* (2014)	27 (21)	1996-2012	Jul.-Nov.
Pacific northwest	Alter *et al.* (2012)	16	150-2,690 ybp	?
Pacific northwest (not yet compared with photo data)	Lang (pers. comm.)	298	2012-15	All except Mar.
PCFG				
Pacific northwest	Ramakrishnan *et al.* (2001)	45	-	?
Pacific northwest	Lang *et al.* (2014)	113 (71)	1996-2012	Apr.-Dec.
Pacific northwest	D'Intino *et al.* (2013)	86 (59)	1996-2010	Jul.-Nov.
Pacific northwest	Frasier *et al.* (2011)	40	1995-2006	Jul.-Nov.
Pacific northwest	Steeves *et al.* (2001)	16	1995-96	Jun.-Nov.
SEA				
Alaska, Kodiak	Lang (pers. comm.)	18	2001, 2005, 2015	Jul.-Sept.
BSCS				
Russia, Chukotka	Kanda *et al.* (2010)	7	2008	Jun.-Oct.
Russia, Chukotka	Meschersky *et al.* (2015)	112 (86)	2001, 2003-05, 2007-08, 2010	-
Russia, Chukotka	Ilyashenko (pers. comm.)	~150	-	-
Russia, Chukotka	Lang *et al.* (2014)	75 (71)	1994, 2001, 2003-05	Aug.-Nov.
Russia, Koryak	Meschersky *et al.* (2015)	21 (17)	2010	Jun.-Aug.
Russia, Koryak	Lang *et al.* (2014)	21 (17)	2010	Jun.
Alaska, Barrow	Lang *et al.* (2014)	17 (14)	1997-98, 2000, 2002, 2010	Jul.-Sep.
Alaska, Barrow	Quakenbush (pers. comm.)	5	2011	Aug.
Alaska, Gambell	Quakenbush (pers. comm.)	5	2012	Aug.
SI				
Russia, Sakhalin Island	Meschersky *et al.* (2015)	22 (21)	2010-11	-
Russia, Sakhalin Island	Lang (reported)	198(156)	1995-2007, 2010-11	Jul.-Sep.
Russia, Sakhalin Island	LeDuc *et al.* (2002)	45	1995-99	Jun.-Oct.
Russia, Sakhalin Island	Bickham *et al.* (2015)	35 (28)	2011-13	Aug.-Sep.
Russia, Sakhalin Island	Bickham (pers. comm.)	56	2014-16	Aug.-Sep.
OS (excluding SI)				
Gizhiginskaya Gulf, Northern Okhotsk Sea	Filatova *et al.* (2016)	1	2016	Jun.-Jul.
SKNK				
Russia, Southern Kamchatka	Meschersky *et al.* (2015)	24 (19)	2004, 2010-11	-
Russia, Southern Kamchatka	Lang (pers. comm.)	25 (17)	1999, 2004, 2010-11	Jun.-Aug.
EJPJ				
Japan, Pacific coast	Kanda *et al.* (2010), Kato (pers. comm.)	7	1995-2016	Jan., Mar.-May, Jul.-Aug.
Japan, Sea of Japan coast	Kanda *et al.* (2010)	1	1996	May
VSC				
China	Lang (pers. comm.)	2*	1996, 2011	Nov.-Dec.

were present. Associated PCFG whales occurred in both the southbound and northbound migrations, although they were more common in the former. Of the 26 PCFG whales identified on the migration, 15 were known from previous genetic analysis to be females and 11 to be males. In the six groups with multiple animals of known sex, four contained animals of both sexes. The association of PCFG whales on both northbound and southbound migration suggests that these animals may also associate on the winter breeding grounds. A similar mechanism may occur in western gray whales as suggested by Lang *et al.* (2011). This may increase the chances that whales using the same feeding areas breed with one another, even when they migrate to a mixed-stock wintering area.

The Workshop thanked the authors for this interesting work. In discussion, it was noted that the photographs used in the study were also provided to the Russian Gray Whale Project (Olga Sychenko) for comparison with their catalogue of whales photo-identified off Sakhalin Island. Whales that feed off Sakhalin Island have been observed migrating together, or at least have been seen on the same day in the same general area, during both the southbound

Table 2

Summary of proportion of PCFG whales in different areas and time periods as defined above.

Area and months	Total identifications	Non-PCFG (0-1 Yr in PCFG)		PCFG >1 Yr	
NBNC Jun.-Nov.	21,621	1,146	5.3%	20,475	94.7%
CA[1] Jun.-Nov.	45	19	42.2%	26	57.8%
Puget Sound[2] Jun.-Nov.	75	69	92.0%	6	8.0%
Puget Sound Dec.-May	1,053	1,049	99.6%	4	0.4%
SEA Jun.-Nov.	37	16	43.2%	21	56.8%
Kodiak Jun.-Nov.	259	203	78.4%	56	21.6%
BSCS Jun.-Nov.	15	13	86.7%	2	13.3%

[1]Identifications for California were from central and southern California. [2]Puget Sound also includes sightings around the San Juan Islands, the eastern Strait of Juan de Fuca, and Boundary Bay.

and the northbound migrations (Weller and Brownell, 2012); J. Jacobsen pers. comm.) The Workshop **encourages** the authors to work with Sychenko and colleagues to develop a joint manuscript that includes results pertaining to both PCFG and Sakhalin Island whales.

The Workshop **agrees** that affiliative behaviour of whales during migration may provide a mechanism for breeding to occur within a feeding group even when migrating to mixed-stock wintering grounds. It was noted that the median date of conception recorded by Rice and Wolman (1971) was 5 December during the southbound migration in the eastern North Pacific, i.e. at a time when PCFG whales have been observed associated in groups. However, it was also noted that association of individuals during migration does not necessarily mean that they breed together; animals have a strong impetus to 'outbreed'. Genetic analyses of PCFG whales have failed to reject the hypothesis that PCFG whales breed at random with PCFG and ENP gray whales (Lang *et al.*, 2014), whilst significant differentiation has been detected between samples taken from animals feeding off Sakhalin Island and those from animals sampled in the eastern North Pacific (Lang *et al.*, 2011; LeDuc *et al.*, 2002).

The Workshop **agrees** that genetic analyses of relatedness of whales (including those associated together during migration) should improve our understanding of this issue. It **welcomes** information from Lang that SWFSC is leading ongoing work on a relatedness analysis of PCFG whales using microsatellites.

The Workshop also **recognises** that relatedness analyses (and other studies of PCFG whales) are challenged by the difficulty of defining PCFG whales. For example, Lang *et al.* (2014) defined PCFG whales as whales seen in more than two years in the PCFG region (excluding Puget Sound) during the months of June to November. Lang noted that it had been originally intended to use a more rigorous definition of PCFG whales as having been observed in the area in six or more years but that approach did not yield a sufficient sample size. However, the subsequent increase in available samples may allow an analysis using a more rigorous definition of PCFG whales. The Workshop **encourages** such an analysis, and noted that it would be interesting to see if p values for F_{ST} values for mtDNA and microsatellites would change with the number of years a whale has been observed in the PCFG area.

2.3 Updated data on mixing rates

There was no new information on mixing rates for regions in the western Pacific.

Calambokidis provided an update on mixing rates of PCFG whales in the regions of California, Puget Sound, Southeast Alaska, and Kodiak Island from the photo-identification catalogue database maintained by Cascadia Research Collective (Table 2). Rates were based on identified whales and therefore the calculations below were based on proportions of *identifications* of whales (e.g. a group of three whales where all were identified represents three identifications and a sighting where no whale was identified is not used). For the analysis, whales were treated as PCFG whales *only* if they were seen in the PCFG region (northern California to northern British Columbia including the Strait of Juan de Fuca but excluding Puget Sound, Boundary Bay or the Strait of Georgia) from June to November in two or more years.

All identifications in the Cascadia ID database through 2015 (total n=26,276) were used in the analysis. Only regions and time periods where there were >25 identifications and also where there were no other major biasing factors were included. For example, whales have been identified in migration off Southern California for matching to the PCFG (SC/A17/GW04), but use of these data to calculate the proportion of PCFG whales in the region would be biased because these studies do not try to catalogue non-PCFG whales.

How these data are incorporated into the modelling framework is discussed under Item 3.2.3.

2.4 Updated bycatch and ship strike data

SC/A17/GW03 compiled and summarised reports of non-hunting, human-caused injury and mortality (NHHCIM) of gray whales in the North Pacific from 1924 through 2015. The reports were compiled from national stranding and human interactions databases, publications and newspaper articles. Over the time period, 397 NHHCIM events were reported, with the majority of them occurring after 1980 when stranding networks were becoming well established in the USA. Of the 397 reports, 152 documented whale deaths. The remaining 245 reports were assessed using methods developed by NOAA (2012) for distinguishing serious from non-serious injuries and prorating a probability of death for seriously injured whales. Fifty-three cases were determined to be non-significant injuries primarily because human intervention resulted in disentanglement of the whale. The sum of serious injuries and deaths was 299.8 whales. Causes of NHHCIM were assigned to entanglement in fishing nets (39.7%), uncertain types of entanglement (21.5%), ship strike (19.1%), and entanglement in pot fishing gear (17.1%). The primary regions for reports were California (62.8%) and northern California through northern British Columbia (21.5%). The most common form of NHHCIM of gray whales was entanglement in fishing nets in the 1980s and 1990s. The most common cause of NHHCIM in the 2000s and 2010s was entanglement in pot fishing gear (the authors considered that it was reasonable to assume that most uncertain-type entanglements were in pot fisheries). The data presented in SC/A17/GW03 are considered to represent a minimum estimate of the number of serious injuries and deaths of gray whales because it is difficult to determine the cause of death definitively for many stranded whales, stranding networks had poor spatial coverage during all or part of the reporting time period, and injured or killed whales not observed at sea may not wash ashore or be reported at sea.

The Workshop thanked the authors for the considerable work they had undertaken in compiling these data. It **agrees** that the numbers presented represented minimum estimates of mortality – how this uncertainty is taken into account in the modelling exercise is discussed further below under Item 3.2.1.1. Reference was also made to previous efforts to compile stranding data. For example, Brownell *et al.* (2007) summarised records by region along the US west coast during the years 1975-2006. Those data included both 'natural' and human-caused strandings.

Kato commented that the Japanese stranding data (including whales that died from entanglement/entrapment, ship strikes or unknown causes) were consistent and reliable from 1982 till the present (Kato *et al.*, 2016). Therefore, in addition to the four whales known to have died from entanglement off Japan between 2005 and 2007 (IWC, 2017), an adult died off Hokkaido in 1996. In addition, six dead gray whales were documented in Japan from 1990 to 2016 for which the cause of death was undetermined.

No new information was received on gray whale bycatch or ship-strike in Russia, although a comprehensive review of entanglement risks and fishery interactions in the Russian Far East, with emphasis on Sakhalin waters, was provided by Burkanov *et al.* (2017). This review, which had been specifically encouraged by the 2016 Workshop (IWC, 2017), reinforced the conclusion that the presence of salmon and pot gear on and near the feeding areas off Sakhalin Island represents an entanglement risk, as evidenced by: (i) body scarring on Sakhalin Island whales; (ii) an observed non-lethal entanglement; (iii) an observed entanglement with unknown survival of the individual; (iv) a beached carcass with associated fishing line; and (v) an unconfirmed report of a lethal bycatch of what was likely a gray whale at Sakhalin Island.

A small working group was formed to summarise what was known about periods with reasonable levels of stranding network coverage that would have documented unintentional human-caused injuries and deaths in various parts of the gray whale's range (see text table, Brownell *et al.* (2007) and SC/A17/GW03). The working group decided, and the Workshop agreed, that the modelling should incorporate such data only back to 1982.

The net fishery for halibut, which accounted for a substantial proportion of the recorded gray whale bycatch off California in the 1980s, had greatly increased in the late 1970s and early 1980s (Barlow *et al.*, 1994; Julian and Beeson, 1997; Vojkovich and Reed, 1983). Therefore, it would not be valid to assume that the same proportion of the population was being removed annually by this fishery in years prior to 1982, the first year with reasonably reliable recording of bycatch in California (see text table). The Workshop therefore **agreed** that, for modelling, bycatches in this fishery would be treated separately from bycatches in other fisheries, under the assumption that effort increased linearly from 1975 to 1982.

Region	Years of coverage
California	1982-2015
Mexico	1995-2015
British Columbia	1990-95; 2008-15
Japan	1982-2015
Korea	??
Russia	??
Alaska	1987-2015

Although it emphasised that there was considerable uncertainty regarding bycatches and their attribution to specific fisheries, the Workshop **agreed** to consider three scenarios as follows.

- Base case: set gillnet and halibut fisheries;
- Low case: do not treat the halibut fishery and other fisheries differently; and
- High case: set gillnet, gillnet, net and halibut fisheries all combined.

The model does not include a sub-area for Puget Sound, but there have been some bycatches there. Few of the animals bycaught in Puget Sound appeared to be PCFG animals (using the 'seen twice' definition). The Workshop agreed to add the bycatches in Puget Sound to the bycatches for the California (migratory) sub-area.

There is a single record of a bycatch off Kodiak. The Workshop agreed that bycatches off Kodiak could be ignored given that the magnitude of the bycatch there is apparently small.

In discussing the work of the small group, Carretta provided additional information on fishing effort and bycatch data for drift and set-net fisheries in California. He confirmed that systematic observer logbook data from the halibut set-gillnet fishery from 1981-2011 (effort shown in Fig. 1) contained no evidence of gray whale entanglements, but noted that these data would not include whales swimming off with the nets (making the entanglements unobservable) should this have occurred. There was no observer effort in this fishery before 1981. Vojkovich and Reed (1983) reported that a near-shore commercial set gillnet fishery for white seabass operated in northern Mexican and southern Californian waters prior to the 1980s (also see Barlow *et al.* (1994) and before any official stranding records were being kept.

The Workshop noted that in California waters, at least since the 1980s, set gillnet fisheries probably accounted for a high proportion of the entanglements of gray whales,

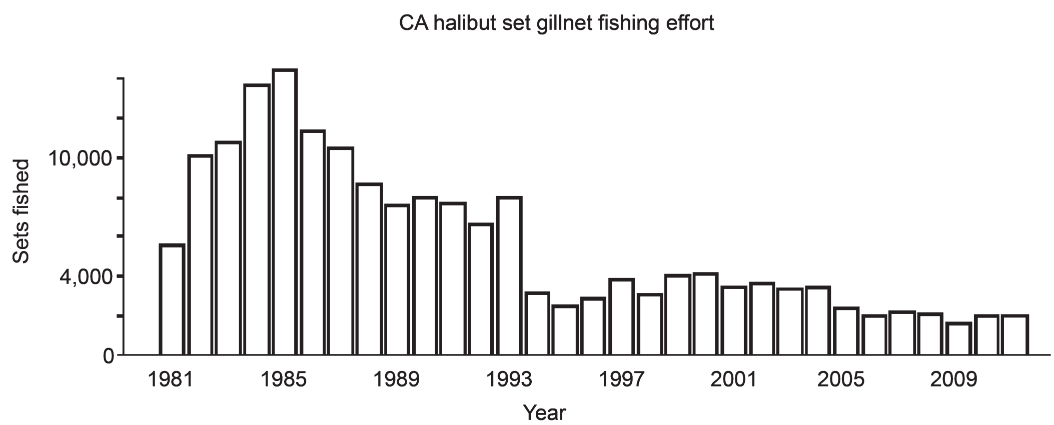


Fig. 1. Available California set net effort data for the halibut fishery.

due to their near-shore migration route (the driftnet fishery operates farther offshore). A re-examination of the data in SC/A17/GW03 was undertaken to calculate the proportion of reports of NHHCIM attributed to set net fisheries. Only the bycatches attributed to net fisheries, pot fisheries, or hook and line fisheries were included in the analysis. Events that were described as related to gillnet, halibut net, unknown net, and set gillnet were all ascribed to a 'set gillnet' category. For the period of 1982-90 the estimated proportion of California reports in this category was 0.866.

There was considerable discussion of factors that might influence trends in recorded entanglement (and ship strike) events. In recent years, for example, there have been increases in whale watching trips, availability of high-resolution cell-phone cameras, changes in stranding network effort, increases in whale abundance, and apparent increases in the rates of reporting from other countries (e.g. Canada). However, it was recognised that quantifying the effect of such factors on entanglement and ship-strike documentation is difficult.

2.5 New abundance estimates

2.5.1 PCFG whales

SC/A17/GW05 provides updated abundance estimates and information on population structure of PCFG whales based on data collected between 1996-2015. The most recent estimate for 2015, following identical methods to those used in the past, was 243 whales (SE=18.9). The abundance estimates have been relatively stable since the early 2000s but increased in the 2013-15 period. Model selection using AICc and QAICc (for the OR-NBC and NCA-NBC models) for the 30 models fitted to each set of data has changed in this updated analysis (see Table 14 of SC/A17/GW05), due in part to changes in estimates of calf survivorship.

In discussion, the authors noted that research effort in some of the peripheral study areas has varied over time but, a substantial reduction in effort/number of identifications occurred in 2015 in a core area (southern Vancouver Island, SVI). Despite this, the analyses presented showed that the population has increased since 2013. The number of calves observed in recent years has also increased, making it possible to obtain more detailed information on reproductive females and their calves. This information was reported in SC/A17/GW04 and included: inter-birth intervals, calf survivorship and mean date of weaning.

The Workshop **agrees** that SC/A17/GW05 should be referred to the ASI Working Group at SC/67a and **is pleased to learn** that the results of analyses of the 1996-2015 time series will be submitted for publication in the near future.

2.5.2 Whales migrating along the US coast

SC/A17/GW06 provides results from two years of new counts and abundance estimates for gray whales migrating southbound off the central California coast between December and February in 2014/15 and 2015/16. These counts were made from a shore-based watch station at Granite Canyon, California, and represent a continuation of the NOAA gray whale abundance time-series that began in 1967 (Laake *et al.*, 2012). Counting methods and analytical techniques for the 2014/15 and 2015/16 estimates followed those previously reviewed by the Scientific Committee and described in Durban *et al.* (2015) for four previous abundance estimates between 2006/07 and 2011/12. The 2014/15 estimate was 28,790 (95% HDPI=23,620-39,210) and the 2015/16 estimate was 26,960 (95% HDPI=24,420-29,830). There was consistency between the model predictions and observed counts for both years. However, daily and total abundance in 2014/15 was subject to considerable uncertainty with a large coefficient of variation (CV=posterior standard deviation/posterior median; CV 2015=0.13). This is likely explained in part by the results of model fitting, as significant departures from the Normal migration model were estimated in 18/90 days in 2014/15 compared to only 9/90 days in 2015/16. These departures, and the uncertainty associated with estimating an independent migration curve, constrained estimation of a precise migration curve. In contrast the CV 2016=0.05 was consistent with previous estimates using this counting approach and model (CV=0.04-0.06 for four previous estimates since 2006/07), and the authors considered this estimate to be useful in the context of the abundance time series. Differences in the CVs from the two years demonstrated the value of completing two counts and abundance estimates in back-to-back years, which provided a useful measure of redundancy.

The Workshop thanked the authors for this update. It **stresses** the great importance of maintaining this long-term dataset in understanding the population status of gray whales. In discussion, a question was raised as to whether the Normal migration curve model could be adjusted (e.g. hermite polynomial), especially for 2014/15. After e-mail correspondence with the senior author and a review of Durban *et al.* (2015), it was explained that there is a hierarchical structure underlying the Normal model for the migration trend, as well as allowance for a non-parametric fit (spline) for flexibility, following Laake *et al.* (2012).

The Workshop **agrees** that SC/A17/GW06, in combination with Durban *et al.* (2015), should be referred to the ASI Working Group at SC/67a.

SC/A17/GW07 provides an update and overview of results from shore-based surveys of northbound gray whale calves conducted between March and June from the Piedras Blancas Light Station on the central California coast each year from 1994-2016. Estimates of the total number of northbound calves displayed a high degree of inter-annual variability, ranging from 254 in 2010 to 1,528 in 2004. Calf production has been particularly high during the past five years (2012-16) with a total of >6,500 calves estimated during this period, including four of the highest years (>1,000 calves per year) since these calf counts began in 1994. The 2016 estimate of calf production (1,351) is about 5% of the estimated total abundance (26,960) of gray whales in the eastern North Pacific (recognising that this count will include at least some PCFG and WFG whales) in 2016. A trend in median migration dates was observed, indicating that the midpoint of the migration is now occurring about a week later than it did in the mid-1990s.

The Workshop thanked the authors for this update. It again **stresses** the great importance of maintaining this long-term dataset in understanding the population dynamics and conservation status of gray whales. In discussion, it was highlighted that the 23-year data set described above serves as an excellent foundation upon which to examine the interplay between changing environmental conditions and gray whale population dynamics.

The Workshop **welcomes** information that a new analysis spanning the entire 23-year data set is underway that will examine not only the relationship between sea ice and calf production, but also investigate three other primary drivers of the Arctic climate, including the Pacific Decadal Oscillation, the North Pacific Index and the Arctic Oscillation Index. These variables will also be examined in the context of the observed changes in migratory timing.

2.5.3 Whales in the Russian Far East

SC/A17/GW08 provided an updated population assessment, with emphasis on the question of stock identity, for gray whales in the western North Pacific off northeastern Sakhalin Island (SI) and southeastern Kamchatka (SKNK), Russia. Data on migration (from telemetry tracks and photo-identification matches to a gray whale catalogue from Laguna San Ignacio, Baja California, Mexico) were incorporated directly into the likelihood along with the photo-identification data from SI and SKNK. The non-calf population in 2016 was estimated to be 320-410 whales using combined data from Sakhalin Island and Kamchatka. Of these, the author concluded that an estimated 180-220 whales feed at least occasionally off Sakhalin Island and, of those, an estimated 130-170 are whales that feed predominantly off Sakhalin Island. This population has been increasing at 2-5% per year over the 20 or so years to 2015.

The author also undertook a test of the population model output against the results of a paternity analysis by Lang *et al.* (2010) which marginally rejected the hypothesis of genetic closure of the Sakhalin feeding population (/p/<0.05), but did not reject the hypothesis of genetic closure of the Sakhalin and Kamchatka feeding populations combined. The author concluded that the existence of a relict western North Pacific breeding stock (which may or may not be genetically closed) remains uncertain, but if it exists it is estimated to number ≤50 whales on the assumption that it is a subset of those that feed predominately off Sakhalin Island.

The Workshop **welcomes** these new analyses, both in the context of stock structure and abundance and in terms of the novel integration of different data types (e.g. telemetry, photo-id, genetics). It again **stresses** the great importance of maintaining this long-term dataset. However, in the unavoidable absence of the senior author (J. Cooke) and given the need for additional information regarding the research approach, methods and related interpretations of the outputs, the Workshop was unable to understand fully the analyses and interpretation of the results.

Given the complex nature of the paper and the integration of multiple types of data used in it, the Workshop **recommends** that the paper be referred to the ASI and SD working groups at SC/67a. While the work described in SC/A17/GW08 provides the only population assessment of gray whales in the western North Pacific and is extremely important, the Workshop **agrees** that it is premature to incorporate new information from the paper into its ongoing modelling work until the review at SC/67a is completed.

The Workshop also **stresses** the importance of collecting additional data (photo-identification and tissue samples) from gray whales off Kamchatka.

3. UPDATE ON MODELLING FRAMEWORK AND RUNS

3.1 Progress on modelling since SC/66

Punt reported that the intersessional modelling work had been focused on conducting model runs to explore reasons for the inability to adequately mimic the rate of increase in the BCNC sub-area. Possible reasons include the timing of the pulse in immigration and a conflict between the ability to mimic the abundance estimates for BCNC sub-area and the reduction in abundance estimates in the BSCS sub-area due to the 1999-2000 mortality event.

SC/A17/GW01 outlines an approach for updating the specifications for how to make fuller use of the bycatch and ship strike data in the model developed as part of the rangewide review. It involves identifying the range of years by sub-area for which bycatch can be calculated using available data, developing scenarios for bycatch for those years based on factors such as the proportion of strandings that are observed, and selecting an approach (such as an exponential increase) to extrapolate bycatch by sub-area back to 1930. Future bycatch can be projected based on a set of exploitation rates by sub-area where these rates by sub-area are a product of a reference bycatch exploitation rate and a time-series of relative exploitation rates.

The Workshop thanked Punt for his usual diligent work. It noted that issues surrounding bycatch are discussed under Items 2.4 and 3.2.1.

Table 3

Recent catches in the BSCS sub-area.

Year	Male	Female	Unknown	Total
2010	57	61	0	118
2011	59	68	3	130
2012	50	89	4	143
2013	41	86	0	127
2014	42	80	2	124
2015	49	75	1	125
2016	54	66	0	120

3.2 Finalise data sets

3.2.1 Removals

3.2.1.1 ABORIGINAL CATCHES

Allison provided updated catches by Russia in the BSCS sub-area (Table 3) for 2010-16. The catch data for the BSCS sub-area for 2010 to 2015 used in the model will be updated based on the revised catches, with animals of unknown sex pro-rated.

3.2.1.2 BYCATCH AND SHIP STRIKES

Item 2.4 outlines the updated information on bycatch. The Workshop **agrees** that the reports of bycatches and ship strikes will greatly underestimate the actual occurrence and spent considerable time discussing how the uncertainty in the removals attributed to these causes should be included in the modelling.

Historical bycatch rates are variable across both time and space (e.g. due to changes in fishing effort and gear type in an area). The previously agreed base case value of 4.0 for a multiplicative correction factor was taken from a study of coastal bottlenose dolphin strandings off California (Carretta *et al.*, 2016). The Workshop **agrees** that further scenarios should be considered and noted that multipliers should refer to observed number of deaths (rather than estimates of whether death might have occurred) to avoid double counting of serious injuries that lead to deaths.

The Workshop **agrees** that multipliers of 10 and 20 should be considered. These values are based on the results of the Punt and Wade (2012) assessment of 'eastern' gray whales. Those authors compared the model-estimated number of deaths during the 1999/2000 mortality event, with the number of reported strandings and included a multiplier of 20.0 to test for plausibility/feasibility. With respect to the latter, it was noted that high correction factors (≥20 times) may not be consistent with survival rates estimated from photo-identification studies (e.g. see SC/A17/GW05). The Workshop **agrees** that a comparison between model survival rates resulting from applied bycatch mortality correction factors and rates estimated from photo-identification data should be carried out to inform or bound plausible rates of cryptic or unreported human-caused mortality.

Table 4

Abundance estimates for: (a) the Sakhalin feeding 'stock', not all of which will be present in Sakhalin in any given year (J.G. Cooke, pers. comm.) [note this will need to be updated after SC/67a discussions]; and (b) the PCFG based on mark-recapture analysis from SC/A17/GW05. Note that these values are from the Workshop – the approach was changed at SC/67a.

Year	Estimate	CV	Estimate	CV
	Sakhalin		**PCFG**	
1995	68.9	0.0567	-	-
1996	71.1	0.0513	-	-
1997	76.3	0.0367	-	-
1998	78.7	0.0338	126	0.087
1999	87.2	0.0240	145	0.101
2000	87.7	0.0235	146	0.098
2001	92.3	0.0190	178	0.076
2002	97.2	0.0172	197	0.069
2003	104.8	0.0170	207	0.084
2004	114.6	0.0175	216	0.077
2005	120.2	0.0191	215	0.125
2006	126.2	0.0181	197	0.108
2007	128.0	0.0192	192	0.136
2008	128.8	0.0215	210	0.089
2009	131.1	0.0232	208	0.101
2010	137.2	0.0238	200	0.095
2011	141.1	0.0240	205	0.078
2012	152.0	0.0282	217	0.052
2013	155.6	0.0333	235	0.059
2014	164.3	0.0390	238	0.080
2015	-	-	243	0.078

Although it was recognised that in some areas (e.g. Alaska and Russia), stranding detection and reporting effort is more limited (or non-existent) than in others (e.g. California and Canada), the Workshop **concludes** that insufficient data are available to incorporate different correction factors by area, noting that such stratification would be unlikely to greatly affect model performance.

The net fishery that targeted *inter alia* halibut, which led to an appreciable proportion of the recorded gray whale bycatch off California during the 1980s, greatly increased in the late 1970s and early 1980s (Barlow *et al.*, 1994). Thus, the assumption that the same proportion of the population was bycaught prior to the first year with reliable recording of bycatch (1982) is unlikely to be valid for California. The Workshop **agrees** that the modelling will treat bycatches by this net fishery separately from those by other fisheries, under the assumption that effort increased linearly from 1975 to 1982. There is uncertainty regarding which bycatches are due to this net fishery.

The Workshop **agrees** to consider three scenarios regarding which bycatches should be attributed to the net fishery:

- base case: set gillnet and halibut fisheries;
- low case: do not treat the net fishery differently from the remaining fisheries; and
- high case: set gillnet, gillnet, net and halibut fisheries combined.

The model does not include a sub-area for Puget Sound, but there is some bycatch there. Few of the bycaught animals in Puget Sound appear to be PCFG animals (using the 'seen' twice definition). The Workshop **agrees** to add the bycatches in Puget Sound to the bycatches for the California (migratory) sub-area. There is a single record of a bycatch off Kodiak. The Workshop **agrees** that bycatch off Kodiak can be ignored given its apparently small magnitude.

3.2.2 Abundance estimates

As noted under Item 2.5, the Workshop **agrees** that SC/A17/GW06 (in combination with Durban *et al.* (2015) and SC/A17/GW08 should be referred to the ASI Working Group at SC/67a. Tables 4 and 5 list the provisional updated estimates of abundance for use when conditioning the trials.

Table 5

Estimates of absolute abundance for the eastern North Pacific stock of gray whales (recognising that this will include some PCFG and WFG animals) based on shore counts (source: 1967/78-2006/07: Laake *et al*, 2012; 2006/07-2010/11: Durban *et al*, 2015; SC/A17/GW06).

Year	Estimate	CV	Year	Estimate	CV
1967/68	13,426	0.094	1987/88	26,916	0.058
1968/69	14,548	0.080	1992/93	15,762	0.067
1969/70	14,553	0.083	1993/94	20,103	0.055
1970/71	12,771	0.081	1995/96	20,944	0.061
1971/72	11,079	0.092	1997/98	21,135	0.068
1972/73	17,365	0.079	2000/01	16,369	0.061
1973/74	17,375	0.082	2001/02	16,033	0.069
1974/75	15,290	0.084	2006/07	19,126	0.071
1975/76	17,564	0.086	2006/07	20,750	0.060
1976/77	18,377	0.080	2007/08	17,820	0.054
1977/78	19,538	0.088	2009/10	21,210	0.046
1978/79	15,384	0.080	2010/11	20,990	0.044
1979/80	19,763	0.083	2014/15	28,790	0.130
1984/85	23,499	0.089	2015/16	26,960	0.050
1985/86	22,921	0.081			

3.2.3 Mixing proportions

Following discussions under Item 2.3, the Workshop **agrees** that the following approach (developed by Punt) should be used to estimate a mixing rate (and a measure of its uncertainty) for the BCNC sub-area during the migratory months for use when fitting the population dynamics model.

Estimates of the proportion of PCFG whales are available for eight areas within the BCNC sub-area (northern British Columbia, western Vancouver Island, southern Vancouver Island, Strait of Juan de Fuca, northern Washington, southern Washington, northern Oregon, southern Oregon, and northern California) for some of the 'migratory' months (December-May).

One simple model is to assume that the true proportion of PCFG whales by area and month is drawn from a beta distribution, with parameters α and β, i.e. $\rho \sim B(\alpha,\beta)$ where ρ is the mixing proportion for a combination of area and month. The values for α and β (and hence the estimate of the mean proportion and its uncertainty) can be estimated under the assumption that the number of animals identified to be PCFG whales is binomially distributed. This model can be compared to alternative models in which the mean and variance of the true proportion of PCFG whales differs among sub-areas. If the latter (or another) model is found to have support compared to the simple model, consideration should be given to including additional sub-areas in the model, each of which is associated with a different time-series of bycatch from entanglements and ship strikes.

3.3 Further development of trials to reflect uncertainty and anthropogenic removals

3.3.1 Review of stock structure hypotheses

The Workshop first reviewed the terminology used in specifying the models representing the stock structure hypotheses under consideration. The Workshop **agrees** that the region representing the feeding area off southern Kamchatka, which was previously labelled as East Kamchatka and the Kuril Islands (EKK), should be renamed as South Kamchatka and the Northern Kurils (SKNK) to clarify that this feeding area is distinct from more northern regions of Kamchatka's eastern coast, which may be used by NFG whales. The full terminology is provided as Annex D.

Table 6

A summary of the stock structure hypotheses initially under consideration (2015, 2016) and their status.

Description	Status	Comment
(1) Panmixia with no matrilineal fidelity to feeding grounds - persistent		
A single breeding stock; no matrilineal fidelity to feeding grounds.	No	Not consistent with available data (IWC, 2015).
(2) Panmixia with no matrilineal fidelity to feeding grounds - post-exploitation		
A single breeding stock exists, although multiple stocks may have existed in the past. No matrilineal fidelity to feeding grounds.	No	Not consistent with available data (IWC, 2015).
(3) Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating		
(a) A single breeding stock (EBS) exists. The EBS includes three feeding groups: NFG, PCFG, WFG. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG.	*High*	-
(b) The EBS is as described in 3a, except that NFG whales do not feed off SKNK. In addition, a WBS exists that overwinters in VSC and feeds in the OS (but not SI) and SKNK. Thus SKNK is used by both the WFG whales and the whales of the WBS.	Low	Few or no data to assess plausibility (IWC, 2015), but may be reconsidered during SC/67a.
(c) Same as 3a except that WFG whales migrating from SI to M occasionally travel through BSCS.	Medium	Sensitivity test
(d) Same as 3a except the EBS contains the original three feeding groups and a fourth feeding group that uses SEA.	Low	Few or no data to assess plausibility (IWC, 2015).
(e) Same as 3a except that a WBS exists that feeds in the OS (but not SI), EJPJ, and KWJ and overwinters in VSC.	*High*	
(4) Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating		
(a) Two breeding stocks exist and overwinter in M. One breeding stock includes NFG and PCFG, and the second breeding stock includes WFG whales. Separation between breeding stocks is maintained by WFG whales mating largely with each other while migrating to M.	Low	Represented in the same way as other hypotheses in modelling (IWC, 2015).
(b) Same as 3b except that a WBS exists and is made up of WFG whales that largely breed with each other while on migration to M.	Low	Represented in the same way as other hypotheses in modelling (IWC, 2015).
(5) Maternal feeding ground fidelity, two migratory routes/wintering grounds used by Sakhalin whales, random mating.		
(a) Two breeding stocks exist: EBS and WBS. The EBS includes three feeding groups: PCFG, North, and the WFG that feeds off SI. The WBS whales feed in SI, OS, and SKNK and then migrate to VSC to overwinter. SKNK is used by the WFG, the NFG, and the feeding whales that are part of the WBS.	*High*	-
(b) Three breeding stocks exist. The EBS is as described in 5a. Two breeding stocks exist in the WNP. Both W breeding stocks feed in SI, OS, and SKNK but whales show fidelity to two different migratory routes (Pacific coast of Japan and eastern Sea of Japan) and use two separate wintering grounds.	Low	Few or no data to assess plausibility (IWC, 2015).
(6) Maternal feeding ground fidelity, Sakhalin whales use two migratory routes/wintering grounds without fidelity, random mating		
(a) A single breeding stock exists that uses wintering grounds off M as well as of VSC. Whales do not exhibit fidelity to a wintering ground. Three feeding groups exist: WFG, NFG, and PCFG. SKNK is used by both WFG and NFG.	Low	Few or no data to assess plausibility (IWC, 2015).
(b) Same as 6a, except the WFG whales largely breed with each other during migration, creating a second breeding stock. Whales from both breeding stocks overwinter in M and in VSC, and show no fidelity to a wintering ground.	*High*[1]	-
(c) Same as 6a except that females' part of the WFG show fidelity to one of the two wintering areas (M and VSC), while males of the WFG do not show fidelity to a wintering ground.	Low	Few or no data to assess plausibility (IWC, 2015); modelling framework represented in the same way as other hypotheses (IWC, 2015).
(7) Maternal feeding ground fidelity, Sakhalin whales use two migratory routes/wintering grounds with fidelity, non-random mating		
Three breeding stocks exist - a breeding stock comprised of WFG whales that migrate to M, a breeding stock (EBS) comprised of PCFG and NFG whales, and a WBS that includes whales that feed off SI and in the OS.	Low	Modelling framework represented in the same way as other hypotheses (IWC, 2015).

[1]Initially considered to be of low priority because modelling framework represented in the same way as other hypotheses (IWC, 2015); when revisited, the Workshop determined that this hypothesis does differ from 5a, in that: (1) all catches off Japan are assumed to be Western stock animals; and (2) the abundance estimates off Sakhalin Island are assumed to relate only to the Western stock. Thus the Workshop agreed to change the status of this hypothesis to high priority (IWC, 2017).

The Workshop reviewed the stock structure hypotheses developed at the first two Workshops (IWC, 2015; 2016); see Table 6). They agreed that the four hypotheses (3a, 3e, 5a, 6b) identified as high priority in past discussions (IWC, 2015; 2016; 2017) should continue to be included in the modelling framework, while the status of the remaining hypotheses, which were classified as inconsistent with the data or of low priority for modelling, should remain the same. However, the Workshop noted that hypothesis 3b, which was previously considered to be a low priority as few data were available to assess its plausibility, might need to be reconsidered in view of the new information put forward in SC/A17/GW08. In hypothesis 3b, the SKNK region is used by two groups of whales: (1) WFG whales that feed off SI and in the SKNK and overwinter in Mexico; and (2) WBS whales that feed in the Okhotsk Sea (but not off SI) and SKNK and overwinter in the WNP. An estimate of the number of whales that feed off SI and/or NKSK is provided in SC/A17/GW08 and might be useful in informing hypothesis 3b. As noted previously, the Workshop **agrees** that additional discussion of SC/A17/GW08 would be needed at SC/67a, when it is expected that Cooke will be available to address the questions raised about the data and their interpretation; the status of hypothesis 3b will need to be reconsidered following that discussion.

The Workshop discussed recent findings of what are thought to be gray whale calls detected on hydrophones towed by a Navy vessel conducting acoustic monitoring in the East China Sea (IWC/66/CC29) These calls were detected between September and March, with whales generally moving south during fall and north during spring months, consistent with migratory movements.

In discussion, it was noted that additional exploration of the acoustic data collected by the Navy in the East China Sea was needed. Regina Guazzo (Scripps Institution of Oceanography and affiliated with the US Space and Naval Warfare Systems Command) has developed an automated call detection algorithm for gray whale calls, which has been used to localise and track gray whales as they migrate

Table 7

Factors considered in the model scenarios. The bold values are the base-levels.

Factor	Levels
Model fitting related	
Stock hypothesis	**3a, 3b, 3e, 5a, 6b**
Proportion of 'Western' stock in Sakhalin sub-area	**0** (stock hypotheses 3a, 3e), **0.33** (stock hypothesis 5a), 0.70
$MSYR_{1+}$ (western)	As for WFG
$MSYR_{1+}$ (north)	**4.5%**, 5.5%, estimated (common); estimate (separately)
$MSYR_{1+}$ (WFG)	**4.5%**, 5.5%, estimated (common); estimate (separately)
$MSYR_{1+}$ (PCFG)	2%, **4.5%**¸ estimated (common); estimate (separately)
Matches	Definite; definite + likely (Table 2 of IWC, 2017)
Immigration into the PCFG	**0, 2**, 4
Bycatches assigned to set gillnet fishery	None; set gillnet + halibut; set gillnet + halibut + gillnet + net
Bycatches and ship strikes	Numbers dead + M/SI, dead x 4; dead x 10; dead x 20
Pulse migrations into the PCFG	10, **20**, 30
Bycatch off Sakhalin Island	**1.5**, 3
Projection-related	
Northern need in final year (from 150 in 2014)	**340**, 530
Struck and lost rate	25% **50%**, 75%
Future effort	**Constant**, increase by 100% over 100 years
Probability of mismatching a north whale, p_1	**0.01**
Probability of mismatching a PCFG, p_2	0.05
PCFG harvest month	**Migratory**

past hydrophones placed off the coast of central California (Guazzo *et al.*, 2014; 2016). The Workshop **recommends** that Guazzo is requested to assist with further analysis of the acoustic data collected in the East China Sea for the purposes of validating species identification and comparing the call types and timing of the East China Sea calls with those collected on the migratory route off central California.

3.3.2 Changes to the trials specifications

The revised specifications for the trials were discussed at the Workshop. These will not be published here as the work is ongoing. The major structural changes from the previously agreed specifications (IWC, 2017) are:

(a) direct removal of the bycatches for the period for which detection and reporting of entanglements, ship strikes, and stranding in general was considered relatively good instead of assuming a constant rate of non-hunting related mortality;
(b) allowance for several ways for back-projecting entanglements and ship strikes, including different treatment of entanglements in the set gillnet and other fisheries;
(c) the bycatch due to entanglement and ship strikes will be included separately in the model with selectivity for bycatch due to entanglements set to ages 0-5 years and to uniform over all ages for ship strikes. SC/A17/GW03 reports that ~90% of entangled gray whales are <1,100cm (or approximately five years); and
(d) inclusion of the survival rate for the PCFG breeding stock (SC/A17/GW06) as part of the conditioning.

3.3.3 Base-case trials and sensitivity tests

The Workshop reviewed the factors on which the trials are based. Table 7 outlines the set of factors and levels considered in the trials. The changes from the factors considered in the previous trials (IWC, 2017) related to conditioning are:

(a) inclusion of stock hypotheses 3b (see discussion of SC/A17/GW08) and 6b (added in (IWC, 2017));
(b) inclusion of three factors on which to base hindcasting of entanglements off California; and
(c) revision of the approach used to scale bycatch estimates to reflect under-reporting.

Table 8 lists the set of trials based on the discussions during the Workshop. This list may be revised once further review of the abundance estimates for Sakhalin and Kamchatka has occurred (see Item 2.5) and further discussion of hypothesis 3b. The Workshop **agrees** that initial calculations (to be undertaken during SC/67a) should focus on the trials in which bycatch is taken to be the observed numbers dead multiplied by four, in case the trials with higher multipliers are not able to the fit the abundance data. In addition, initial trials should set MSYR, but it may be necessary to estimate MSYR if some of the model fits are poor.

3.3.4 Projections

Projection will be undertaken from all combinations of the factors in Table 7. The factors reflect those selected during the 3rd Rangewide Workshop, except the projections for Sakhalin Island will be conducted for changes in human-related removal rates as well as for constant removals of 1.5 and 3 animals per year.

4. WORK PLAN

Before SC/67a:
(1) Calambokidis – mixing rates up to 2015; and
(2) Calambokidis - IDs of stranded animals (with and without cause of death).

During SC/67a:
(1) present the 2014/15 and 2015/16 southbound estimates of abundance for formal adoption (ASI);
(2) present the updated time-series of abundance estimates for BCNC sub-area for formal adoption (ASI);
(3) review the model applied to estimate abundance for gray whales off Sakhalin and Kamchatka (ASI);
(4) review hypothesis 3b (SD);
(5) code the trials and provide initial validation runs (Punt);
(6) update specifications (Punt);
(7) develop a proposal for a final Workshop (Donovan and Punt); and
(8) develop a proposal for a small CMP drafting group meeting (Donovan and Reeves).

After SC/67a:
(1) complete all projections and develop a paper; and
(2) hold intersessional Workshop.

Table 8

Draft final trial specifications.

Trial	Description/stock hypothesis	PCFG/BSCS	MSYR$_{1+}$			Sakhalin western prop^n	PCFG		
			North	PCFG	WFG		Imm.	Pulse	Bycatch
1A	Reference 3a	No	4.5%	4.5%	4.5%	0	2	20	x4
1B	Reference 3e	No	4.5%	4.5%	4.5%	0	2	20	x4
1C	Reference 5a	No	4.5%	4.5%	4.5%	0.33	2	20	x4
1D	Stock hypothesis 3b	No	4.5%	4.5%	4.5%	0	2	20	x4
1E	Stock hypothesis 6b	No	4.5%	4.5%	4.5%	1	2	20	x4
2A	Lower MSYR PCFG 3a	No	**4.5%**	**2%**	**4.5%**	0	2	20	x4
2B	Lower MSYR PCFG 3e	No	**4.5%**	**2%**	**4.5%**	0	2	20	x4
2C	Lower MSYR PCFG 5a	No	**4.5%**	**2%**	**4.5%**	0.33	2	20	x4
3A	Higher MSYR WFG and North 3a	No	**5.5%**	**5.5%**	**4.5%**	0	2	20	x4
3B	Higher MSYR WFG and North 3e	No	**5.5%**	**5.5%**	**4.5%**	0	2	20	x4
3C	Higher MSYR WFG and North 5a	No	**5.5%**	**5.5%**	**4.5%**	0.4	2	20	x4
4C	Higher WBS in Sakhalin 5a	No	4.5%	4.5%	4.5%	**0.7**	2	20	x4
5E	Higher WBS in Mexico=0.7	No	4.5%	4.5%	4.5%	1	2	20	x4
6A	Alternative matches 3a	No	4.5%	4.5%	4.5%	0	2	20	x4
6B	Alternative matches 3e	No	4.5%	4.5%	4.5%	0	2	20	x4
6C	Alternative matches 5a	No	4.5%	4.5%	4.5%	0.33	2	20	x4
7A	Lower PCFG Immigration 3a	No	4.5%	4.5%	4.5%	0	**0**	20	x4
7B	Lower PCFG Immigration 3e	No	4.5%	4.5%	4.5%	0	**0**	20	x4
7C	Lower PCFG Immigration 5a	No	4.5%	4.5%	4.5%	0.33	**0**	20	x4
8A	Higher PCFG Immigration 3a	No	4.5%	4.5%	4.5%	0	**4**	20	x4
8B	Higher PCFG Immigration 3e	No	4.5%	4.5%	4.5%	0	**4**	20	x4
8C	Higher PCFG Immigration 5a	No	4.5%	4.5%	4.5%	0.33	**4**	20	x4
9A	Lower Pulse into PCFG 3a	No	4.5%	4.5%	4.5%	0	2	**10**	x4
9B	Lower Pulse into PCFG 3e	No	4.5%	4.5%	4.5%	0	2	**10**	x4
9C	Lower Pulse into PCFG 5a	No	4.5%	4.5%	4.5%	0.33	2	**10**	x4
10A	Higher pulse into PCFG 3a	No	4.5%	4.5%	4.5%	0	2	**30**	x4
10B	Higher pulse into PCFG 3e	No	4.5%	4.5%	4.5%	0	2	**30**	x4
10C	Higher pulse into PCFG 5a	No	4.5%	4.5%	4.5%	0.33	2	**30**	x4
11A	Bycatch=Dead x MSI	No	4.5%	4.5%	4.5%	0	2	20	**+ MSI**
11B	Bycatch x 4 3e	No	4.5%	4.5%	4.5%	0	2	20	**+ MSI**
11C	Bycatch x 4 5a	No	4.5%	4.5%	4.5%	0.33	2	20	**+ MSI**
12A	Bycatch x 10 3a	No	4.5%	4.5%	4.5%	0	2	20	**x10**
12B	Bycatch x 10 3e	No	4.5%	4.5%	4.5%	0	2	20	**x10**
12C	Bycatch x 10 5a	No	4.5%	4.5%	4.5%	0.33	2	20	**x10**
13A	Bycatch x 20 3a	No	4.5%	4.5%	4.5%	0	2	20	**x20**
13B	Bycatch x 20 3e	No	4.5%	4.5%	4.5%	0	2	20	**x20**
13C	Bycatch x 20 3e	No	4.5%	4.5%	4.5%	0.33	2	20	**x20**
14A	Set Gillnet=None 3a	No	4.5%	4.5%	4.5%	0	2	20	x4
14B	Set Gillnet=None 3e	No	4.5%	4.5%	4.5%	0	2	20	x4
14C	Set Gillnet=None 5a	No	4.5%	4.5%	4.5%	0.33	2	20	x4
15A	Set Gillnet=set gillnet, halibut, gillet, net 3a	No	4.5%	4.5%	4.5%	0	2	20	x4
15B	Set Gillnet=set gillnet, halibut, gillet, net 3e	No	4.5%	4.5%	4.5%	0	2	20	x4
15C	Set Gillnet=set gillnet, halibut, gillet, net 5a	No	4.5%	4.5%	4.5%	0.33	2	20	x4
16A	PCFG in BSCS (CHECK)	**Yes**	4.5%	4.5%	4.5%	0	2	20	x4
16B	PCFG in BSCS (CHECK)	**Yes**	4.5%	4.5%	4.5%	0	2	20	x4
16C	PCFG in BSCS (CHECK)	**Yes**	4.5%	4.5%	4.5%	0.33	2	20	x4
17A	MSYR$_{1+}$ estimated (common) 3a	No		**Estimated**		0	2	20	4
17B	MSYR$_{1+}$ estimated (common) 3e	No		**Estimated**		0	2	20	4
17C	MSYR$_{1+}$ estimated (common) 5a	No		**Estimated**		0.33	2	20	4
18A	MSYR$_{1+}$ estimated (by FA) 3a	No	**Est**	**Est**	**Est**	0	2	20	x4
18B	MSYR$_{1+}$ estimated (by FA) 3e	No	**Est**	**Est**	**Est**	0	2	20	x4
18C	MSYR$_{1+}$ estimated (FA) 5a	No	**Est**	**Est**	**Est**	0.33	2	20	x4
19A	Lower PCFG immigration and higher bycatch 3a	No	4.5%	4.5%	4.5%	0	**0**	20	**x10**
19B	Lower PCFG immigration and higher bycatch 3e	No	4.5%	4.5%	4.5%	0	**0**	20	**x10**
19C	Lower PCFG immigration and higher bycatch 5a	No	4.5%	4.5%	4.5%	0.33	**0**	20	**x10**
20A	MSYR estimated and lower pulse 3a	No	**Est**	**Est**	**Est**	0	2	**10**	x4
20B	MSYR estimated and lower pulse 3e	No	**Est**	**Est**	**Est**	0	2	**10**	x4
20C	MSYR estimated and lower pulse 5a	No	**Est**	**Est**	**Est**	0.33	2	**10**	x4
21A	MSYR estimated and higher pulse 3a	No	**Est**	**Est**	**Est**	0	2	**30**	x4
21B	MSYR estimated and higher pulse 3e	No	**Est**	**Est**	**Est**	0	2	**30**	x4
21C	MSYR estimated and higher pulse 5a	No	**Est**	**Est**	**Est**	0.33	2	**30**	x4
22A	MSYR estimated and higher immigration 3a	No	**Est**	**Est**	**Est**	0	**4**	20	x4
22B	MSYR estimated and higher immigration 3e	No	**Est**	**Est**	**Est**	0	**4**	20	x4
22C	MSYR estimated and higher immigration 5a	No	**Est**	**Est**	**Est**	0.33	**4**	20	x4
23A	MSYR estimated and much higher immigration 3a	No	**Est**	**Est**	**Est**	0	**8**	20	x4
23B	MSYR estimated and much higher immigration 3e	No	**Est**	**Est**	**Est**	0	**8**	20	x4
23C	MSYR estimated and much higher immigration 5a	No	**Est**	**Est**	**Est**	0.33	**8**	20	x4

5. RELATIONSHIP TO CMP DISCUSSIONS

The Workshop **supports** the proposed stakeholder workshop agreed at IWC/66 and likely to be held in 2018. It **agrees** that the updated CMP will require information from the additional modelling work proposed at the present Workshop. It also **agrees** that a proposal for a small drafting group to meet to continue to update the present CMP should be drafted and that that the meeting should be held well in advance of the stakeholder workshop.

6. ADOPTION OF REPORT

The report will be adopted by email. Donovan and Punt reiterated their thanks to the rapporteurs and to Weller and Lang and the staff of SWFSC for holding the Workshop in their excellent facilities.

REFERENCES

Alter, S.E., Flores, S.R., Nigenda, S., Urban, J.R., Rojas Bracho, L. and Palumbi, S.R. 2009. Mitochondrial and nuclear genetic variation across calving lagoons in eastern North Pacific gray whales (*Eschrichtius robustus*). *J. Hered.* 100: 34-46.

Alter, S.E., Newsome, S. and Palumbi, S.R. 2012. Pre-whaling genetic diversity and population ecology in Eastern Pacific gray whales: Insights for the ancient DNA and stable isotopes. *PLoS ONE* 7: e35039.

Alter, S.E., Rynes, E. and Palumbi, S.R. 2007. DNA evidence for historic population size and past ecosystem impacts of gray whales. *Proc. Natl. Acad. Sci. USA* 104(38): 15162-67.

Barlow, J., Baird, R.W., Heyning, J.E., Wynne, K., Manville, A.M., Lowry, L.F., Hanan, D., Sease, J. and Burkanov, V.N. 1994. A review of cetacean and pinniped mortality in coastal fisheries along the west coast of the USA and Canada and the east coast of the Russian Federation. *Rep. Int. Whal. Comm. (special issue)* 15: 405-26.

Bickham, J.W., Brykov, V.A., Dewoody, J.A. and Godard-Codding, C.A.J. 2015. Mitochondrial DNA analyses of western gray whale biopsy samples collected off Sakhalin Island in 2011 to 2013. Paper SC/66a/SD04rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 14pp. [Paper available from the Office of this Journal].

Brownell, R.L., Makeyev, C.A.F. and Rowles, T.K. 2007. Stranding trends for eastern gray whales, *Eschrichtius robustus*: 1975-2006. Paper SC/59/BRG40 presented to the IWC Scientific Committee, May 2007, Anchorage, Alaska (unpublished). 11pp. [Paper available from the Office of this Journal].

Burkanov, V.N., Lowry, L.F., Weller, D.W. and Reeves, R.R. 2017. Entanglement risk to western gray whales in Russian Far East fisheries. Working paper submitted to IUCN for Western Gray Whale Panel. Gland, Switzerland.

Carretta, J.V., Danil, K., Chivers, S.J., Weller, D.W., Janiger, D.S., Berman-Kowalewski, M., Hernandez, K.M., Harvey, J.T., Dunkin, R.C., Casper, D.R., Stoudt, S., Flannery, M., Wilkinson, K., Huggins, J. and Lambourn, D.M. 2016. Recovery rates of bottlenose dolphins (*Tursiops truncatus*) carcasses estimated from stranding and survival rate data. *Mar. Mam. Sci.* 32(1): 349-62.

D'Intino, A.M., Darling, J.D., Urbán R., J. and Frasier, T.R. 2013. Lack of nuclear differentiation suggests reproductive connectivity between 'southern feeding group' and the larger population of eastern North Pacific gray whales, despite previous detection of mitochondrial differences. *J. Cetacean Res. Manage* 13(2): 97-104.

DeWoody, J.A., Fernandez, N.B., Brüniche-Olsen, A., Antonides, J.D., Doyle, J.M., San Miguel, P., Westerman, R., Godard-Codding, C. and Bickham, J.W. 2016. Novel single nucleotide polymorphisms from functional genes in the gray whale (*Eschrichtius robustus*) genome provide a powerful genotyping platform. Paper SC/66b/DNA04 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 58pp. [Paper available from the Office of this Journal].

Durban, J., Weller, D., Lang, A. and Perryman, W. 2015. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. *J. Cetacean Res. Manage.* 15: 61-68.

Filatova, O.A., Shpak, O.V., Paramonov, A.Y., Glazov, D.M., Grechev, A.I. and Meschersky, I.G. 2016. Cetacean encounters in the coastal waters of the northern Okhotsk Sea in the summer 2016. Marine Mammals of the Holarctic, IX International Conference, Astrakhan, Russia, 31 October - 5 November 2016.

Frasier, T.R., Koroscil, S.M., White, B.N. and Darling, J.D. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. *Endang. Species Res.* 14: 39-48.

Goerlitz, D.S., Urbán R., J., Rojas-Bracho, L., Belson, M. and Schaeff, C.M. 2003. Mitochondrial DNA variation among Eastern North Pacific gray whales (*Eschrichtius robustus*) on winter breeding grounds in Baja California. *Can. J. Zool.* 8: 1965-72.

Guazzo, R.A., Hildebrand, J.A. and Wiggins, S.M. 2014. Acoustic detection of migrating gray, humpback, and blue whales in the coastal, northeast Pacific. *J. Acoust. Soc. Am.* 136(4): 2153-53.

Guazzo, R.A., Hildebrand, J.A., Wiggins, S.M., D'Spain, G.L. and Weller, D.W. 2016. The correlation between the local environment and gray whale behavior as tracked using a sparse hydrophone array in Monterey Bay National Marine Sanctuary. *J. Acoust. Soc. Am.* 140(4): 3360.

International Whaling Commission. 2015. Report of the Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, 8-11 April 2014, La Jolla, California, USA. *J. Cetacean Res. Manage. (Suppl.)* 16:487-528.

International Whaling Commission. 2016. Report of the Second Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, 1-3 April 2015, La Jolla, CA, USA. *J. Cetacean Res. Manage. (Suppl.)* 17:565-82.

International Whaling Commission. 2017. Report of the Third Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, 18-20 April 2016, La Jolla, CA, USA. *J. Cetacean Res. Manage. (Suppl.)* 18:641-71.

Julian, F. and Beeson, M. 1997. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. *Fish. Bull.* 96: 271-84.

Kanda, N., Goto, M., Ilyashenko, V.Y. and Pastene, L.A. 2010. Update of the mitochondrial DNA analysis in gray whales using new acquired data. Paper SC/62/BRG5 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 8pp. [Paper available from the Office of this Journal].

Kato, H., Nakamura, G., Yoshida, H., Kishiro, T., Okazoe, N., Ito, K., Bando, T., Mogoe, T. and Miyashita, T. 2016. Status report of conservation and researches on the Western North Pacific gray whales in Japan, May 2015-April 2016. Paper SC/66b/BRG11 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Laake, J.L., Punt, A.E., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2012. Gray whale southbound migration surveys 1967-2006: an integrated re-analysis. *J. Cetacean Res. Manage* 12(3): 287-306.

Lang, A.R., Calambokidis, J., Scordino, J., Pease, V.L., Klimek, A., Burkanov, V.N., Gearin, P., Litovka, D.I., Robertson, K.M., Mate, B.R., Jacobsen, J.K. and Taylor, B.L. 2014. Assessment of genetic structure among eastern North Pacific gray whales on their feeding grounds. *Mar. Mam. Sci.* (Online early).

Lang, A.R., Weller, D.W., LeDuc, R.G., Burdin, A.M. and Brownell, R.L., Jr. 2010. Delineating patterns of male reproductive success in the western gray whale (*Eschrichtius robustus*) population. Paper SC/62/BRG10 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 22pp. [Paper available from the Office of this Journal].

Lang, A.R., Weller, D.W., LeDuc, R.G., Burdin, A.M., Pease, V.L., Litovka, D., Burkanov, V.N. and Brownell, J.R. 2011. Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG10 presented to the IWC Scientific Committee, June 2011, Tromsø, Norway (unpublished). 20pp. [Paper available from the Office of this Journal].

LeDuc, R.G., Weller, D.W., Hyde, J., Burdin, A.M., Rosel, P.E., Brownell, R.L., Jr., Würsig, B. and Dizon, A.E. 2002. Genetic differences between western and eastern North Pacific gray whales (*Eschrichtius robustus*). *J. Cetacean Res. Manage.* 4(1): 1-5.

Meschersky, I.G., Kuleshova, M.A., Litovka, D.I., Burkanov, V.N., Andrews, R.D., Tsidulko, G.A., Rozhnov, V.V. and Ilyashenko, V. 2015. Occurrence and Distribution of Mitochondrial Lineages of Gray Whales (*Eschrichtius robustus*) in Russian Far Eastern Seas. *Biol. Bull.* 42(1): 34-42.

NOAA. 2012. National Policy for Distinguishing Serious from Non-Serious Injuries of Marine Mammals. Federal Register 77: 3233. Available at: *http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf*.

Punt, A.E. and Wade, P.R. 2012. Population status of the eastern North Pacific stock of gray whales in 2009. *J. Cetacean Res. Manage* 12(1): 15-28.

Ramakrishnan, U., LeDuc, R.G., Darling, J., Taylor, B.L., Gearin, P., Gosho, M., Calambokidis, J., Brownell, R.L., Jr., Hyde, J. and Steeves, T.E. 2001. Are the southern feeding group of eastern Pacific gray whales a maternal genetic isolate? Paper SC/53/SD8 presented to the IWC Scientific Committee, July 2001, London (unpublished). [Paper available from the Office of this Journal].

Rice, D.W. and Wolman, A.A. 1971. *The Life History and Ecology of the Gray Whale (Eschrichtius robustus)*. American Society of Mammalogists, Special Publication No. 3, Stillwater, Oklahoma. viii+142pp.

Steeves, T.E., Darling, J.D., Rosel, P.E., Schaeff, C.M. and Fleischer, R.C. 2001. Preliminary analysis of mitochondrial DNA variation in a southern feeding group of eastern North Pacific gray whales. *Conservation Genetics* 2: 379-84.

Tsai, C.H. and Boessenecker, R.W. 2015. An early Pleistocene gray whale (Cetacea: Eschrichtiidae) from the Rio Dell Formation of northern California. *J. Paleontology* 89: 103-09.

Vojkovich, M. and Reed, R.J. 1983. White seabass, *Atractoscion nobilis*, in California-Mexico waters: Status of the fishery. *CalCOFI Rep.* 24: 79-83.

Weller, D.W. and Brownell, R.L., Jr. 2012. A re-evaluation of gray whale records in the western North Pacific. Paper SC/64/BRG10 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 4pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

USA

R.L. Brownell, Jr.
J. Carretta
J. Laake
A. Lang
W. Perryman
D. Weller

REPUBLIC OF KOREA

H.W. Kim
H. Sohn

INVITED PARTICIPANTS

J. Bickham
J. Brandon
J. Calambokidis
H. Kato
A.E. Punt
J. Scordino
R.R. Reeves

IWC

G.P. Donovan

Annex B

Agenda

1. Introductory items
    1.1 Convenor's opening remarks
    1.2 Election of Chair
    1.3 Appointment of rapporteurs
    1.4 Adoption of Agenda
    1.5 Documents and data available
    1.6 Terminology
2. Progress on 'non-modelling' recommendations and new data
    2.1 Updated information from the co-operative genetics study
    2.2 Updated information from photogrammatic studies
    2.3 Updated data on mixing rates
    2.4 Updated bycatch data
    2.5 New abundance estimates
3. Update on modelling framework and runs
    3.1 Progress on modelling since SC/66b
    3.2 Finalise data sets
        3.2.1 Removals
        3.2.2 Abundance estimates
        3.2.3 Mixing proportions
    3.3 Further development of trials to reflect uncertainty and anthropogenic removals
        3.3.1 Review of stock structure hypotheses
        3.3.2 Changes to the trials specifications
        3.3.3 Base-case models and sensitivity tests
        3.3.4 Projections
4. Work plan
5. Relationship to CMP discussions
6. Adoption of Report

Annex C

List of Documents

SC/A17/GW

1. Punt, A.E. Proposed approach for including bycatch data directly into the gray whale model.
2. Calambokidis, J. and Pérez, A. Association of PCFG gray whales on migration.
3. Scordino, J., Carretta, J., Cottrell, P., Greenman, J., Savage, K., Scordino, J., and Wilkinson, K. Ship strikes and entanglements of gray whales in the North Pacific Ocean, 1924-2015.
4. Calambokidis, J. and Pérez, A. Sightings and follow-up of mothers and calves in the PCFG and implications for internal recruitment
5. Calambokidis, J., Laake, J. and Pérez, A. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996-2015.
6. Durbin, J.W., Weller, D.W. and Perryman, W.L. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16.
7. Perryman, W.L., Weller, D.W. and Durban, J.W. Estimates of eastern North Pacfic gray whale gray production 1993-2016.
8. Cooke, J.G., Weller, D.W., Bradford, A.L., Sychenko, O., Burdin, A.M., Lang, A.R., Brownell, J.R., R.L. Population assessment update for Sakhalin, gray whales with reference to stock identity.

Annex D

Terminology Used With Respect to Stock Structure Hypotheses

Table 1

Feeding groups or aggregations.

	Feeding groups or aggregations	Abbreviation	Definition (may vary with hypothesis)
1	Western Feeding Group	WFG	Animals that feed regularly off Sakhalin Island* according to photo-identification data.
2	Pacific Coast Feeding Group	PCFG	Animals that feed regularly in the PCFG area according to photo-identification data.
3	North Feeding Group	NFG	Animals found in other feeding areas (and for which there is relatively little information including photo-identification).

*May need revising with regard to southern Kamchatka animals given information in SC/A17/GW08.

Breeding stocks. There are up to two extant breeding stocks: Western (WBS) and Eastern (EBS).

Feeding groups or aggregations. There are up to three feeding groups or aggregations. There is dispersal between the Pacific Coast Feeding Group (PCFG) and North Feeding Group (NFG), but the Western Feeding Group (WFG) is demographically independent of the other two feeding groups (i.e. there is no permanent movement of animals from the NFG or PCFG to the WFG).

Sub-areas. The model includes 11 geographical sub-areas that are used to explain the movements of gray whales (breeding stocks and feeding groups) in the North Pacific and two 'latent sub-areas' used to link model predictions to observed indices of abundance.

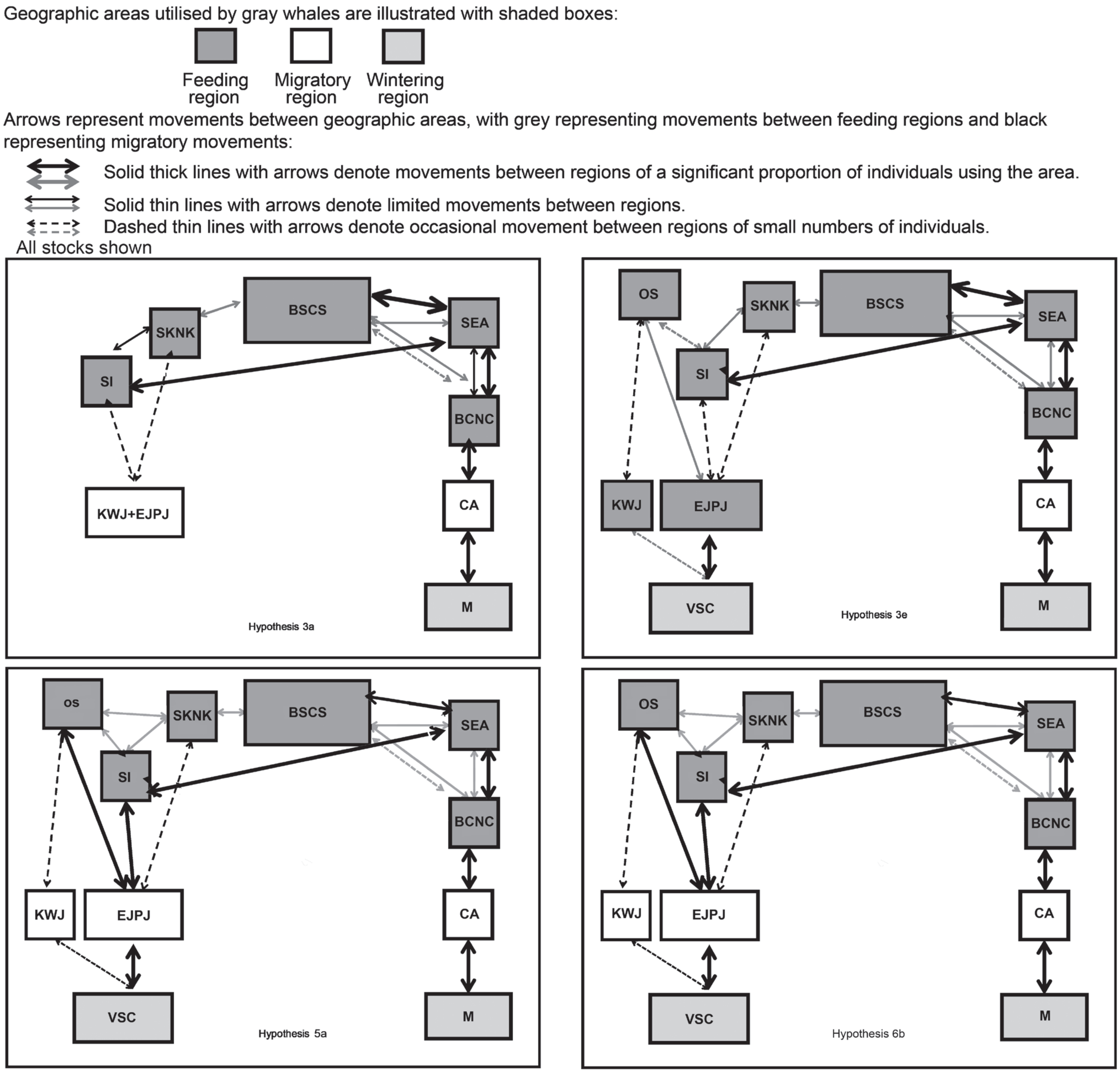
Schematic diagrams of the hypotheses being considered are found on pp.534-536.

Table 2

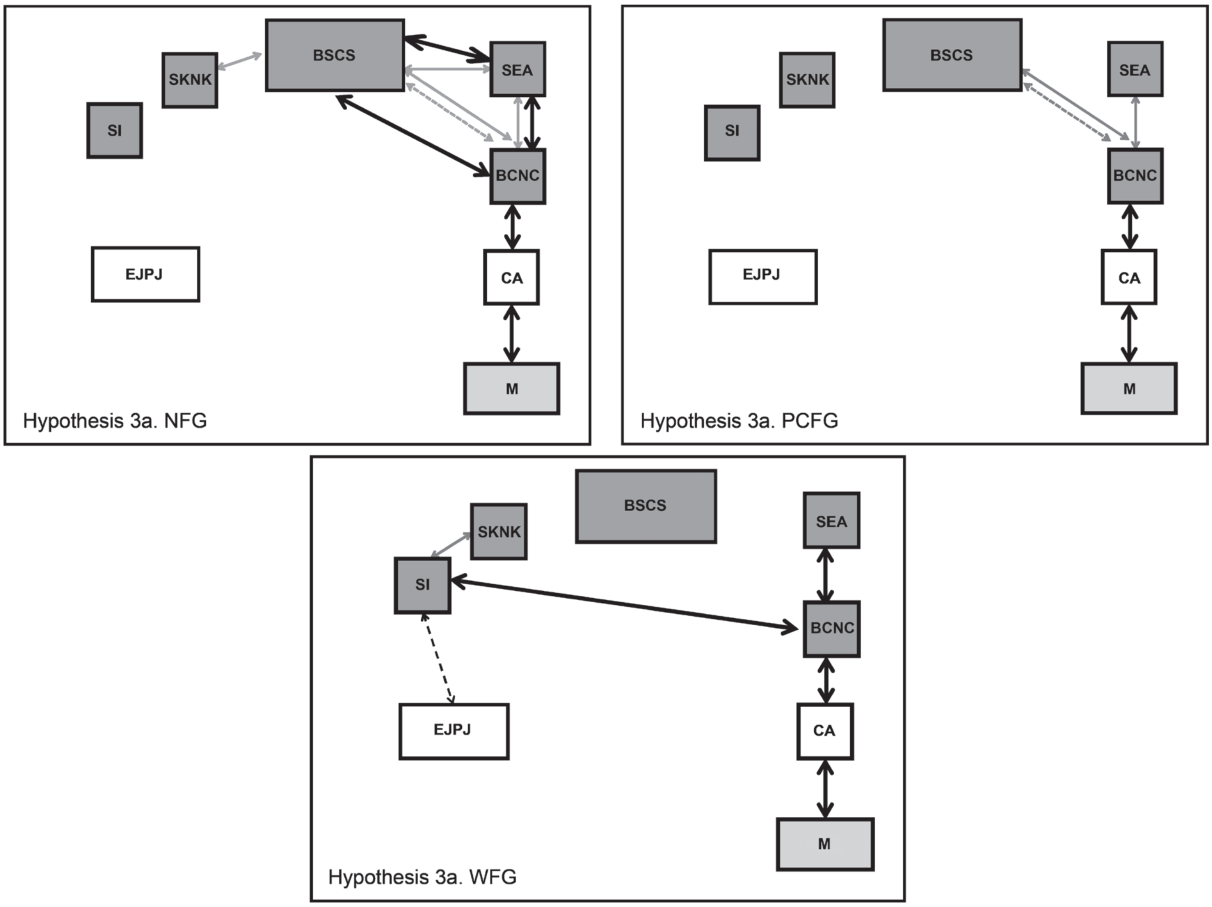
Sub-areas.

	Sub-area	Abbreviation
1	Vietnam-South China Sea	VSC
2	Korea and western side of the Sea of Japan	KWJ
3	Eastern side of the Sea of Japan and the Pacific coast of Japan	EJPJ
4	Northeastern Sakhalin Island	SI
5	Southern Kamchatka and northern Kuril Islands*	SKNK
6	Areas of the Okhotsk Sea not otherwise specified	OS
7	Northern Bering and Chukchi Sea	BSCS
8	Southeast Alaska	SEA
9	British Columbia to northern California	BCNC
10	California	CA
11	Mexico	M
12	Latent sub-area	Calif-3
13	Latent sub-area	BC-BCA-3

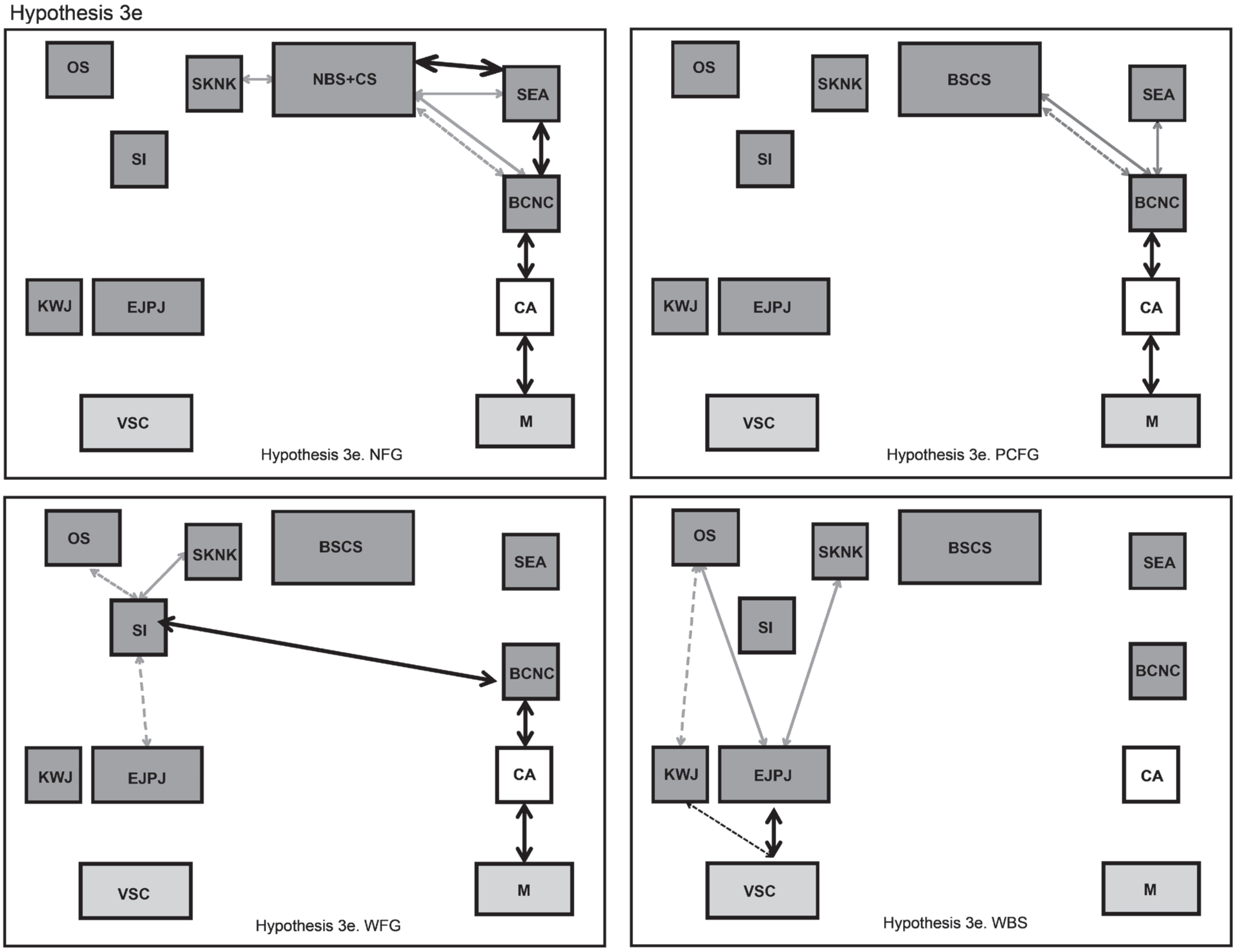
*New at this Workshop – replaces the old East Kamchatka and Kuril Islands sub-area to recognise the information from telemetry and photo-identification.


Geographic areas utilised by gray whales are illustrated with shaded boxes:
Feeding region
Migratory region
Wintering region
Arrows represent movements between geographic areas, with grey representing movements between feeding regions and black representing migratory movements:
Solid thick lines with arrows denote movements between regions of a significant proportion of individuals using the area.
Solid thin lines with arrows denote limited movements between regions.
Dashed thin lines with arrows denote occasional movement between regions of small numbers of individuals.
All stocks shown
BSCS
SKNK
SEA
SI
BCNC
KWJ+EJPJ
CA
M
Hypothesis 3a
OS
SKNK
BSCS
SEA
SI
BCNC
KWJ
EJPJ
CA
VSC
M
Hypothesis 3e
os
SKNK
BSCS
SEA
SI
BCNC
KWJ
EJPJ
CA
VSC
M
Hypothesis 5a
OS
SKNK
BSCS
SEA
SI
BCNC
KWJ
EJPJ
CA
VSC
M
Hypothesis 6b

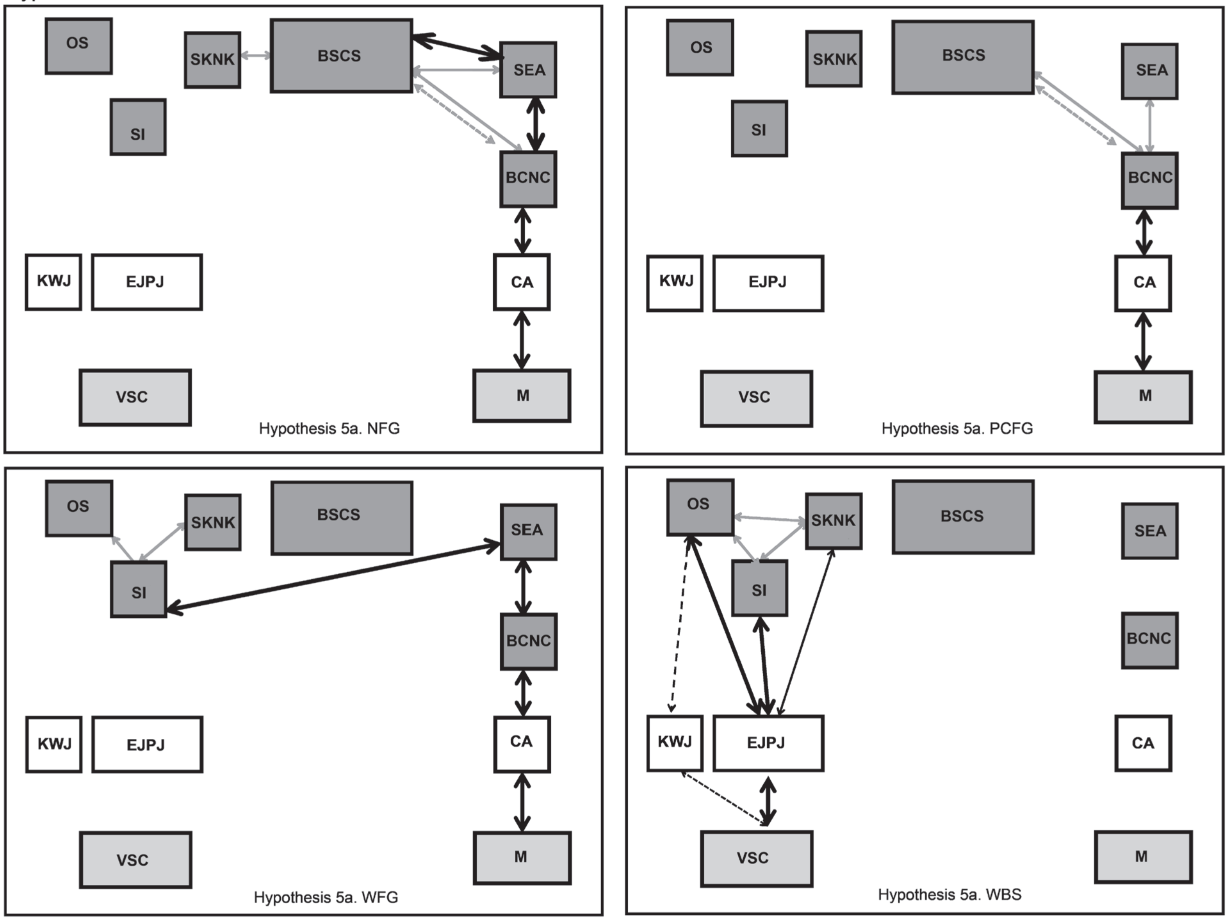
Hypothesis 3a



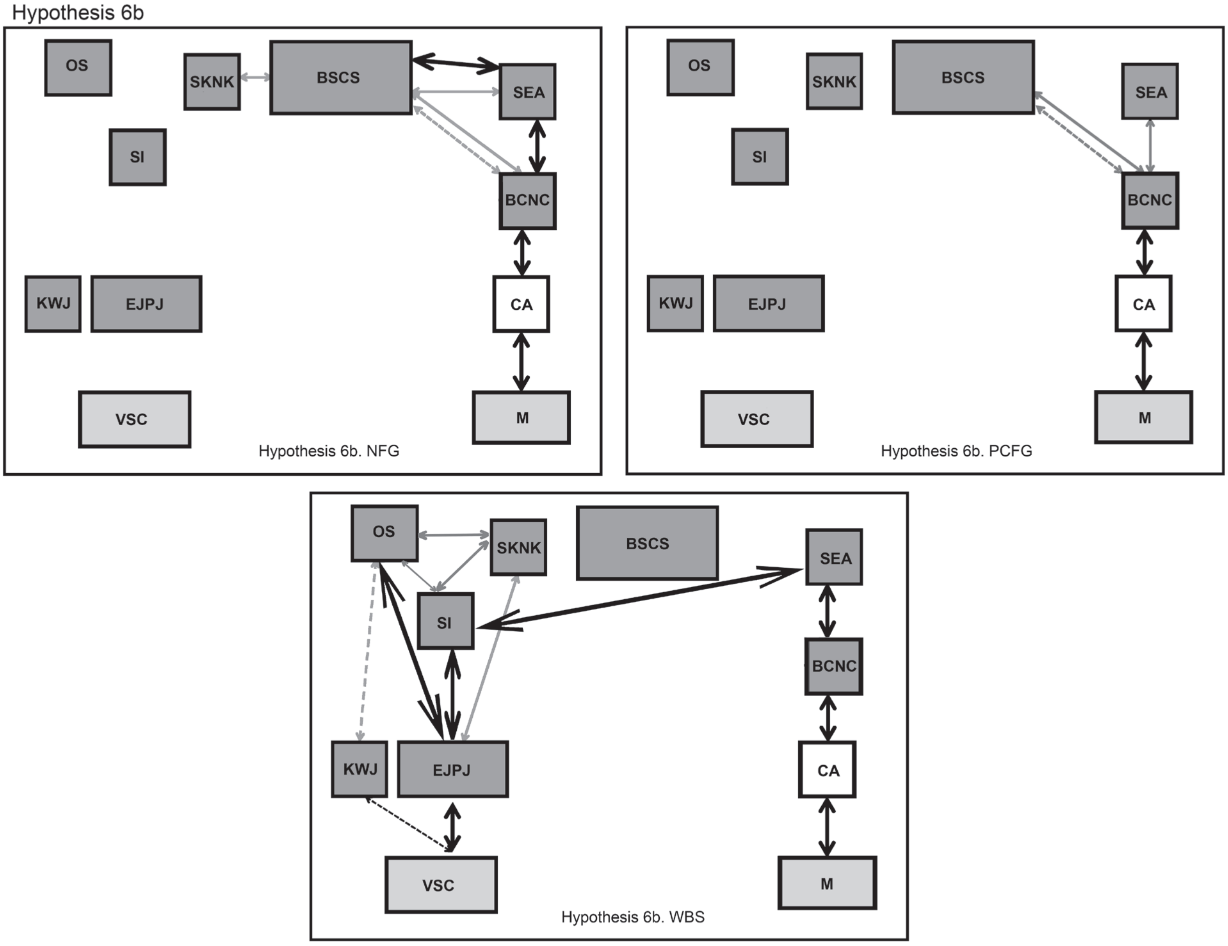
Hypothesis 3e



Hypothesis 5a



Hypothesis 6b



Report of the Third RMP Intersessional Workshop on the *Implementation Review* for North Atlantic Common Minke Whales

Report of the Third RMP Intersessional Workshop on the *Implementation Review* for North Atlantic Common Minke Whales[1]

The Workshop was held at the Greenland Representation, Copenhagen, from 16-18 December 2016. The list of participants is given as Annex A. Part of the time was shared with the intersessional AWMP Workshop (SC/67a/Rep02).

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan (unable to attend on the first afternoon) welcomed the participants to the Workshop and thanked the Greenland Representation for its excellent facilities. Since it had not proved possible to complete the *Implementation Review* at its 2016 Annual Meeting, the Scientific Committee had agreed that work towards the completion of the review and interpretation of the trial results should be undertaken during a two-day meeting to allow finalisation of the *Implementation Review* at the 2017 Annual Meeting. He reminded participants that the primary focus of the RMP *Implementation Review* was to provide advice on the commercial whaling by Iceland and Norway, but that the operating model was to form a key component of the development of an *SLA* (or *SLA*s) for the West and East Greenland hunts.

1.2 Election of Chair and appointment of rapporteurs

Butterworth (16 December) and Donovan (17 December onwards) were elected chairs. Punt, with help from Butterworth and Donovan acted as rapporteur.

1.3 Adoption of Agenda

The adopted agenda is shown as Annex B.

1.4 Documents available

The Workshop based its deliberations on past reports (e.g. IWC, 2015) and computer runs completed during the Workshop. Fig. 1 shows a map of the 11 sub-areas referred to in the text.

2. REVIEW OF PROGRESS SINCE THE 2016 MEETING OF THE SCIENTIFIC COMMITTEE

The work conducted since the 2016 meeting had focused on how the common minke whales that are found in the WG sub-area are modelled for the trials based on the five-stock[2] (W-1, W-2, C, E-1, E-2) hypothesis (see Fig. 2, which shows all of the hypotheses considered). This was because a number of simulations examined at that meeting led to implausibly low estimates of the size of the W-2 stock prior to exploitation and because projections under a constant aboriginal catch (164 West Greenland and 12 East Greenland) led to more than 5% of simulated W-2 populations being extirpated. In addition, there was also considerable variability in the proportion of each stock in each area in the future, which can lead to high exploitation rates in the WG sub-area in some years.

Allison reported that she had examined two possible approaches to address these issues.

(1) Placing a lower limit on the value of the parameter that determines the proportion of the W-1 stock in the WG sub-area (γ_{10}) because more than 5% of replicate simulations led to simulated W-2 stocks for which the unexploited abundance was 200 whales or less. Three values for this lower limit were considered (0.1, 0.2 and 0.5). The analyses conducted intersessionally showed that increasing the value for the lower limit for γ_{10} increased the lower 5[th] percentage for the number of whales in the W-2 stock prior to exploitation from 200 to approximately 2,000. It also reduced the rate of decline of the lower 5[th] percentage of depletion for the W-2 stock under constant catch projections.

(2) Allowing for an increase in the proportion of W-1 or C stock animals in the WG sub-area in 2006 or over the years 2000-10. This change reduced the rate of decline of the lower 5[th] percentage of depletion for the W-2 stock and improved the fit to the change in the abundance estimates for the WG sub-area.

The Workshop **agreed** that while increasing the proportion of W-1 or C stock animals in the WG sub-area led to better fits to the abundance estimates for the WG sub-area, there is no independent information which supports such an increase given lack of data for the WC sub-area where the W-1 stock is generally found. This potential revision was consequently not considered further. The options to place a lower limit on the value of the parameter that determines the proportion of the W-1 stock in the WG sub-area are discussed further below.

3. CHANGES TO THE TRIAL SPECIFICATIONS

3.1 CVs for the abundance estimates for the E sub-areas

The CVs used by Norway when applying the RMP to the E *Medium Area* during the *catch cascading* process account for process error. However, the trials considered at the 2016 meeting of the Scientific Committee ignored process error, which led to larger catch limits than would be expected in reality. The trial specifications were therefore modified by multiplying the CVs for the estimates abundance for the E *Medium Area* by the slope of a regression of the CVs for the E *Medium Area* which took process error into account against the CVs for this Area when process error is ignored (1.43; Fig. 3).

3.2 Distribution

The Workshop **agreed** to impose a minimum value of 0.1 for γ_{10} as this eliminated the possibility of unrealistically low values for the size of the W-2 stock prior to exploitation (Fig. 4, grey compared to black lines). The fit to the data, as quantified by the value of the objective function for each replicate, was essentially unaffected by this change to the specifications.

3.3 Maximum exploitation rates in the WG sub-area

In a small number of years, the exploitation rate (catch as a proportion of the number of animals aged 1 and older) for

[1]Presented to the Scientific Committee meeting as SC/67a/Rep05.

[2]Formally, W-1 and W-2, and also E-1 and E-2, are sub-stocks of the W and E stocks in this scenario, but for ease of reporting, all are subsequently referred to as 'stocks' here.

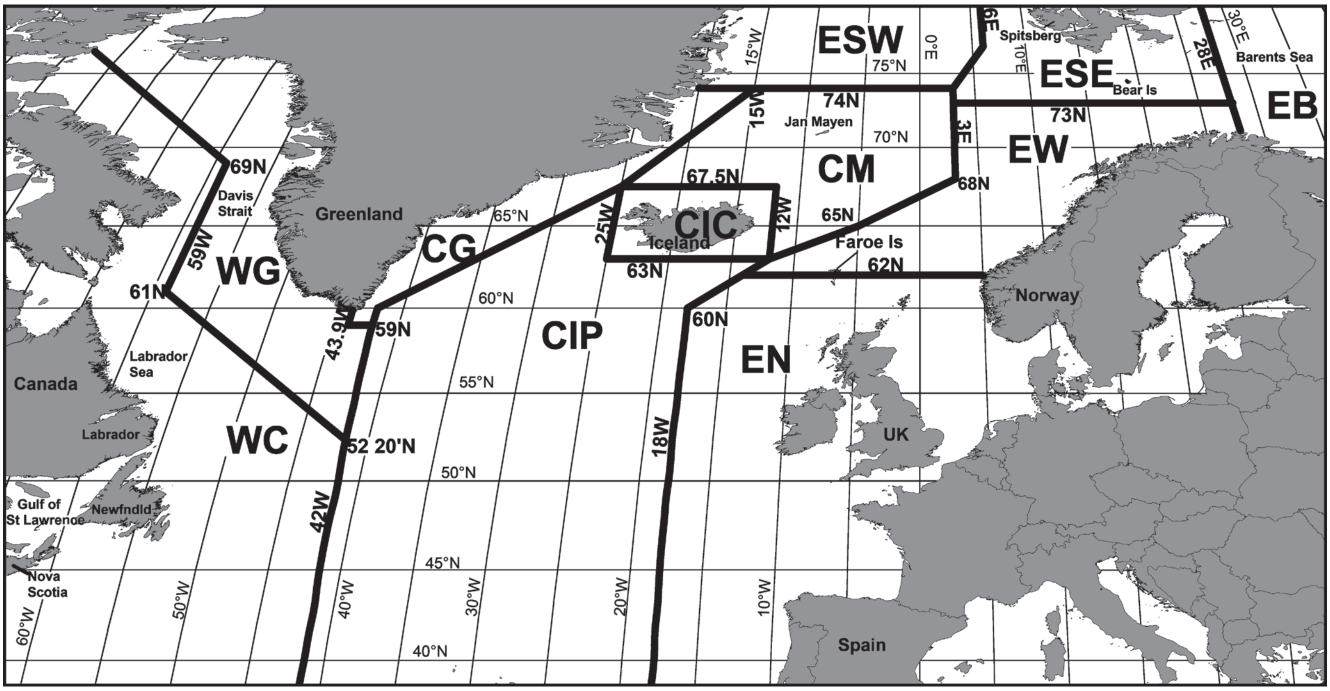


Fig. 1. Sub-areas used in the *Implementation Review.*

Table 1

The *Implementation Simulation Trials* for North Atlantic minke whales (Trials NM08 and NM11 were deleted and so are not shown here).

Trial no.	Stock hypothesis	*MSYR*	No. of stocks	Boundaries	Catch sex-ratio for selectivity	Trial weight	Notes
NM01-1	I	1%[1]	3	Baseline	2008-13	M	3 stocks, E and W with sub-stocks
NM01-4	I	4%[2]	3	Baseline	2008-13	H	3 stocks, E and W with sub-stocks
NM02-1	II	1%[1]	2	Baseline	2008-13	M	2 stocks, E with sub-stocks
NM02-4	II	4%[2]	2	Baseline	2008-13	H	2 stocks, E with sub-stocks
NM03-1	III	1%[1]	1	Baseline	2008-13	M	1 stock
NM03-4	III	4%[2]	1	Baseline	2008-13	M	1 stock
NM04-1	IV	1%[1]	2	Baseline	2008-13	M	2 cryptic stocks
NM04-4	IV	4%[2]	2	Baseline	2008-13	M	2 cryptic stocks
NM05-1	I	1%[1]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM05-4	I	4%[2]	3	Stock C not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM06-1	II	1%[1]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM06-4	II	4%[2]	2	Stock C not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM07-1	I	1%[1]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM07-4	I	4%[2]	3	Baseline	**2002-07**	M	Alternative years to adjust selectivity-at-age
NM09-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 10%
NM09-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 10%
NM10-1	I	1%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM10-4	I	4%	3	Baseline	2008-13	M	E-2 stock in EN 90%
NM12-1	I	1%[1]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM12-4	I	4%[2]	3	Stock E1 not in ESW	2008-13	M	3 stocks, E and W with sub-stocks
NM13-1	II	1%[1]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM13-4	II	4%[2]	2	Stock E1 not in ESW	2008-13	M	2 stocks, E with sub-stocks
NM01-1v	I	1%[1]	3	Baseline	2008-13	M	CV of future abundance = ½ basecase value
NM01-4v	I	4%[2]	3	Baseline	2008-13	H	Ditto
NM02-1v	II	1%[1]	2	Baseline	2008-13	M	Ditto
NM02-4v	II	4%[2]	2	Baseline	2008-13	H	Ditto
NM03-1v	III	1%[1]	1	Baseline	2008-13	M	Ditto
NM03-4v	III	4%[2]	1	Baseline	2008-13	M	Ditto
NM04-1v	IV	1%[1]	2	Baseline	2008-13	M	Ditto
NM04-4v	IV	4%[2]	2	Baseline	2008-13	M	Ditto

[1] – 1+; [2] –mature.

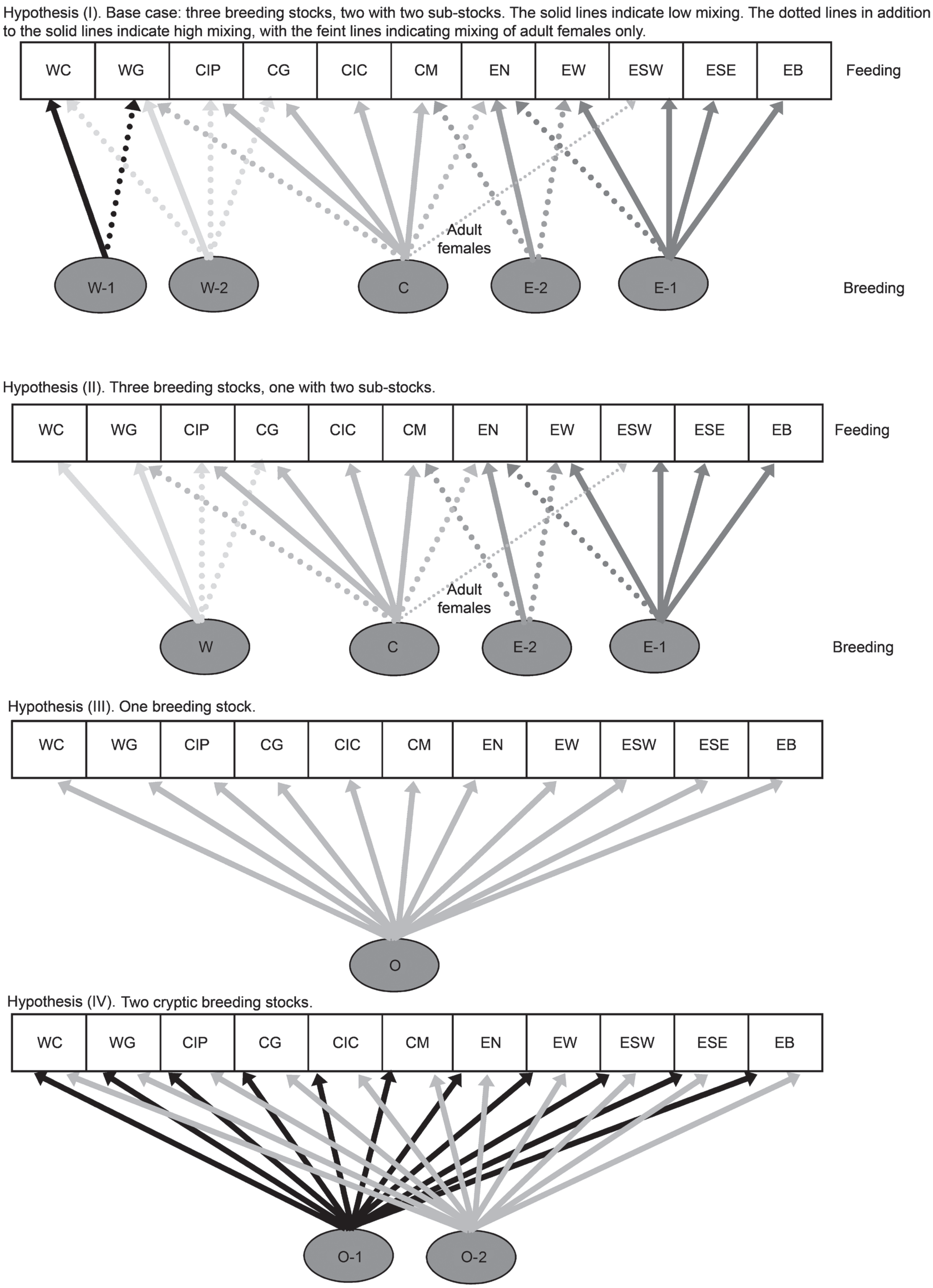


Fig. 2. Stock hypotheses considered in the *Implementation Review.* Hypotheses I and II are considered high priority whilst Hypotheses III and IV are considered medium priority.

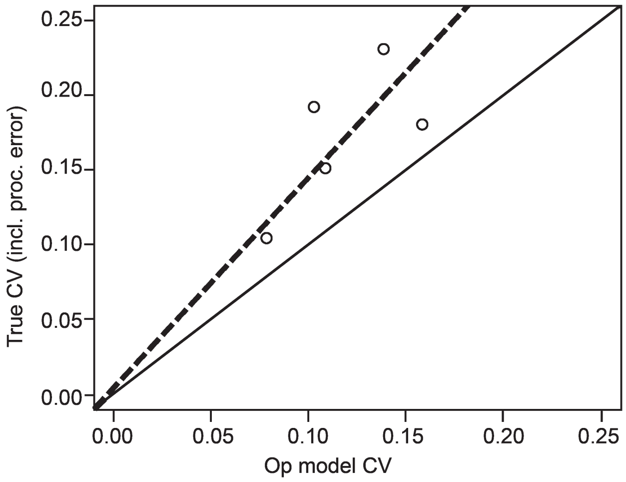


Fig. 3. CVs for the E *Medium Area* accounting for process error (vertical axis) against those that ignore process error (horizontal axis). The dashed line (regression fit) has a slope of 1.43.

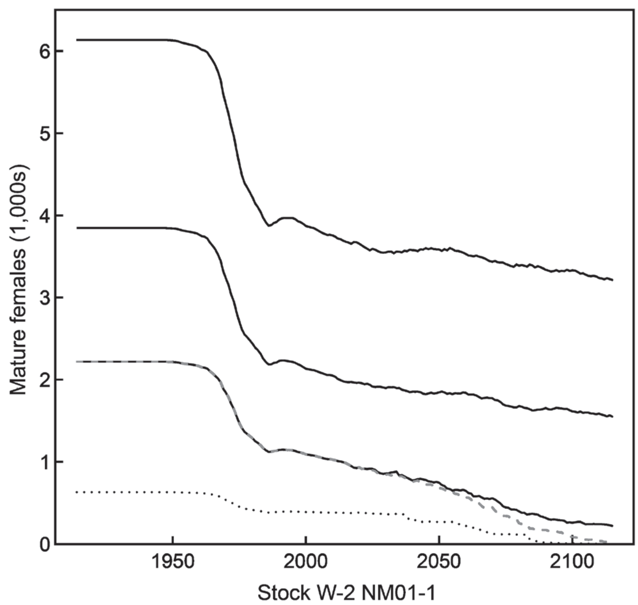


Fig 4. Time trajectory of mature numbers for the W-2 stock for trial NM01-1 for three operating model variants. The black lines show the upper 5%ile, median and lower 5%ile for the revised operating model imposing a lower limit of 0.1 on g_{10} and constraining the maximum exploitation rate in WG sub-area. The grey dotted line shows the lower 5%ile for the operating model considered during the 2016 Annual Meeting and the grey dashed line shows the model imposing a lower limit of 0.1 on g_{10}).

the WG sub-area is very high in the future when the catch off the WG sub-area is set to 164 whales. This usually occurs when mixing is such that only animals of one stock (usually the W-2 stock) are in the WG sub-area. Given the nature of the hunt, the Workshop did not consider it plausible that aboriginal whalers could catch most of the whales found off West Greenland in any one year. It therefore **agreed** to place a maximum on the annual exploitation rate in the WG sub-area. This maximum exploitation rate needs to be realistic given past exploitation rates achieved by aboriginal whalers, but not so low that the conservation performance of a candidate *Strike Limit Algorithm* would be impacted substantially, such that it would be difficult or impossible for any candidate to fail on conservation performance. The Workshop **agreed** to set the maximum exploitation rate to twice the maximum historical exploitation rate achieved by aboriginal hunters, as this level is both sufficiently precautionary (exploitation rates can still be high enough that stocks can be depleted) but also more realistic given past exploitation rates. Imposing the maximum (Fig. 4, black compared to grey lines) impacts only the lower 5th percentiles for the depletion of the W-2 stock in the future. This change is sufficient to eliminate cases in which the W-2 stock is extirpated.

4. CONDITIONING

4.1 Review conditioning results

The Workshop agreed that all of the trials based on the 5-stock operating models (Table 1) need to be re-conditioned given the impositions of a lower limit on γ_{10}. There was insufficient time during the Workshop to achieve this so it was decided to focus on the more complex trials (Trials NM01-1 and NM01-4; Table 1). Table 2 provides a summary of the diagnostic statistics used to evaluate whether conditioning has been achieved satisfactorily and Fig. 5 shows the diagnostic plots.

4.2 Conclusion

The Workshop considered that conditioning had been achieved satisfactorily for trials NM01-1 and NM01-4. It is not necessary to recondition *Implementation Simulation Trials* when the only new information relates to abundance data and catches. However, the trials for which conditioning results were reviewed and accepted at the 2016 Scientific Committee meeting do require re-conditioning, as this *Implementation Review* has revised the underlying set of plausible hypotheses. The trial specifications should be updated to include:

- the catches up to 2015;
- the agreed estimates of abundance (and their CVs) from the TNASS-2015 for the CIC and CIP sub-areas;
- an estimate of abundance for the CG sub-area based on adding the estimate of abundance from TNASS-2015 (2,727; CV 0.52) and the estimate from the East Greenland aerial survey (2,681; CV 0.45) for a combined estimate of 5,408 (CV 0.344).
- an updated estimate of abundance for West Greenland for 2007 of 9,853 (CV 0.43) - this estimate replaces the earlier estimate of 16,609 (CV 0.428) as it takes into account improved information on availability bias used for the revised estimate (see discussion in SC/67a/Rep02); and
- an estimate of abundance for West Greenland for 2015 of 5,241 (CV 0.49).

The updated estimates should be incorporated and the results of the conditioning should be provided to the Steering Group for review.

5. CONSIDERATION OF PLAUSIBILITY INCLUDING WEIGHTING OF TRIALS IN TERMS OF OVERALL BALANCE

Plausibility ranks had been assigned to the trials at the 2nd Intersessional Workshop (IWC, 2017; Table 1). The Workshop agreed that these weights were appropriate.

6. REVIEW OF PROJECTION RESULTS

The five management variants to be considered were as follows.

(1) Sub-areas CIC, CM, CG, CIP, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and

Table 2

Summary of the diagnostic plots and statistics used to evaluate conditioning.

Plot/statistic	Description	Factors in the evaluation
Fit of the operating model by subarea to the estimates of abundance	The plot for each subarea shows the abundance estimates and their 90% confidence intervals, the fit of the model to the actual data ('deterministic'; solid red lines), and the median and 90% intervals from the 100 replicates (solid black and dashed lines respectively).	Adequate performance for these plots is that: (i) the 'deterministic' trajectory passes through the centroid of the data points; (ii) the 'deterministic' and median trajectories are not markedly different[1]; (iii) the 90% interval for the 1+ abundance in a year with data matches the sampling distribution for the data when there is only one data point; and (iv) the 90% intervals for 1+ abundance for years with data are narrower than the sampling distributions when there are multiple abundance estimates for a sub-area.
Fit of the operating model to the sex ratio types ('original' and 'fishery').	The plots for each sex ratio type show the data points by sub-area and their assumed (normal) sampling distributions, along with the model-predictions from the fit to actual data, and the median and the 90% intervals for the model predictions.	For these plots, the 'deterministic' estimates should match the data almost exactly, and the 95% intervals from the stochastic replicates should closely match the sampling distributions. The model should mimic the original sex ratios fairly closely, but should not match them as well as the fishery sex ratios because the model imposes relationships among the abundances by sub-area, in particular that the overall sex ratio is 1:1 across the spatial domain of the model.
Individual trajectories of mature female numbers by subarea	This plot shows 10 time-trajectories of mature female numbers by sub-area and the abundance estimates and their 90% confidence intervals.	This plot is examined qualitatively to ensure that there are no 'unexpected' trajectories that would be missed by simply looking at overall 90% limits only.
Annual numbers of mature females.	This plot shows the median and 90% intervals for the annual numbers of mature females.	This plot is examined qualitatively to check that the model has not converged to an 'unrealistic' situation (e.g. that one of the stocks never existed).

[1]Some differences are to be expected given the model is non-linear and the distributions for the abundance estimates are skewed. However, marked differences between the 'deterministic' and median trajectories require more detailed examination of results.

Table 3

Work plan.

Item	Persons responsible	Date
Obtain the CVs for the estimates of abundance from TNASS-2015 for the CIC and CIP sub-areas from the data-providers.	Allison, Gunnlaugsson, Pike	-
Update the trial specifications and analyses to include the estimates of abundance from TNASS-2015.	Allison	
Recondition the full set of trials and provide the results for final evaluation by the Steering Group by March 2017.	Allison	March 2017
Conduct the projections for each trial under each of the RMP variants.	Allison	March 2017
Construct single stock trials that are 'equivalent' to each stock in each trial and then conduct two sets of 100 simulations based on these single stock trials in which future catch limits are set by the *CLA*. The two sets of simulations correspond to the 0.60 and 0.72 tunings of the *CLA*. Rather than basing these calculations on a single initial depletion, the simulations for each stock shall be conducted for the distribution of initial depletions for the stock concerned in the *Implementation Simulation Trial* under consideration.	Allison and Punt	March 2017
Send the ABU results to the Steering Group for consideration.	Allison	Early April
Write a Steering Group report of the results and recommendations for consideration by the Committee at SC/67a.	Donovan and Steering Group	End April
Update the trial specifications as a working paper for SC/67a.	Allison	End April

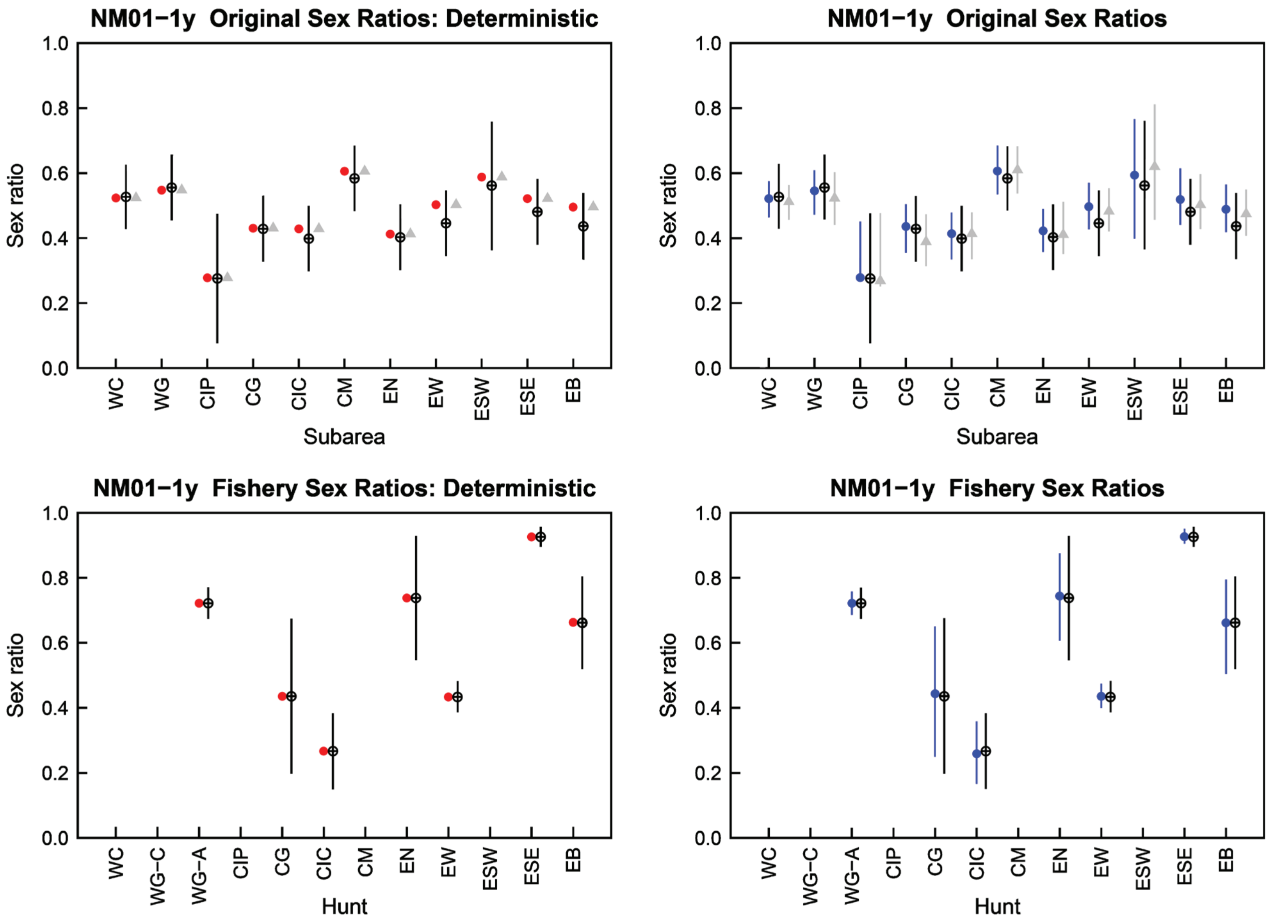
E *Combination Areas*. The catch from the ESW+ESE *Small Area* is all taken in sub-area ESE. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG).

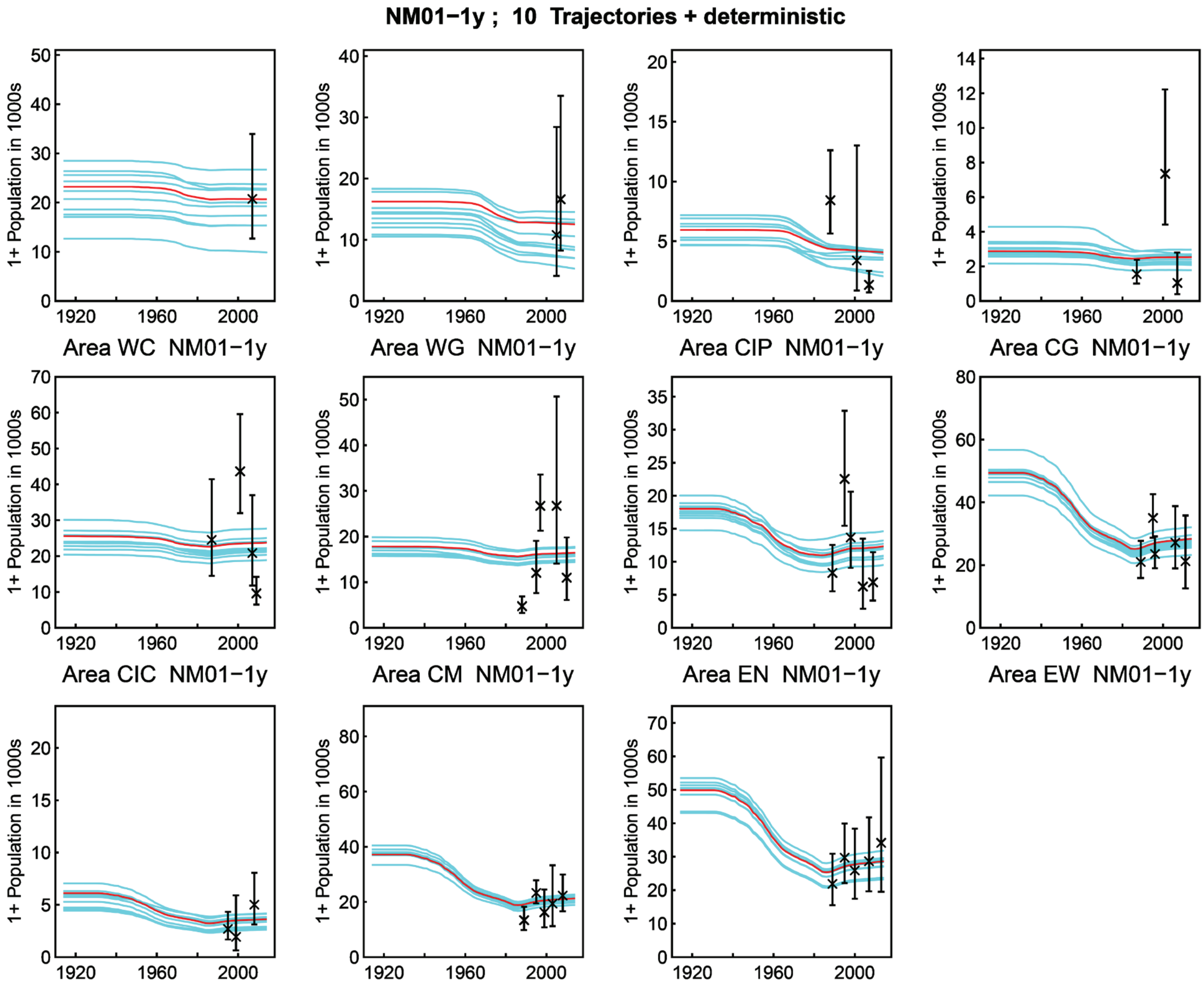
(2) Sub-areas CIC, CM, CG, CIP, EN and EB+ESW+ESE+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ ESW+ESE +EW *Small Area* is all taken in sub-area EW. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG).

(3) Sub-areas CIC, CM, CG, CIP, EN, ESW+ESE, and EB+EW are *Small Areas*, with the catch limits for these *Small Areas* based on catch cascading from the C and E *Combination Areas*. The catch from the EB+ EW *Small Area* is all taken in sub-area EW and the catch from the ESW+ESE *Small Area* is taken in the ESE sub-area. The catch limits set for the CM, CG and CIP *Small Areas* are not taken (except that the Aboriginal catch is taken from CG).

(4) As for variant 1, except that sub-areas CIC+CIP+CM are a single *Small Area* and all of the catches from this *Small Area* are taken in sub-area CIC. The catch limits set for the CG *Small Area* are not taken (except that the Aboriginal catch is taken).

(5) Sub-areas CIP+CIC+CG+CM, EN, EB, ESW+ESE and EW are *Small Areas*, with the catch limits for the E *Small Areas* based on catch cascading from the E *Combination Area*. All the catches from CIP+CIC+CG+CM *Small* Area are taken in sub-area CIC (after taking the Aboriginal catch from CG) and those for the ESW+ESE *Small Area* are taken in sub-area ESE.


NM01−1y Original Sex Ratios: Deterministic
NM01−1y Original Sex Ratios
Sex ratio
WC WG CIP CG CIC CM EN EW ESW ESE EB
Subarea
NM01−1y Fishery Sex Ratios: Deterministic
NM01−1y Fishery Sex Ratios
WC WG−C WG−A CIP CG CIC CM EN EW ESW ESE EB
Hunt


NM01−1y ; 10 Trajectories + deterministic
1+ Population in 1000s
Area WC NM01−1y
Area WG NM01−1y
Area CIP NM01−1y
Area CG NM01−1y
Area CIC NM01−1y
Area CM NM01−1y
Area EN NM01−1y
Area EW NM01−1y

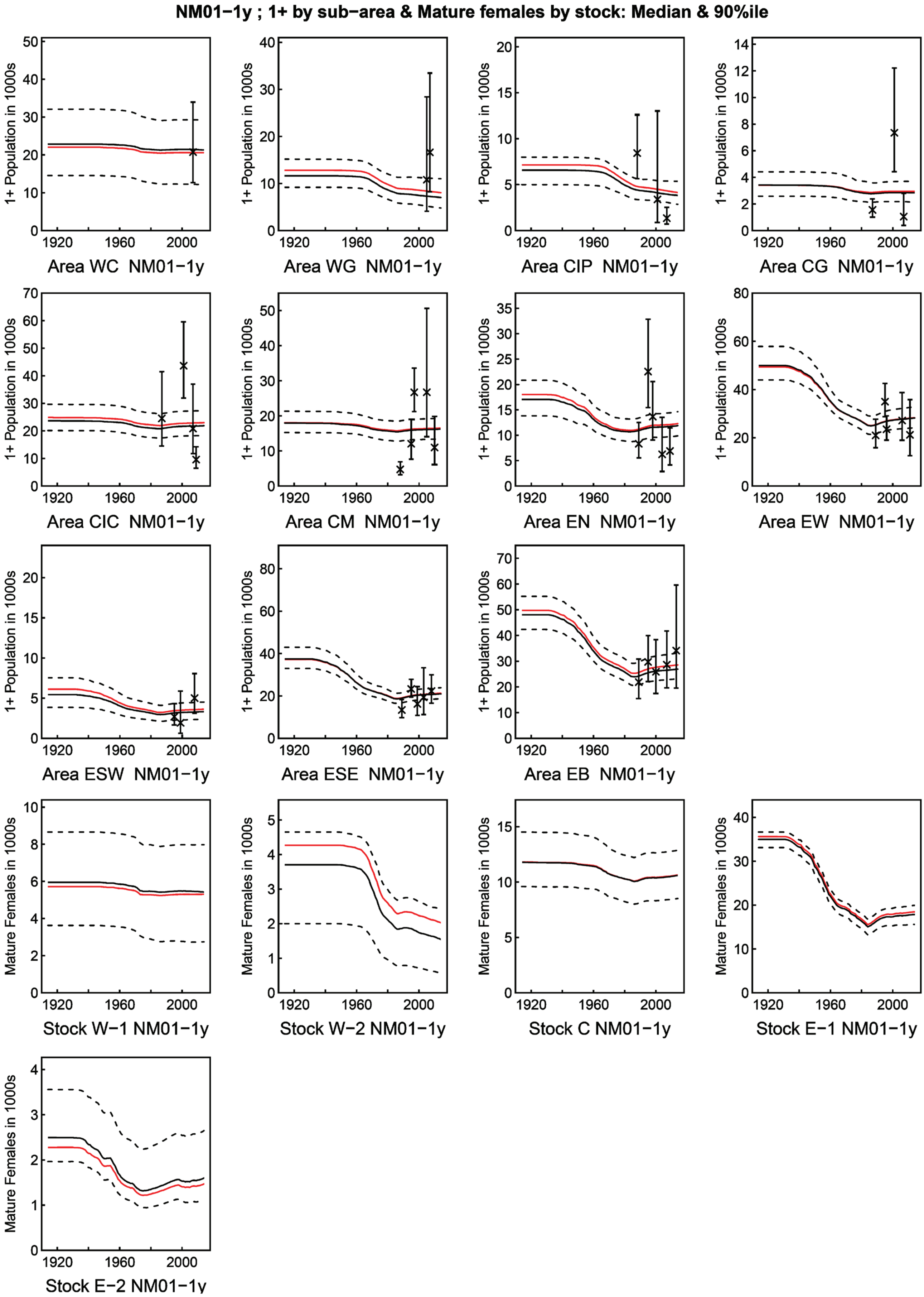


Fig 5. Diagnostic plots for trial NM0-1.

Allison reported that she has completed projections for trial NM01-1. However, there was insufficient time during the Workshop to complete all of the projections. The Workshop **agreed** that the projections be based on the removals from the WG sub-area set to minimum of need and the output from the interim *SLA* (IWC, 2009), rather than assuming the catch equals the need.

7. WORK PLAN

The work plan before the 2017 meeting of the Scientific Committee is given in Table 3.

The work plan during the 2017 meeting of the Scientific Committee:

- Apply the procedure for evaluating 'acceptable', 'borderline' and 'unacceptable' performance agreed by the Committee (IWC, 2007) and provide final recommendations.
- Draw final conclusions from the *Implementation Review*.

8. ADOPTION OF REPORT

The report was adopted by correspondence on 25 January 2017. The Chair thanked the staff of the Greenland Representation for the usual excellent facilities. He also thanked the participants for their co-operation and the quality of the debate in addressing complex issues and Punt and Allison for their hard work on difficult computational aspects. The Workshop thanked Jette Donovan Jensen for her customary cheerful assistance with logistics, especially with respect to dining.

REFERENCES

International Whaling Commission. 2007. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 1. Agenda. *J. Cetacean Res. Manage. (Suppl.)* 9:104-05.

International Whaling Commission. 2009. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2015. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

International Whaling Commission. 2017. Report of the AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS, 14-17 December 2015, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 18:489-515.

Annex A

List of Participants

DENMARK

Lars Witting

ICELAND

Thorvaldur Gunnlaugsson

NORWAY

Nils Øien
Hiroko Solvang

INVITED PARTICIPANTS

Doug Butterworth
Geof Givens
André Punt
Lars Walløe

IWC

Cherry Allison
Greg Donovan

Annex B

Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair and appointment of rapporteurs
   - 1.3 Adoption of Agenda
   - 1.4 Documents available
2. Review of progress since the 2016 meeting of the Scientific Committee
3. Changes to the trial specifications
   - 3.1 CVs for the abundance estimates for the E sub-areas
   - 3.2 Distribution
   - 3.3 Maximum exploitation rates in the WG sub-area
4. Conditioning
   - 4.1 Review conditioning results
   - 4.2 Conclusion
5. Consideration of plausibility including weighting of trials in terms of overall balance
6. Review of projection results
7. Work plan
8. Adoption of Report

Report of the 2016 AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS

Report of the 2016 AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS[1]

The Workshop was held at the Greenland Representation, Copenhagen, from 17-22 December 2016. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Donovan welcomed the participants to Copenhagen. He thanked the Greenland Representation for once again hosting an AWMP Workshop in their excellent facilities. The main tasks of the Workshop were to: (1) review new abundance estimates off Greenland; (2) advance the development of *SLA*'s for the Greenlandic fin and common minke whale hunts; and (3) consider various issues related to the Aboriginal Whaling Scheme (AWS).

1.2 Election of Chair
Donovan was elected Chair.

1.3 Appointment of rapporteurs
Butterworth and Givens acted as rapporteurs, assisted by Donovan.

1.4 Adoption of Agenda
The adopted agenda is given as Annex B.

1.5 Documents available
The list of documents is given as Annex C.

2. NEW ABUNDANCE ESTIMATES OFF GREENLAND

2.1 Presentation of the results of the 2015 surveys
Heide-Jørgensen and Hansen introduced SC/D16/AWMP06. An aerial line transect survey of whales in East and West Greenland was conducted in August-September 2015. The survey covered the area between the coast of West Greenland and offshore (up to 100km) to the shelf break. In East Greenland, the survey lines covered the area from the coast up to 50km offshore crossing the shelf break. The survey was conducted as a double platform experiment with two front and two rear observers in a *Twin Otter* equipped with bubble windows following previous protocols (e.g. Heide-Jørgensen *et al.*, 2010; IWC, 2009, item 3.1, p.413). A total of 423 sightings of 12 cetacean species was obtained and abundance estimates were developed for common minke whales (32 sightings), fin whales (129 sightings), humpback whales (84 sightings), harbour porpoises (55 sightings), long-finned pilot whales (42 sightings) and white-beaked dolphins (50 sightings).

The at-surface abundance estimates were corrected for perception bias[2] with point independence models where it is assumed that only detections at zero distance from the trackline were independent between the two platforms. Separate detection functions were fitted for the mark-recapture data and the distance sampling data. Conditional detection functions for the mark-recapture data were developed where heterogeneity between observers was modelled with covariates (perpendicular distance to sightings, sea state, group size and observers) and the best model selected based on AIC (Akaike Information Criterion). The mark-recapture detection function was used to estimate the correction for perception bias ($p(0)$). With respect to large whales, data on surface corrections for five common minke whales and a single fin whale were collected from whales instrumented with satellite-linked time-depth-recorders. Only the sample size for common minke whales was considered adequate to develop a correction factor. The instruments provided data on the proportion of time the whales are at the surface (considered 0-2m) for common minke whales (16%, CV=0.08). The final correction for availability bias (19.5%, CV=0.26) was adjusted for the time the whales can be potentially seen from the aircraft (time-in-view).

The fully corrected abundance estimates for the species subject to aboriginal subsistence whaling considered best by the authors were: common minke whales: 4,204 (CV=0.48, 95% CI: 1,732-10,204) in West Greenland and 2,681 (CV=0.46, 95% CI: 1,139-6,312) in East Greenland, humpback whales: 1,321 (CV=0.44, 95% CI: 578-3,022) in West Greenland and 4,012 (CV=0.35, 95% CI: 2,044-7,873) in East Greenland. No corrections for availability bias could be applied for the fin whales, but the estimates corrected for perception bias were 465 (95% CI: 233-929) in West Greenland and 1,932 (95% CI: 1,204-3,100) in East Greenland. The abundance of cetaceans in such coastal areas of East Greenland has not been estimated before, but despite the lack of previous estimates from the area, the achieved abundance estimates were higher than expected.

The use of dive and surface time information from satellite-linked time-depth-recorders was preferred over previous methods and recalculation of the 2007 minke whale abundance estimate with the availability correction factor from 2015 (including time-in-view adjustment) gives an estimate of 9,853 (cv=0.43, 95% CI: 4,433-21,900) common minke whales in West Greenland in 2007. A comparison of the point estimates from 2015 in West Greenland with a similar survey conducted in 2007 suggests that the three baleen whale species (and white-beaked dolphins) were present in much lower densities in 2015; however, only fin whales showed a significant difference in abundance. Harbour porpoises and pilot whales, however, did not show a similar decline. The authors suggested that the decline in baleen whale and white-beaked dolphin abundance was probably due to emigration to the East Greenland shelf areas where recent climate-driven changes in pelagic productivity may have accelerated favourable conditions for baleen whales.

2.2 Discussion
Discussion focused on the substantial (and in the case of fin whales, statistically significant) changes in abundance estimates for common minke, fin and humpback whales from the 2007 to the 2015 surveys off West Greenland. There are various possible explanations for this, which have implications for the specification of projections in *SLA* testing (for example as regards whether these changes reflect variability in the factors that underlie them, or rather a permanent shift). These matters are discussed further below and under Item 3.

[1]Presented to the Scientific Committee as SC/67a/Rep06.
[2]Perception bias reflects the probability of sighting a whale (school) given that it is sufficiently close to the surface to potentially be seen. Availability bias accounts for the proportion of time a whale school is not sufficiently close to the surface to be potentially sighted from (in this case) an aircraft.

2.2.1 Survey areas, methods (field and analytical)

The Workshop noted that the design and implementation of the 2007 and 2015 surveys had been consistent and at least some of the same observers were used. From this perspective, the Workshop **agreed** that results from the two surveys are comparable.

2.2.2 Estimates for large whales subject to ASW

SC/D16/AWMP06 had suggested that reduced abundance estimates for various species off West Greenland in 2015 compared to 2007 might in part reflect a movement from west to east Greenland given the relatively high abundance estimates evident in the east in 2015. There are insufficient data (e.g. photo-identification data from East Greenland for humpback whales) to evaluate this hypothesis.

An addendum to SC/D16/AWMP06 summarises results for abundance estimates for fin, minke and humpback whales from the 2007 and 2015 surveys for a number of analytical methods and assumptions needed in their implementation. These were examined at considerable length during the Workshop from the perspective of deciding the most appropriate estimates for use in *SLA* development and implementation. Table 1 summarises the selections from that addendum for input to *SLA* analyses. Such selections are not intended to imply that those choices are the only possible, but rather that for the reasons given below they are considered to be the most appropriate for that purpose.

2.2.2.1 FIN WHALES INCLUDING DISCUSSION OF CORRECTION FACTORS

The Workshop noted that there is an approximate halving in the average fin whale school size from the 2007 to the 2015 survey with its much lower estimate of abundance. Perception bias is small (i.e. estimates of this multiplicative factor to adjust abundance estimates are all only slightly below 1). No attempt has been made to adjust for availability bias (i.e. whales unable to be seen as they were below the surface) because the telemetry sample size is only one animal.

The selected estimate for the 2015 survey (see Table 1) was based on a line transect rather than a strip census approach to adjust for the negative bias in the latter as a result of a drop in the detection function with perpendicular distance from the trackline. The mark recapture distance sampling approach (MRDS) was preferred to conventional distance sampling (CDS) so that account could be taken of perception bias (although the difference was minimal). East as well as West Greenland sightings were included for more precise estimates of the detection function and hence also of abundance.

The reasons for the much lower abundance estimate for 2015 compared to 2007 are discussed further below in sub-sections 3.2 and 3.3.

2.2.2.2 COMMON MINKE WHALES INCLUDING DISCUSSION OF CORRECTION FACTORS

Both perception and availability bias estimates are available for the minke whale abundance estimates for West Greenland from the 2007 and 2015 surveys, and for East Greenland for the 2015 survey (see SC/D16/AWMP06 addendum). Perception bias corrections are generally small. In contrast, as one would expect for diving animals and a plane travelling at around 100 knots, the availability bias correction (this is based on detectability of whales down to a depth of 2m, which is considered more realistic than assuming detection only when on the surface), is large and leads to increasing estimates by a multiplicative factor of about 5.

For the 2015 West Greenland survey, after inspection of the data, the estimate provided by the strip census method for a width of 300m was selected (see Table 1) as most appropriate. There was an evident drop in detection at the increased distances (see SC/D16/AWMP06 and addendum). Preference over MRDS estimates arose from these being broadly similar to corresponding strip estimates, suggesting minimal negative bias in the latter, as well as avoidance of the complex computational task of taking covariance of estimates for different years into account if sample size was increased to provide more precise estimation of the detection function and hence abundance for comparable CVs to the strip-based approach.

For similar reasons, the strip survey estimate for a strip width of 240m was selected for the 2007 survey off West Greenland. However, for East Greenland in 2015, the MRDS estimate was selected given clear indication of a negative bias in the strip-based estimate.

Heide-Jørgensen introduced SC/D16/AWMP07. The time series of aerial surveys of large cetaceans off West Greenland conducted at regular intervals since 1984 was used to construct an index of the relative abundance of common minke whales in the area. The effort was corrected for varying detection probabilities but no correction could be applied for the lack of coverage in south Greenland in 1984 and 1985 (south of 62°N). To account for this, an alternative series covering the areas north of 62°N was developed. The resulting indices of relative abundance showed considerable variation, suggesting that there is not a consistent fraction of common minke whales from the North Atlantic that use the West Greenland banks as a summer feeding ground.

Some variation had already been taken into account in conditioning the RMP *Implementation Simulation Trials* (IWC, 2017c). The single further year's datum now available for a fairly long series made no qualitative difference to the broad features on this series; hence it was not deemed necessary to revise the conditioning of the RMP *Implementation Simulation Trials* to take this information from a single further year into account. Trial development for *SLA* testing is discussed under Item 4.

2.2.2.3 HUMPBACK WHALES INCLUDING DISCUSSION OF CORRECTION FACTORS

The estimated perception bias for humpback whales result in rather small adjustments to the abundance. There were no new data to inform availability bias; survey-specific calculations were made to provide an estimate of 0.42 by which to divide to adjust 2015 abundance estimate (see the addendum to SC/D16/AWMP06 and Table 1).

As for fin whales, line transect estimates of abundance were preferred to strip-based estimates. Furthermore, MRDS estimates were preferred to CDS estimates as the former took perception bias into account without greatly prejudicing estimates of precision. The final selections preferred global to stratum based adjustments because the very small sample sizes in some strata led to higher estimates of variance.

2.3 Conclusions

The Workshop **recommended** that the abundance estimates in Table 1 were appropriate for use in *SLA* development and implementation. It also **recommended** that the Scientific Committee review the estimates of abundance provided in SC/D16/AWMP06 for the other species.

3. DEVELOPMENT OF AN *SLA* FOR THE GREENLANDIC FIN WHALE HUNT

3.1 Review of discussions at SC/66b including progress made

At its 2016 Annual Meeting, the Scientific Committee had recommended that the Workshop should consider the reasons

Table 1

Summary of new agreed abundance estimates (see text) for common minke, fin and humpback whales in West and East Greenland. Detection depth was assumed to be up to 2m apart from for fin whales which was not corrected for availability bias. Availability bias takes into account time in view. For the MRDS for humpback whales a combined mean group size was used.

Method	ESW	N	Perception bias: Model	Perception bias: Value	Availability bias	Abundance	CV	95% CL
Common minke whale – east 2015								
LT	450m	23 E+W	MRDS 2015	0.97 (0.04)	0.20 (0.26)	2,681	0.45	1,153; 6,235
Common minke whale – west 2015								
SC	300m	12	Chapman	0.94 (0.06)	0.18 (0.32)	5,241	0.49	2,114; 12,992
Common minke whale – west 2007								
SC	240m	18	Chapman	0.98 (0.02)	0.18 (0.32)	9,853	0.43	4,433; 21,900
Fin whale – west 2015								
LT	700m	75 E+W	MRDS 2015	0.99 (0.001)	-	465	0.35	233; 929
Humpback whale – east 2015								
LT	1,200m	76 E+W	MRDS 2015	0.98 (0.02)	0.42 (0.14)	4,288	0.38	2,097; 8.770
Humpback whale – west 2015								
LT	1,200m	76 E+W	MRDS 2015	0.98 (0.02)	0.42 (0.14)	1,008	0.38	493; 2,062

Key: LT=line transect; SC=strip census; ESW=effective search width; *N*=number of sightings, E+W indicates that sightings from East and West Greenland were pooled to estimate the detection function.

for the sensitivity of the values for the performance metrics to small changes to the specifications of the *SLA* trials (IWC, 2017d, section 2.3, p.175). Brandão had examined the precision with which estimates of 5th percentiles from these trials could be obtained as the number of replicates was increased beyond the customary choice of 100. Example results for two of the fin whale trials are shown in Fig. 1.

This examination yielded no clear result for a single number of replicates that would provide sufficient precision, as the extent of precision required for a particular trial depended on the expected value and performance threshold for the performance statistic under consideration - the importance of running a large number of trials is high only if the value of performance statistic is close to a threshold value.

In these circumstances, the Workshop took an operational decision to:

(a) increase the initial number of replicates for *Evaluation Trials* to 400;
(b) maintain the number of replicates for stochastic *Evaluation Trials* and *Robustness Trials* at 100; and
(c) when evaluating results, should the value of the 5th percentile for a key performance statistic be close to the associated threshold for an *Evaluation Trial*, perform sufficient additional replicates for that trial before accepting (or rejecting) performance for that trial.

Consideration of the number of trials used in the previous Greenlandic *SLA* developments is given under Item 5.3.

3.2 New abundance estimate

The fin whale abundance estimate from the 2015 survey off West Greenland of 465 (see Table 1 and Item 2) is significantly less than that from the 2007 survey of 4,470. Previous *SLA* testing procedures, as well as candidate *SLA*'s, have assumed that all surveys provide abundance estimates of the total number of whales subject to aboriginal strikes that are either unbiased, or at least that the bias is consistent over time. The difference between the 2007 and 2015 estimates is certainly too large to attribute to catches made over the intervening period, and there is no other evidence to suggest a real decline in abundance of the population of whales subject to these strikes. Consequently the possibility arises that only a part of this population is present off West Greenland in at least some years. If this is the case, this aspect needs to be reflected in the manner in which future survey abundance estimates for this region are generated when testing *SLA*'s and which retains a conservative and realistic testing scenario to manage the Greenland hunts.

3.3 Updated density-regulated assessment

Witting presented SC/D16/AWMP02 which modelled West Greenland fin whales as a single population. The 1987, 2005 and 2007 surveys indicated a population that increased from about 1,000 animals in 1987 to 3-4,000 animals around 2005/2007, with no direct evidence of larger fluctuations between years. However, as discussed under Item 2, with only 465 (CV: 0.35) fin whales at the surface during an aerial survey in 2015 (SC/D16/AWMP06), and no indication of problems with the survey, the author believed that it was prudent to reconsider whether the simulation framework for West Greenland fin whales remained adequate.

This was examined by the development of density-regulated assessment models. The first approach resembled the present framework, where it is assumed that all the whales in the population migrate to West Greenland waters each year. It was fitted to three time series of abundance: (1) the 2005/07 estimates; (2) the 1987/2005/07 estimates; and (3) the 1987/2005/07/15 estimates. The model was able to reconcile the abundance data for the two shorter time series with no additional variance, while this was possible for series 3 only with a high level of additional variation (additional CV estimate of 1.2 with 90% CI: 0.52-2.2).

A second approach transformed the additional variation into a simple model for fluctuations in the number of whales that move to the West Greenland area during years of survey. This was achieved by assuming that the high abundance estimates from 2005 and/or 2007 reflected the total number of whales in the population in those years, while the additional variation in the abundance estimates around the expected trajectory was taken to reflect variation in the fraction of whales that moved to the West Greenland area in those years. This process estimated an average negative bias of 0.4 (90% CI:0.11-0.88) across all the abundance estimates when the 2005/07 estimates were assumed to be absolute, with an additional CV of 1.1 (90% CI:0.5-2.2) reflecting inter-annual variation in the fraction of whales that move to the West Greenland area.

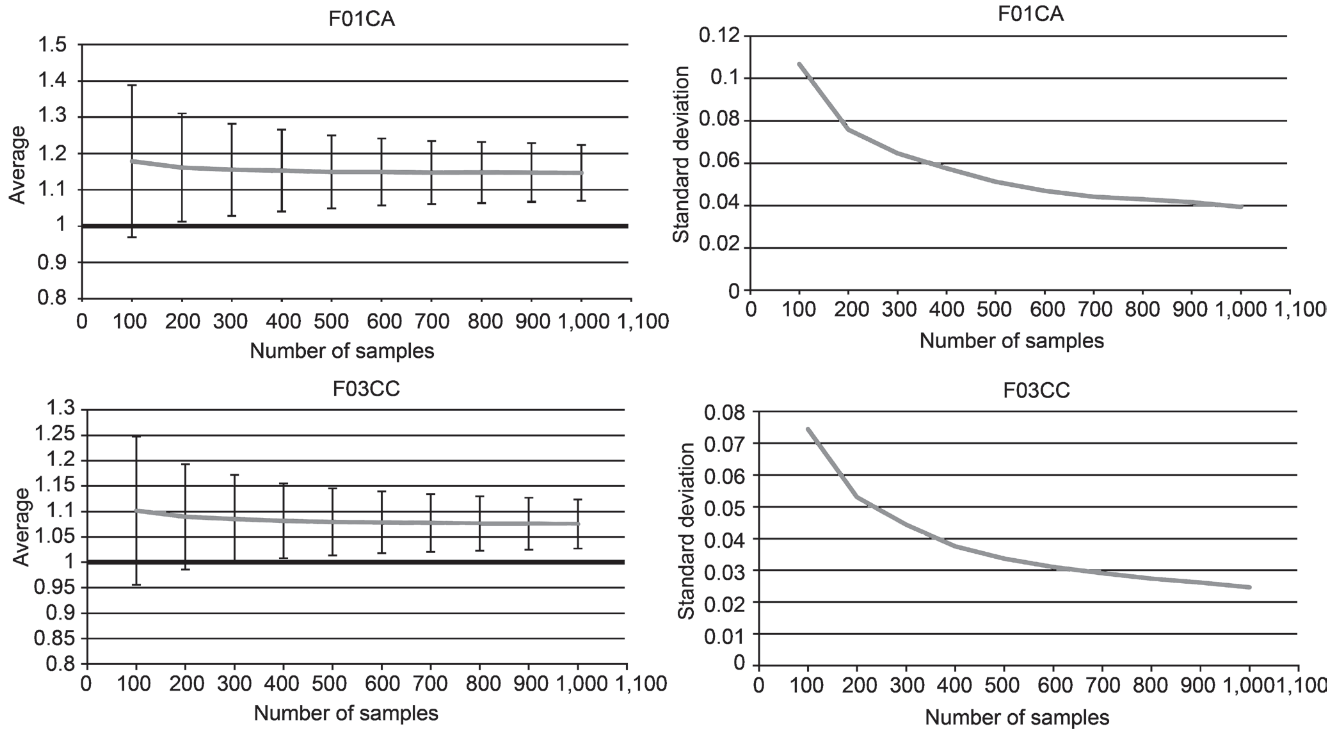


Fig. 1. Average (with 95% confidence intervals) and the standard deviation of the 5-%tile for various numbers of draws samples with replacement from 1,000 values of the conservation performance statistic D10 (the relative increase of 1+ population size) over 1,000 simulations for two fin whale *SLA Evaluation Trials.*

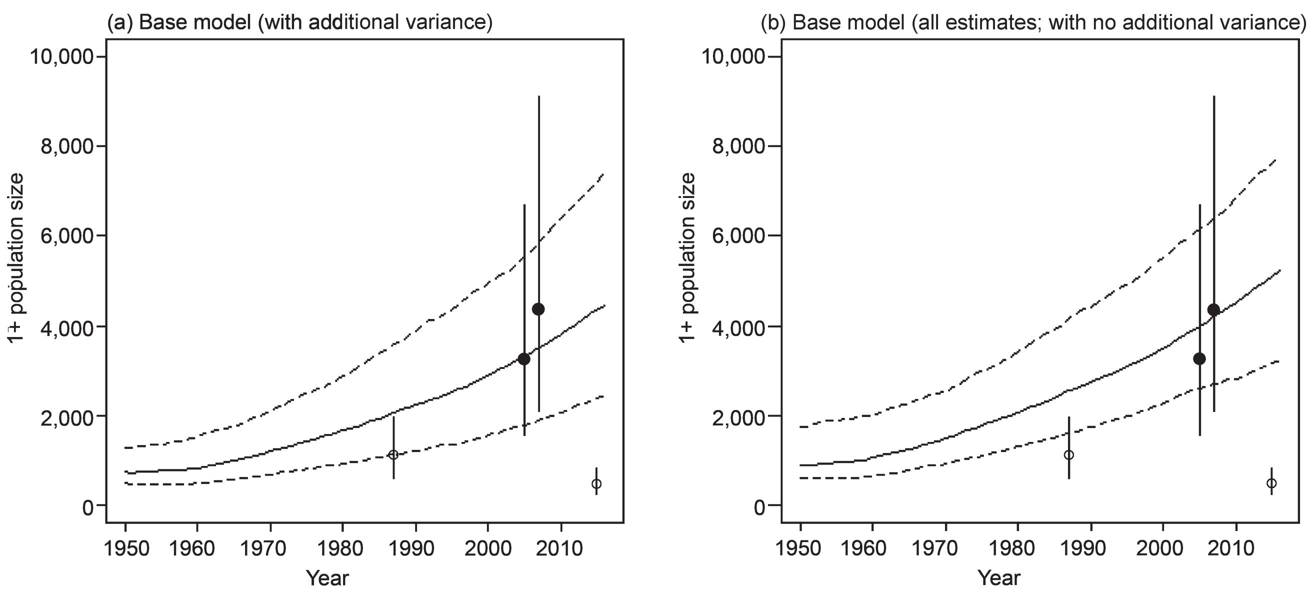


Fig. 2. Posterior distributions (medians and 90% intervals; solid and dotted lines respectively) for 1+ population size for fin whales off West Greenland. Results are shown when the operating model is fitted: (a) to the estimate of abundance for 2005 (indirectly) and 2007; and (b) to the estimates of abundance for 1987, 2005 (indirectly), 2007, and 2015 (b). The prior for the population size in 2005 is lognormal, parameterized using the estimate of abundance for 2005, with the point estimate taken as the mean of the prior.

Figs 1-4 of the addendum to SC/D16/AWMP02 show the results from a population model fit to the abundance estimates from all four years assuming no additional variance. The Workshop **agreed** that it is clear from this that given their survey sampling variances, those estimates taken together are not compatible with such a model, so that further approaches need to be considered, in particular with a view towards realistic generation of future abundance estimates for *SLA* trials.

3.4 Discussion of implications of new information for finalising the *SLA*

The Workshop **agreed** that it was not an acceptable approach to obtaining a statistically adequate fit to the four fin whale survey estimates of abundance by adding further additional variance of estimable magnitude to the survey sampling variances for each estimate. This is because in this case the point estimates differ so substantially that the resultant model fit would imply that in some years substantially more whales than the actual number in the population entered the West Greenland region. It was therefore **agreed** to model these abundance estimates by means of a two-component process whereby each year either all whales in the population entered the West Greenland region, or only a proportion of those whales, where the proportion was drawn from a distribution. Given that abundance estimates were available for four years only, the Workshop **agreed** that no purpose would be served by attempting other than a fairly simple model. Hence the two years 2005 and 2007 (with the highest estimates of abundance) were considered to be instances where all whales had entered the West Greenland region and were available to be surveyed. The probability in a future year that this would occur is to be modelled by a Beta(3;3) distribution, which reflects the posterior resulting from the assumption of a uniform prior over [0; 1], updated by data indicating that this had occurred in two out of four instances.

In years for which only a proportion of the whales enter the region, that proportion is to be modelled by a Beta(3;7) distribution. This implies a proportion of 30% on average, but importantly allocates nearly equal likelihood to the values of 0.1 and 0.5, which correspond roughly to the proportions estimated to be present to best account for the 2015 and 1987 survey results respectively for a scenario with an $MSYR_{1+}$ value of 2.5%.

Annex D specifies how the operating model for the trials is fitted to the survey data for this model, with results (a) excluding and (b) including the survey data for 1987 and 2015 in the fit shown in Fig. 2. The latter case reflects proportions of 11% and 53% of the whales being present in 2015 and 1987 respectively, thus indicating reasonable compatibility with the two Beta distribution forms assumed for the model developed.

Given the weak basis in data for the model assumed, together with its important influence on results for candidate *SLA* acceptability through effectively specifying an average multiplicative negative bias of abundance estimates of 0.65, the Workshop **recommended**:

(a) an *Implementation Review*, which is to include re-specification of these Beta distributions, take place once a further survey of the West Greenland region has been conducted; and
(b) robustness trials be conducted for fixed proportions of years for which all whales are present in the West Greenland region, set equal to the 5^{th} and 95^{th} percentile of the Beta(3;3) distribution.

3.5 Conclusions and recommendations
Given the operating model revisions specified above, the Workshop **agreed** that the fin whale trials would need to be reconditioned. Punt was thanked for already having updated the code to incorporate the recently agreed modification of the link between survey frequency and rules for phasing out strike limits otherwise permitted under an *SLA*.

The existing trials (IWC, 2017a, Annex E, pp. 17-23) were reviewed and modified, as set out in Annex E. A complete list of the trials is shown as Table 2. Important changes to previous lists of trials include survey frequencies of 5, 10 and 15 years linked to *SLA* applications every 6 years (as agreed at last year's Scientific Committee meeting); the use of two CV values for generating abundance estimates; and robustness tests for high and low probabilities that all whales are to be found in the West Greenland region each year.

3.6 Work plan
Updates of the trials code incorporating the changes reflected in Annex E will be completed shortly by Punt.

The Workshop **agreed** that if possible the results from re-runs of the revised candidate fin whale *SLA*s should be made available for comment by the Steering Group some six weeks before the 2017 Annual Meeting of the Scientific Committee.

The tests of sensitivity to the number of replicates of the results from the *WG-Bowhead SLA Evaluation Trials* will be completed by Brandão in consultation with the Steering Group and submitted to the 2017 Annual Meeting of the Scientific Committee.

4. DEVELOPMENT OF AN *SLA* FOR THE GREENLANDIC COMMON MINKE WHALE HUNTS

4.1 Review of discussions at SC/66b and the RMP intersessional Workshop
At its last meeting, the Scientific Committee had reaffirmed the value of the ongoing RMP *Implementation Review* to its work to develop an *SLA* for the common minke whale hunts off Greenland (IWC, 2017b, item 8.1.2, p.21). It therefore agreed that the present AWMP intersessional workshop should take place immediately after the RMP Workshop to complete the RMP *Implementation Review* of common minke whales in the North Atlantic. This would allow the AWMP workshop to benefit from the results of that review.

The Workshop reviewed the RMP Workshop discussions (SC/67a/Rep05). That Workshop had finalised agreements on all outstanding issues with respect to the completion of the common minke whale RMP *Implementation Simulation Trials*; the results for those trials will become available before the 2017 Annual Meeting of the Scientific Committee and will facilitate the development of an *SLA* for the Greenlandic common minke whale hunts by 2018.

4.2 New abundance estimate
SC/D16/AWMP06 provided further minke whale abundance estimates for areas off Greenland from the 2015 survey. These are discussed under Item 2.2 above, which specifies the reasons for choosing the particular estimates selected (see Table 1) for input to conditioning further trials.

The Workshop noted that Item 2 of SC/67a/Rep05 detailed an approach to ensure that future variability in the number of common minke whales present each year off West Greenland would be modelled in a more realistic manner.

4.3 Initial modelling and trial structure
Given results for abundance estimates from the 2015 survey which were suggestive of movement of whales from the west to the east coast of Greenland, the Workshop **agreed** that Punt and Allison will check whether the covariance in the relative proportions of common minke whales present in these regions in the existing RMP trials was consistent with the 2015 results. They will also to check the implication of the results from close-kin genetic data in this regard so as to determine whether or not the existing trials need amendment in this respect to provide a more realistic representation of common minke whale distribution patterns off Greenland. The Workshop noted that the results from this investigation would not have implications for conclusions to be drawn from the existing RMP trials for North Atlantic minke whales, as those were intended to inform in regard to commercial whaling in the Eastern and Central regions of the North Atlantic, and the stocks which dominated in those regions were not considered to be present off West Greenland in other than relatively small numbers.

Table 2a

The *Evaluation Trials* for fin whales. Values given in bold type show differences from the base case values. For all trials the probability *p* that all animals are off West Greenland when a survey takes place = 0.5; if some whales are not off West Greenland, the proportion off West Greenland is generated from a beta distribution with parameters (3,7).

Trial	Description	$MSYR_{1+}$	Need scenarios	Survey freq.	Historical survey bias	No of replicates	Future survey CV
01-4	$MSYR_{1+}$ = 4%	4%	A, B, C	10	1	400	0.40
01-2	$MSYR_{1+}$ = 2.5%	2.5%	A, B, C	10	1	400	0.40
01-1	$MSYR_{1+}$ = 1%	**1%**	A, B, C	10	1	400	0.40
01-7	$MSYR_{1+}$ = 7%	**7%**	A, B, C	10	1	400	0.40
02-4	5 year surveys	4%	A, B	**5**	1	400	0.40
02-2	5 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	**5**	1	400	0.40
03-4	15 year surveys	4%	A, B	**15**	1	400	0.40
03-2	15 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	**15**	1	400	0.40
03-1	15 year surveys; $MSYR_{1+}$ =1%	**1%**	A, B, C	**15**	1	400	0.40
04-4	Survey bias = 0.8	4%	A, B	10	**0.8**	400	0.40
04-2	Survey bias = 0.8; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	**0.8**	400	0.40
05-4	Survey bias = 1.2	4%	A, B	10	**1.2**	400	0.40
05-2	Survey bias = 1.2; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	**1.2**	400	0.40
06-4	3 episodic events	4%	A, B	10	1	400	0.40
06-2	3 episodic events; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	10	1	400	0.40
06-1	3 episodic events; $MSYR_{1+}$ =1%	**1%**	A, B, C	10	1	400	0.40
07-4	Stochastic events every 5 years	4%	A, B	10	1	**100**	0.40
07-2	Stochastic events every 5 years	2.5%	A, B	10	1	**100**	0.40
08-4	Asymmetric environmental stochasticity	4%	A, B	10	1	**100**	0.40
08-2	Asymmetric environmental stochasticity	2.5%	A, B, C	10	1	**100**	0.40
08-1	Asymmetric environmental stochasticity	**1%**	A, B, C	10	1	**100**	0.40
09-2	$MSYR_{1+}$ = 2.5% with future survey CV 0.35	2.5%	A, B, C	10	1	**400**	**0.35**
10-2	$MSYR_{1+}$ = 2.5% with future survey CV 0.45	2.5%	A, B, C	10	1	**400**	**0.45**

Table 2b

The *Robustness Trials* for fin whales.

Trial no.	Factor	$MSYR_{1+}$	Need scenario	No of rep	Future survey CV
21-4	Linear decrease in *K* in future	4%	A, B	100	0.40
21-2	Linear decrease in *K* in future	2.5%	A, B	100	0.40
22-4	Linear increase in *M* in future	4%	A, B	100	0.40
22-2	Linear increase in *M* in future	2.5%	A, B	100	0.40
23-4	Strategic surveys	4%	A, B	100	0.40
23-2	Strategic surveys	2.5%	A, B	100	0.40
24-4	*p*=0.5; Propn generated from beta (7,3)	4%	A, B	100	0.40
24-2	*p*=0.5; Propn generated from beta (7,3)	2.5%	A, B	100	0.40
25-4	*p*=0.5; Propn generated from beta (2,10)	4%	A, B	100	0.40
25-2	*p*=0.5; Propn generated from beta (2,10)	2.5%	A, B	100	0.40
26-4	*p*=0.189 (Propn generated from beta (3,7)	4%	A, B	100	0.40
26-2	*p* =0.189 (Propn generated from beta (3,7))	2.5%	A, B	100	0.40
27-4	*p* =0.811 (Propn generated from beta (3,7))	4%	A, B	100	0.40
27-2	*p* =0.811 (Propn generated from beta (3,7))	2.5%	A, B	100	0.40
28-2	Baseline with future survey CV 0.2	2.5%	A, B	100	**0.20**
29-2	*p*=0.5; Propn generated from beta (2,10)	2.5%	A, B	100	**0.20**

The Workshop **agreed** that the AWMP Steering Committee should receive the report from Punt and Allison and examine whether the further information that has become available should be taken into account in conditioning the planned new trials. The Workshop noted further that information about the need envelopes to be considered in developing an *SLA* for the Greenlandic minke whale hunts was detailed in IWC (2014, p.443); further analyses would be based on these envelopes unless Greenland provided revised information in regard to need.

4.4 Conditioning issues
Additional conditioning of operating models will be required if these change from those adopted for the current North Atlantic common minke whale RMP *Implementation Review*.

4.5 Advice on initial testing using 'preliminary' *SLA*s
Given the limited time available, discussion of this issue was deferred to the 2017 Annual Scientific Committee Meeting.

4.6 Conclusions and recommendations
The development of this *SLA* for Greenlandic minke whale hunts will be progressed further during the 2017 Annual Meeting of the Scientific Committee with a view to completion at the 2018 Annual Meeting. The Steering Group will request the provision of further papers concerning the stock structure of western North Atlantic minke whales for discussion at the 2017 meeting.

4.7 Work plan
The Workshop **agreed** that the following should be addressed before the 2017 Scientific Committee Meeting:

(1) completion of the RMP *Implementation Review* for North Atlantic common minke whales to serve as a basis for developing the operating models for *SLA* testing;
(2) submission of the report by Allison and Punt to the Steering Group with respect to the relative proportions of different stocks/sub-stocks off Greenland as detailed under Item 4.3; and
(3) request for further information to contribute to the conditioning of those operating models as set out in the sub-sections immediately above.

5. GENERAL MATTERS INCLUDING THE ABORIGINAL WHALING SCHEME (AWS)

5.1 AWS

AWS provisions are one of the last major remaining components of the comprehensive indigenous whaling management framework first requested by the Commission in 1994 and developed with an enormous expenditure of scientific effort and resources over the last two decades. The Commission has agreed that the AWS is a key component of this framework. Accordingly, in consultation with the Commission and its ASW sub-committee, the Scientific Committee informed the Commission in 2015 that it intends to develop recommendations for all scientific components and aspects of an AWS. Ideally, this work will be completed during the 2017 Scientific Committee meeting, i.e. well in advance of the 2018 Commission meeting when new aboriginal whaling limits are due to be established.

5.1.1 Carryover specification

A proposed AWS provision for the carryover of unused strikes has been considered recently by the Scientific Committee. During the initial development of *Strike Limit Algorithms*, the Commission had agreed (IWC, 2001a, p.20):

> '…that blocks of five years with an inter-annual variation of fifty percent were satisfactory in terms of allowing for the likely variability in hunting conditions. It therefore agreed that these values are appropriate for use in trials. It was recognised that this does not commit the Commission to these values in any final aboriginal whaling management procedure.'

At that time, the Committee also agreed that the same 50% allowance could be carried over between the last year of one block and the first year of the next. The rationale for this limitation has not changed: from a scientific perspective, *SLA*s are robust with respect to this carryover provision.

The Committee had reported last year (IWC, 2017b, item 8.2, p.22) that it is continuing to develop these ideas and intends to provide final advice on carryover provisions before the 2018 Commission meeting and ideally in 2017.

Givens presented SC/D16/AWMP05 that reviewed the current carryover provisions in the Schedule and proposed a scheme that does not rely on multi-year block boundaries or inconsistent application across stocks. Specifically, unused strikes would be accumulated annually, available for use as soon as the next year, and expire after 12 years. The number of carryover strikes that could be used in a year would be limited to 50% of the annual strike limit if given, or the annualized strike limit if only a block limit is given. Tracking this scheme was suggested to be the responsibility of the IWC Secretariat.

In discussion, the Workshop noted a number of desirable features of this scheme and also developed a possible alternative scheme based upon the fifty percent criterion cited above. Denoting the block-to-block carryover as Ct this proposed scheme was:

$$C_t = \min \{ 0.5Q_t, 0.5Q_{t-1}, U_{t-1} \}$$

where

Q_t is the strike limit for the *t*th block, not counting any carryover;
U_t is the unused strikes during the *t*th block, namely X_t-S_t;
X_t is the total strikes allowed for the *t*th block, namely Q_t+C_t; and
S_t is the total strikes used during the *t*th block.

Additionally, no more than $1.5Q_t/6$ strikes may be taken in any single year. The division by 6 is intended to 'annualise' a 6-year block quota. The choices of 0.5 and 1.5 reflect the 50% interannual variation limit referred to in IWC (2001b). This approach draws unused strikes from both the previous block strike limit itself and from any unused carryover in that same block.

One notable difference between these two options is that the SC/D16/AWMP05 does not depend on a 'blocks' structure, whereas 'blocks' are a central concept underlying the second approach. The latter reflects the way in which the Commission currently establishes block limits for ASW hunts.

Table 3 provides an example of both options. The left hand portion of the table illustrates the block-based approach, including instances where carryover is limited to 50% of the previous or next block strike limit. The right hand portion of the table illustrates the approach of SC/D16/AWMP05, showing how carryover strikes are accumulated, used, and expired after 12 years. The Workshop welcomed the development of additional options and recommended that any such options be submitted to the Scientific Committee in advance of its 2017 meeting.

The Workshop **agreed** that whatever approach is used to calculate carryover limits, the manner in which the Scientific Committee recommends carryover limits to the Commission should be as simple as possible to facilitate inclusion in any Schedule amendment. Example language for each option is as follows. For the SC/D16/AWMP05 approach:

> '...in addition, unused strikes from previous years may be added as carryover to the strike limit in any year(s) of the new block provided that the additional strikes are not more than 12 years old at the time of usage and the total strikes taken in any year does not exceed Z.'

In the above, Z is replaced by a number equalling 150% of the annualised strike limit before carryover.

For the second approach:

> '...in addition, Y unused strikes from the previous block may be added as carryover to the block strike limit for the new block provided that the total strikes taken in any year does not exceed Z.'

In the above, Y is replaced by the number C_t and Z is as previously defined.

5.1.2 Interim allowance approach: extending testing to other SLAs

The Workshop recalled the development of the 'interim allowance' strategy, which deals with the situation where an abundance estimate is temporarily and unintentionally delayed more than 10 years from the previous survey. The interim allowance strategy was first tested using the *Bowhead SLA* and found to be acceptable in that case.

The Workshop thanked Punt for developing code for testing the interim allowance strategy for West Greenland bowhead, humpback and fin whales. The results of testing for the West Greenland humpback whale case will be reviewed at the 2017 Scientific Committee meeting. Testing for West Greenland bowhead whales will occur only after the evaluation of the number of replicates is completed.

Table 3

Illustration of two options for carryover (CO). This table is initialised (prior to the tabled years) as follows: (i) for the block-based option, 24 strikes carried forward from the previous block; (ii) for the annual expiration option, 24 strikes carried forward from the previous block, with 2 of these of each age from 12 to 1 years old. Although no annual strike limit is assumed, the block strike limit is annualised for the 'annual expiration' option to determine the number of strikes allocated to carryover usage. This mimics the situation when there is both a block and annual strike limit, as is the case for B-C-B bowheads.

Block strike limit	Strikes used during year	Block-based option		Annual extirpation option						
		CO at start of block[H]	Strikes available at end of year[I]	Taken from block limit[A]	Taken from CO[B]	CO at start of year[C]	Expired CO[D]	CO added[E]	CO at end of year[F]	Remainder of block limit at end of year[G]
360	50	24	334	50	0	24	2	10	32	310
	35		299	35	0	32	2	25	55	275
	70		229	60	10	55	2	-10	43	215
	48		181	48	0	43	2	12	53	167
	60		121	60	0	53	2	0	51	107
	82		39	60	22	51	2	-22	27	47[1]
360	23	39	376[2]	23	0	27	2	37	62	337
	75		301	60	15	62	2	-15	45	262
	62		239	60	2	45	2	-2	41	200
	51		188	51	0	41	2	9	48	149
	49		139	49	0	48	2	11	57	100
	65		74	60	5	57	2	-5	50	35
360	21	74	413	21	0	50	10[3]	39	79	339
	25		388	25	0	79	25	35	89	314
	30		358	30	0	89	0[4]	30	129	284
	17		341	17	0	129	12	43	160	267
	32		309	32	0	160	0	28	188	235
	38		271	38	0	188	0	22	210	197
360	60	180[5]	480	60	0	210	37	0	173	300
	60		420	60	0	173	0	0	173	240
	60		360	60	0	173	0	0	173	180
	60		300	60	0	173	9	0	164	120
	60		240	60	0	164	11	0	153	60
	60		180	60	0	153	0	0	153	0
200		100[6]				153[7]				

Key: [A]minimum of the block strike limit divided by six and the number of strikes in the year; [B]difference between the number in A and the block strike limit divided by six (or zero is negative); [C]equal to the value F from the previous year; [D]equal to the C added (column E) 10 years before; [E]minimum of 0 and difference between the block strike limit divided by six and the value in column A; [F]value in column C less than value in column D plus the value in column E; [G]block strike limit less the cumulative number of strikes in the block; [H]carrying over from the previous block; [I]block strike limit plus (allowed) carryover from the previous less cumulative strikes in the block to the year concerned.

Footnotes: [1]These 47 are not added to carryover at the end of the block. They have been spent as follows: net 35 allocated to 'CO added' and 12 allocated to 'Expired CO'. [2]Calculated as 360+39-23. [3]The 10 CO in the first year of the first block have expired after 12 years. [4]No strikes expire because no were accumulated as CO in the third year of the first block. [5]Reduced from 271 due to requirement that block-to-block carryover does not exceed half the previous (or next) block quota. [6]Reduced from 180 due to requirement that block-to-block carryover does not exceed half of the next block quota. [7]This is greater than the final carryover on the left hand side because strikes from the severely underutilised third block persist using the annual expiration scheme. They will expire during the next block.

Similarly, testing for fin whales will be occur after the Scientific Committee has agreed on a West Greenland fin whale *SLA*. Application of the interim allowance strategy for the *SLA* for eastern north Pacific gray whales will be tested during the next *Implementation Review* for this stock.

5.2 Use of minimum abundance estimates

SC/D16/AWMP04 described an opportunity that had arisen to estimate the abundance of Bering-Chukchi-Beaufort Seas bowhead whales. A set of five flights from the US Bureau of Ocean Energy Management (BOEM) and the National Marine Fisheries Service's Marine Mammal Laboratory (MML) project termed Aerial Surveys of Arctic Marine Mammals (ASAMM) found unprecedented large numbers of bowhead whales in the Alaskan Beaufort Sea in late August, 2016. There were 183 sightings of 676 animals seen during transect flights and circling. Although not explicitly designed to estimate absolute population abundance, the survey protocols and design, data collected and encounter rates could enable abundance estimation of bowhead whales within the survey region (extending to the 200m isobath) during a short 5-day sampling period. However, data from past surveys, satellite tags, opportunistic encounters and traditional knowledge all indicated that the bowhead whales in the survey region during these days are likely to constitute only a portion of the overall population. The authors posed two questions. First, could an abundance estimate of a portion of a population, and therefore known to be negatively biased, be used alongside the series of absolute abundance estimates when applying the *Bowhead SLA*, and if so, how? Second, if such an abundance estimate were used, would it 'reset the clock' so that the next abundance estimate would be due within ten years of 2016? They noted that answers to these questions would provide guidance about the timing of upcoming traditional ice-based or aerial photo-id surveys which were originally planned for 2017, but are now unlikely due to poor ice conditions and lack of sufficient funding.

In discussion, the Workshop **encouraged** the research team to use these data to derive an estimate of the abundance of bowhead whales in the survey region during the five-day sampling period. This estimate would be an important scientific contribution regardless of whether it was used with the *Bowhead SLA*.

With respect to use of such an estimate with the *Bowhead SLA,* the Workshop noted that the *Bowhead SLA* is robust to abundance estimates with large CVs. It had also been tested with several levels of constant survey bias, for which performance had been found acceptable. A single negatively biased abundance estimate is unlikely to change the advice provided using the *Bowhead SLA*.

The Workshop noted that the situation above differs from that of 'strategic surveys' considered during RMP and AWMP development. The latter related to a hunting country discarding the results of a good survey that produced a low estimate that might reduce the strike limit. In the case considered here, it is known in advance that the estimate will be substantially negatively biased, likely to be imprecise, and potentially unsuitable for use with the *SLA*.

The decision as to whether to submit an estimate for consideration for use with the *SLA* rests with the USA. If a estimate submitted is deemed suitable by the Scientific Committee for use with the *Bowhead SLA*, the Workshop **agreed** that this would 'reset the clock' so that the next abundance survey would then be due by 2026.

In terms of developing an estimate, the Workshop noted the importance of examining the extent to which the spatio-temporal layout of tracklines and survey blocks might prevent or reduce instances of double-counting individuals. It also suggested that the researchers examine whether survey-independent data (e.g. telemetry data) might be used to develop a less negatively-biased estimate by estimating the proportion of the population in the survey area at that time. However, it recognised that the August 2016 bowhead distribution was clearly unusual, making such an approach problematic. The Workshop suggested that a variety of analytical options and approaches be considered and reported in any paper submitted to the Scientific Committee. This would assist the Committee in deciding whether an estimate is suitable for use with the *Bowhead SLA*.

5.3 Number of replicates used in Greenland trials

As discussed under Item 3.1, the Workshop had examined the issue of the number of replicates used in the development of an *SLA* for the West Greenland fin whale hunt and developed an operational approach to deal with this issue. It recognised that this issue should also be investigated for the other West Greenland hunts.

During the workshop, Brandão undertook these computations for all the *Humpback SLA Evaluation Trials* and for some *WG-Bowhead SLA Evaluation Trials*. The results showed that the problem did not arise for the humpback whale trials but for one of the bowhead trials, even for 1000 simulations, the estimated probability interval for the D10 performance statistic included the threshold. It was therefore **agreed** that Brandão would extend this exercise for all the *WG-Bowhead SLA Evaluation Trials***.** The results will be examined during the 2017 meeting of the Scientific Committee.

During discussion, it was also noted that the *WG-Bowhead SLA* had been tested using only the abundance estimates from West Greenland, although it was recognised that this region covered only part of the Eastern Canada-West Greenland stock (catches from Canada were included). Last year it was agreed that the Scientific Committee will review a new estimate from Canada. The Workshop agreed that the AWMP Steering Group will consider whether preliminary use of this abundance estimate should also be considered in the runs undertaken by Brandão.

5.4 Work plan

The Workshop **agreed** to the following work plan:

(1) Punt and Brandão will conduct trials of the interim allowance approach for West Greenland humpback case (see Item 5.1.2) and submit the results to the 2017 Annual Meeting; and
(2) Brandão (in conjunction with the Steering Group) will rerun the full set of *WG-Bowhead SLA Evaluation Trials* and submit these to the 2017 Annual Meeting as discussed under Item 5.3.

6. ANY OTHER BUSINESS

There were no matters raised for discussion under this item of the agenda.

7. ADOPTION OF REPORT

The report was adopted by correspondence on 25 January 2017. Before the Workshop ended, the Chair thanked the staff of the Greenland Representation for the usual excellent facilities. He also thanked the participants for their co-operation and the quality of the debate in addressing complex issues. In particular, he thanked the rapporteurs and especially Witting and Brandão for their exceptionally hard work to progress *SLA* development for the Greenlandic hunts, and Punt and Allison for work on computational aspects. The Workshop thanked Jette Donovan Jensen for her customary cheerful assistance with logistics, especially with respect to dining.

REFERENCES

Heide-Jørgensen, M.P., Laidre, K., Simon, M., Burt, M.L., Borchers, D.L. and Rasmussen, M.H. 2010. Abundance of fin whales in West Greenland in 2007. *J. Cetacean Res. Manage.* 11(2): 83-88.

International Whaling Commission. 2001a. Chairman's Report of the 52nd Annual Meeting. *Ann. Rep. Int. Whal. Comm.* 2000:11-63.

International Whaling Commission. 2001b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 3:1-76.

International Whaling Commission. 2009. Report of the AWMP Workshop on Greenlandic Fisheries, 26-29 March 2008, National Institute of Aquatic Resources (DTU-Aqua), Dept. of Marine Fisheries, Charlottenlund Castle, Copenhagen, Denmark. *J. Cetacean Res. Manage (Suppl.)* 11:409-21.

International Whaling Commission. 2014. Report of the Fourth AWMP Workshop on the Development of *SLA*s for the Greenlandic Hunts, 15-18 December 2012, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 15:437-54.

International Whaling Commission. 2017a. Report of the AWMP Intersessional Workshop on Developing *SLA*s for the Greenland Hunts and the AWS, 14-17 December 2015, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 18:489-515.

International Whaling Commission. 2017b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

International Whaling Commission. 2017c. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 3. *Implementation Simulation Trial* specifications for North Atlantic fin whales. *J. Cetacean Res. Manage. (Suppl.)* 18:138-60.

International Whaling Commission. 2017d. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 18:174-84.

Annex A

List of Participants

DENMARK

Rikke Hansen
Mads-Peter Heide-Jørgensen
Lars Witting

ICELAND

Thorvaldur Gunnlaugsson

NORWAY

Nils Øien

INVITED PARTICIPANTS

Anabela Brandão
Doug Butterworth
Geof Givens
André Punt
Lars Walløe

IWC

Cherry Allison
Greg Donovan

Annex B

Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of agenda
   - 1.5 Documents available
2. New abundance estimates off Greenland
   - 2.1 Presentation of the results of the 2015 surveys
   - 2.2 Discussion
     - 2.2.1 Survey areas, methods (field and analytical)
     - 2.2.2 Estimates for large whales subject to ASW
   - 2.3 Conclusions
3. Development of an *SLA* for the Greenlandic fin whale hunt
   - 3.1 Review of discussions at SC/66b including progress made
   - 3.2 New abundance estimate
   - 3.3 Updated density-regulated assessment
   - 3.4 Discussion of implications of new information for finalising the *SLA*
   - 3.5 Conclusions, recommendations
   - 3.6 Work plan
4. Development of an *SLA* for the Greenlandic common minke whale hunts
   - 4.1 Review of discussions at SC/66b and the RMP intersessional Workshop
   - 4.2 New abundance estimate
   - 4.3 Initial modelling and trial structure
   - 4.4 Conditioning issues
   - 4.5 Advice on initial testing using 'preliminary' *SLA*s
   - 4.6 Conclusions and recommendations
   - 4.7 Work plan
5. General matters including the Aboriginal Whaling Scheme (AWS)
   - 5.1 AWS
     - 5.1.1 Carryover specification
     - 5.1.2 Interim allowance approach: extending testing to other *SLA*s
   - 5.2 Use of minimum abundance estimates
   - 5.3 Number of replicates used in Greenland trials
   - 5.4 Work plan
6. Any other business

Annex C

List of Documents

SC/D16/AWMP

01. Witting, L. Density regulated model for west Greenland humpback whales.
02. Witting, L. Density regulated models for west Greenland fin whales.
03. NO PAPER.
04. Givens, G., Ferguson, M., Clarke, J., George, J. and Suydam, R. Can *SLA*s use minimum population size estimates?
05. Givens, G. On the simple carryover of strikes.
06. Hansen, R., Boye, Larsen, T., Nielsen, R., Tervo, O., Nielsen, R., Singing, M. and Heide-Jørgensen, M.P. Abundance of whales in east and west Greenland in 2015.
07. Heide-Jørgensen, M.P. and Hansen, R.G. An index of the relevant abundance of minke whales in west Greenland.

Annex D

Accounting for a Time-Varying Proportion off Fin Whales of West Greenland

André E. Punt

The proposed working model for West Greenland fin whales is that there is a probability p that all of the animals in the 'stock' exploited off West Greenland are off West Greenland when a survey takes place (and hence there is a probability of 1-p that at least some of the animals are not off West Greenland). When some of the whales are not off West Greenland, the proportion off West Greenland, β, is generated from a beta distribution with parameters (3,7).

Conditioning of the operating model involves constructing a posterior distribution for the parameters given the available data. The likelihood function for the analysis consists of two components: (a) the estimates of abundance for 2005 and 2007, which are assumed to be estimates of absolute abundance; and (b) the estimates of abundance for 1987 and 2015, which are assumed to be subject to bias owing to the proportion β. The likelihood for the estimates of abundance for 1987 and 2015 marginalize over the distribution for β under the assumption that β for each year is treated as a random effect, i.e.:

$$L_y \propto \int_{\alpha}^{1} \frac{1}{\sqrt{2\pi}\sigma_y I_y} e^{-(\ell n I_y - \ell n(\beta N_y))^2/(2\sigma_y^2)} \beta^2 (1-\beta)^6 \, d\beta \qquad \text{(D.1)}$$

Where L_y is the likelihood for the i^{th} abundance estimate, I_y is the estimate of abundance for year y, N_y is the total (1+) number of animals in year y, and σ_y is the standard error of the log of I_y.

Data generation for each future year y will be based on first generating a value from U[0,1]. If this value is less than p, the bias, β, is assumed to be equal 1 otherwise β is generated from Beta (3,7).

Annex E

West Greenland Fin Whale *SLA* Trial Specifications

Please see *J. Cetacean Res. Manage. (Suppl.)* 18: 501-510 for the latest version of these specifications. This should be read in conjunction with Punt, 2018, p.559 in this volume (see above) which details updates in the model used. A final version of the specification will be published in next year's *Supplement*.

Report of the Workshop on the *Implementation Review* of Western North Pacific Bryde's Whales

Report of the Workshop on the *Implementation Review* of Western North Pacific Bryde's Whales[1]

EXECUTIVE SUMMARY

The Workshop on the RMP *Implementation Review* of offshore western North Pacific Bryde's whales, chaired by Donovan, was held in Tokyo from 21-24 March 2017 at the Ministry of Agriculture, Forestry and Fisheries Sanbancho Branch Office.

The Workshop made considerable progress with this, the first *Implementation Review* since the completion of the *Implementation* in 2007, as summarised below.

(1) The Workshop reviewed the new information relevant to stock structure and agreed to take forwards two stock structure hypotheses (see Fig. 5 below) - one of the four considered at the 2007 *Implementation* and one new hypothesis:
   (a) *Hypothesis 2*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2.
   (b) *Hypothesis 5*: There are two stocks, one feeding in sub-area 1 and the second feeding in sub-area 2 with mixing occurring in sub-area 1E. There are more animals from stock 1 than stock 2 in the mixing area.

(2) The Workshop reviewed new information on abundance estimates and developed a workplan to try to obtain agreed abundance estimates (including additional variance) for use in conditioning the trials and the *CLA*.

(3) The Workshop developed a new set of simulation trials for the *Implementation Review* that involve testing for uncertainty in stock structure, stock boundaries, MSYR, removals and additional variance.

(4) The Workshop developed an ambitious work plan to try to complete the *Implementation Review* at SC/67a in May 2017.

The Workshop was held in Tokyo, from 21-24 March 2017 at the Sanbancho Branch Office of the Ministry of Agriculture, Forestry and Fisheries. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants to Tokyo. He thanked the Fisheries Agency of Japan and the Institute of Cetacean Research for hosting the Workshop in such excellent facilities.

The purpose of the Workshop was to facilitate the first *Implementation Review* of western North Pacific Bryde's whales; the *Implementation* was completed in 2007 (IWC, 2008b, pp.91-115). The RMP states that:

> '… an *Implementation Review* for a species and *Region* should normally be scheduled no later than six years since the completion of the previous *Implementation (Review)*. In some cases, an *Implementation (Review)* may require the specification and running of further *Implementation Simulation Trials*, especially when major changes to *Management Area* boundaries or the selection of different options for *Catch-capping* and/or *Catch-cascading* than those currently used is contemplated. In such cases the *Implementation Review* would probably not be completed at a single meeting.'

The Scientific Committee had agreed that the *Implementation Review* would take place later than six years in light of the additional information expected to become available from the JARPN II review (IWC, 2010; 2017a) and to avoid overlap with ongoing *Implementation Reviews*.

The objective of the Workshop was to examine any new information available (including that on stock structure, catch and abundance) and determine whether the existing trials (and by extension hypotheses) are adequate, whether further trials are necessary (and if so develop them) or whether some existing trials are no longer required. If additional work is necessary, then the Workshop will develop a timetable to complete the *Implementation Review*.

1.2 Election of Chair and appointment of rapporteurs

Donovan was elected Chair. Allison, Butterworth, Palka, Punt and Tiedemann acted as rapporteurs, assisted by Donovan.

1.3 Adoption of agenda

The adopted agenda is given as Annex B.

1.4 Documents and data available

The list of documents is given as Annex C.

2. SUMMARY OF THE INITIAL *IMPLEMENTATION*

The Initial *Implementation* completed in 2007 followed the timetable and process agreed for the RMP, including two intersessional workshops (IWC, 2007b; 2008a; 2008b, pp.91-115; 2008c).

2.1 Overview of hypotheses

The 2007 *Implementation* of western North Pacific offshore Bryde's whales (IWC, 2008c) identified four hypotheses about mixing and stock structure for the western North Pacific Bryde's whales. In developing these hypotheses, it had been assumed that:

(1) the breeding grounds are in lower latitudes where no whaling will take place;
(2) no whaling will occur during migration to the feeding grounds; and
(3) the hypotheses could be represented using three spatial cells (sub-areas 1W, 1E and 2; see Fig. 1.).

The four general hypotheses regarding stock structure considered in the *Implementation* are illustrated in Fig. 2, Hypotheses 1-4.

(1) Hypothesis 1 is that there is only one stock in sub-areas 1 and 2.
(2) Hypothesis 2 comprises two stocks, one stock in sub-area 1 and the other in sub-area 2.
(3) Hypothesis 3 also involves two stocks in sub-areas 1 and 2. One stock is found in both sub-areas whilst the other is found in sub-area 2 only.
(4) Hypothesis 4 involves two stocks in sub-areas 1 and 2. Stock 1 consists of two sub-stocks that mix in sub-areas 1W and 1E. Stock 2 is only found in sub-area 2. Sub-stocks are modelled as stocks (i.e. there is no permanent transfer of animals among sub-stocks).

[1]Presented to the Scientific Committee as SC/67a/Rep07.

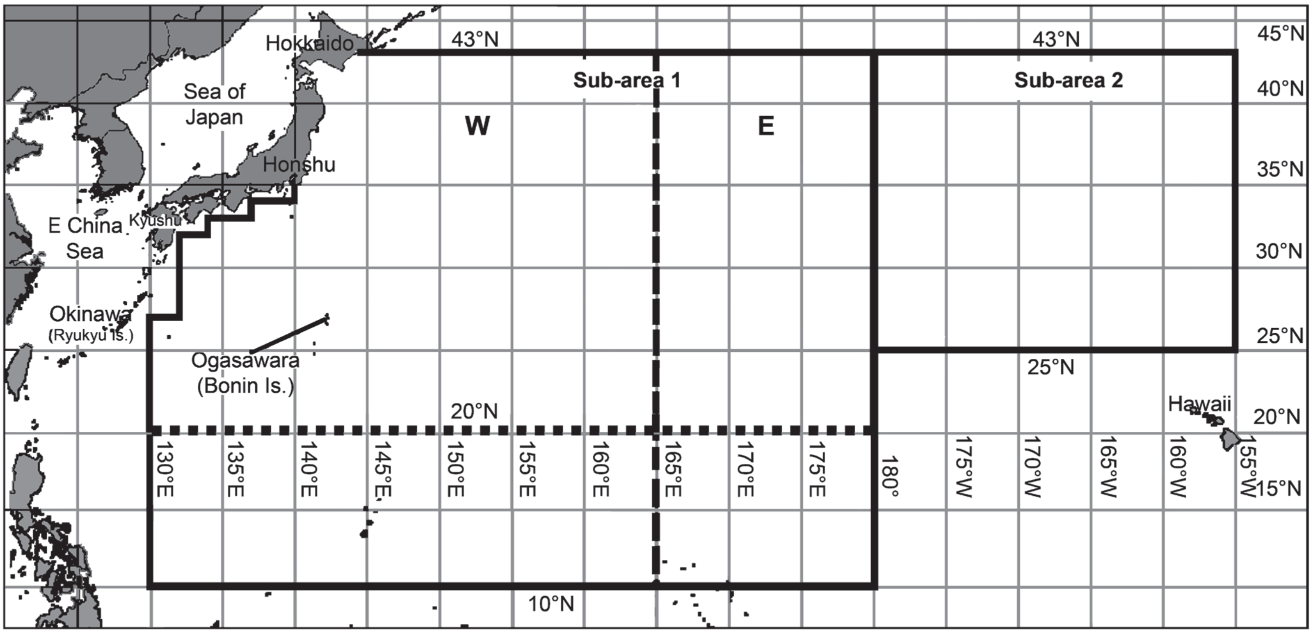


Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales during the *Implementation* (IWC, 2008b, pp.91-115). The staggered border to the south of Japan is used to ensure that no catches of the inshore form occur. The dotted line at 20°N shows the revised southern border of sub-area 1 agreed at this Workshop (see Item 4.2) to avoid the breeding grounds.

Table 1

Management variants considered in the 2007 *Implementation.*

Variant	Description
Variant 1	Sub-areas 1W, 1E and 2 are *Small Areas.*
Variant 2	Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area.*
Variant 3	Sub-area 2 is taken as a *Small Area* and sub-area 1 is a *Combination Area*. Sub-areas 1W and 1E are *Small Area*s, with catch-cascading applied.
Variant 4	Sub-areas 1 and 2 (combined) are a *Combination Area*, and sub-areas 1W, 1E and 2 are *Small Areas*, with catch-cascading applied.

The data used in the trials included historical catches, abundance estimates, ages (commercial, 1971-79 and special permit, 2000-03) and marking (animals marked 1972-84, recovered 1976-86). The full trial specifications and list of trials are given in (IWC, 2008b, pp.91-115). In addition to the stock hypotheses, the following factors were tested:

(1) uncertainty in historical catches (particularly regarding the allocation between sei and Bryde's whales as these whales were not differentiated in the data prior to 1954);
(2) additional process error;
(3) position of the boundary between sub-areas 1W and 1E;
(4) age dependent mixing; and
(5) stochastic mixing (Hypothesis 4).

2.2 Results and conclusions

The four management variants given in Table 1 were tested. Variants 1, 3 and 4 were considered 'acceptable' whereas Variant 2 was considered 'acceptable with research'. The last result was due to the poor performance of Variant 2 in some trials related to stock structure Hypothesis 4.

3. REVIEW OF NEW INFORMATION

3.1 Stock structure and movements

The Workshop noted that the *Implementation* had developed stock structure hypotheses based on genetic, mark-recapture and age data. Most of the new information relevant to stock structure considered in this *Implementation Review* related to additional genetic data (including refined analyses) and age data.

3.1.1 Movements

Kishiro (1996) examined movements of Bryde's whales in the western North Pacific using information from whale marks recovered by Japanese and Soviet whaling vessels until the end of the 1987 season. The data suggested that whales summering in the whaling grounds of sub-area 1, winter over a wide latitudinal range (1-25°S). The study did not find evidence of more than one stock of Bryde's whales in the western North Pacific whaling grounds of sub-area 1.

Murase *et al.* (2016) reported the movements of two individual Bryde's whales using satellite-monitored radio tags in offshore waters of the western North Pacific (sub-area 1). One whale was tracked for 13 days in July 2006 and the second whale was tracked for 20 days in July/August 2008. The first whale showed a north-south movement while the second one moved from west to east and then to the south.

The Workshop welcomed this information, noting that the marking data had also been considered in the 2007 *Implementation.*

It agreed that this information would be considered when evaluating potential stock structure hypotheses (see Item 3.1.4).

3.1.2 Age data

SC/M17/RMP03 reported on progress in earplug-based age determination and on the estimation of biological parameters for Bryde's whales sampled during the 2000 to 2014 JARPN II surveys. Age readability was reported, and the age distribution for JARPN II and commercial whaling was compared by sub-area, with no significant differences detected for whales of age 9 and older.

The comparison of age distributions by sub-area is important, as differences detected between sub-areas 1W and 1E during the original *Implementation* had been the primary basis for introducing stock structure hypothesis 4 (IWC, 2007a, pp.94-96; 2007b, pp407-414), which assumes different stocks in those two sub-areas.

The Workshop examined the updated age data set, giving particular consideration to the consequences of a change in age reader (from Kato to Bando) over the period under consideration, and the locations and method of collection of the samples.

Annex D lists estimates of ages of the same earplug by the two readers, and provides associated comparative plots. The Workshop noted an appreciable systematic difference evident between Bando's age readings and the earlier readings of JARPN II by Kato, with the former being notably larger than the latter for most earplugs. Bando explained that Bryde's whale earplugs were particularly difficult to read. A careful study had revealed frequent cases of additional rings present that were particularly difficult to identify. He considered the fact that he was counting these additional rings to be the main reason for his readings frequently being greater than those by Kato.

The Workshop also noted differences (see Annex D2) in the latitudinal distribution of the commercial and JARPN II catches (the latter being further north). Furthermore, readability of earplugs from the commercial operations (around 17%) was much lower than that for JARPN II (around 65%), with the difference being attributed to the less careful extraction process possible during commercial whaling.

Given the above, the Workshop **agreed** that the data could not be pooled across the commercial and JARPN II activities, and that consequently comparisons of age distributions between sub-areas should be restricted to Bando's readings of the JARPN II earplugs (or Ohsumi and Masaki's readings of the commercial samples). To avoid possible confounding by selectivity effects, comparisons were restricted to whales aged 10 and above, with a sensitivity analysis for ages of 12 and above.

The results of $\chi 2$ tests comparing these age distributions across sub-areas 1W and 1E are reported in Annex D. No differences significant at the 5% level were found. This contrasts with a difference significant at the close to the 1% level found previously (IWC, 2007b, pp.413-414) that provided the basis for stock structure Hypothesis 4. The Workshop **agreed** that the earlier result was probably an artefact caused by pooling non-comparable data that had been available in different proportions in the two sub-areas.

The desirability of an age reader calibration exercise, *inter alia* to allow the estimation of ageing error is discussed under Item 3.5.

3.1.3 Genetic data

Considerable new genetic information on North Pacific Bryde's whales was presented by Kanda *et al.* (2007), Pastene *et al.* (2016a; 2016b), SC/M17/RMP01 and Annex E, based on analysis of mitochondrial control region and 17 autosomal microsatellites, derived from sub-area 1W (SA1W), sub-area 1E (SA1E), and sub-area 2 (SA2).

Pastene *et al.* (2016b) examined a total of 1,019 and 1,026 samples of North Pacific Bryde's whales with microsatellite DNA (17 loci) and mtDNA sequences (299bp), respectively, to examine stock structure in sub-areas 1 and 2. Samples were from different sources: JARPN II (catches), Japanese dedicated sighting surveys (biopsy), IWC/POWER surveys (biopsy) and past commercial whaling (catches). No significant genetic heterogeneity was found between the western and eastern sectors of sub-area 1 divided at 165°E, a result supported by high statistical power. However, both genetic markers showed significant differences (males, females and both sexes combined) between sub-areas 1 and 2. Phylogenetic analysis of mtDNA haplotypes revealed no sub-area specific clades. The authors concluded that the results are consistent with the occurrence of two stocks with a stock division around longitude 180°.

Pastene *et al.* (2016a) presented the results of a STRUCTURE analysis based on the same Bryde's whale data set used in Pastene *et al.* (2016b). The results of the analyses revealed no structuring of the Bryde's whale within sub-areas 1 and 2. The STRUCTURE approach showed structure at the oceanic basin level (western North Pacific, eastern South Pacific off Peru, western South Pacific off Fiji and eastern Indian Ocean off Java; Kanda *et al.*, 2007).

SC/M17/RMP01 examined the stock structure of Bryde's whale in the North Pacific using a Discriminant Analysis of Principal Component (DAPC), based on the same data set used in Pastene *et al.* (2016b) and Kanda *et al.* (2007). The DAPC analysis revealed no structure in the North Pacific region involving sub-areas 1 and 2. However, the DAPC analysis showed differentiation of Bryde's whales among western North Pacific, eastern South Pacific off Peru, western South Pacific off Fiji and eastern Indian Ocean off Java. The lack of an evident structure within the North Pacific analysis was explained by the low *Fst* estimates among whales in sub-areas 1W, 1E and 2.

The Workshop thanked the authors of these papers. The results of three additional analyses of these data that could assist in examining stock structure are presented in Annex E:

(a) heterogeneity test between sub-areas 1 and 2 by year;
(b) heterogeneity test between sub-areas 1 and 2 by moving the longitudinal boundaries between the two sub-areas (150°E, 155°E, 160°E, 165°E, 170°E, 175°E, 180° and 175°W); and
(c) test for Hardy-Weinberg (HW) equilibrium.

Regarding (a), tests were conducted for the years 1979 to 2014 and in 12 cases significant differences were found for both genetic markers. Regarding (b) significant differences were found for both markers when the boundaries were 165°E, 170°E, 175°E and 180°. The test for HW equilibrium (c) was not considered informative with respect to stock structure. Based on these results, the following evaluation of the stock structure hypotheses from the 2007 *Implementation* was made by the authors of Annex E:- Hypothesis 1: not consistent with the current genetic data; Hypotheses 2 and 3: consistent with the current genetic data; Hypothesis 4: not specifically supported by the current genetic data. In addition, an additional hypothesis was proposed that is also consistent with the genetic data: Hypothesis 5, which proposes two stocks, one in sub-area 1W and the other in sub-area 2 with the two stocks mixing in sub-area 1E. These are illustrated in Fig.2.

In order to evaluate the five stock structure hypotheses, the Workshop identified a number of additional analyses. These are discussed below (and see Annex E). As well as the material on ages and movements, a series of genetic diversity measures were considered (arising from analyses included in presented papers, complemented by analyses described in Annex E and summarised in Table 2):

(a) for microsatellites: observed heterozygosity, H_O, expected heterozygosity, H_E, test for departure from Hardy-Weinberg-equilibrium, HWE; and
(b) for mtDNA: haplotype diversity, HD, and haplotype frequencies.

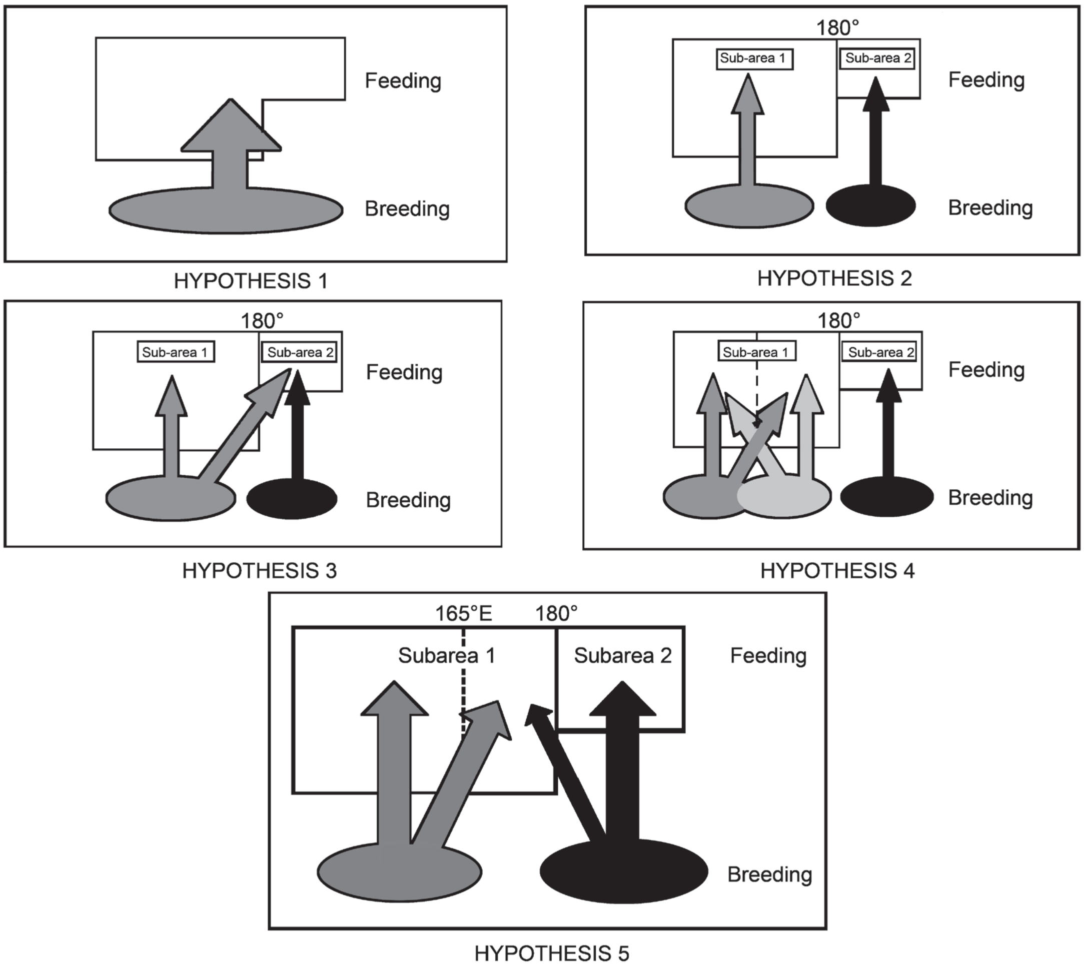


Fig. 2. Schematic showing the stock structure hypotheses considered during this *Implementation Review.* Hypotheses 1-4 were also used in the 2007 *Implementation.* Hypothesis 5 is the hypothesis developed at this Workshop.

Table 2

Measures of genetic diversity and haplotype frequencies (+/- 1SD).

Genetic diversity measures	SA1W	SA1E	SA1	SA2	SA1E+SA2	Total
H_O	0.67+/-0.15	0.68+/-0.16	0.67+/-0.15	0.70+/-0.14	0.68+/-0.15	0.67+/-0.15
H_E	0.68+/-0.15	0.69+/-0.14	0.68+/-0.15	0.68+/-0.14	0.69+/-0.14	0.68+/-0.15
HWE	0.713	0.111	0.419	0.370	0.,157	0.407
HD	0.82+/- 0.01	0.82+/- 0.03	0.90+/- 0.02	0.82+/- 0.01	0.85+/- 0.02	0.83+/- 0.01
Sample size for microsatellites	847	119	966	53	172	1,019
Sample size for mtDNA	855	117	972	53	190	1,025

Microsatellites: HO, observed heterozygosity; HE, expected heterozygosity; HWE, p-value for Hardy-Weinberg-Equilibrium; mitochondrial DNA: HD, haplotype diversity

Table 3

Genetic divergence measures.

	SA1W *vs* SA1E *vs* SA2	SA1W *vs* SA1E	SA1E *vs* SA2	SA1 *vs* SA2	SA1W *vs* combined SA1E/SA2	SA1W *vs* SA2
Microsatellite F_{ST}	0.002	0.000	0.003	0.004	0.001	0.004
	p=**0.002**	p=0.155	p=**0.029**	p<**0.001**	p=**0.010**	p<**0.001**
mtDNA F_{ST}	0.009	0.002	0.017	0.022	0.011	0.023
	p=**0.002**	p=0.090	p=0.045	p<**0.001**	p=**0.004**	p=**0.003**
mtDNA exact test	p=**0.001**	p=0.148	p=**0.010**	p<**0.001**	p<**0.001**	p<**0.001**

Bold text indicates a statistical significance at alpha=0.05 after FDR correction.

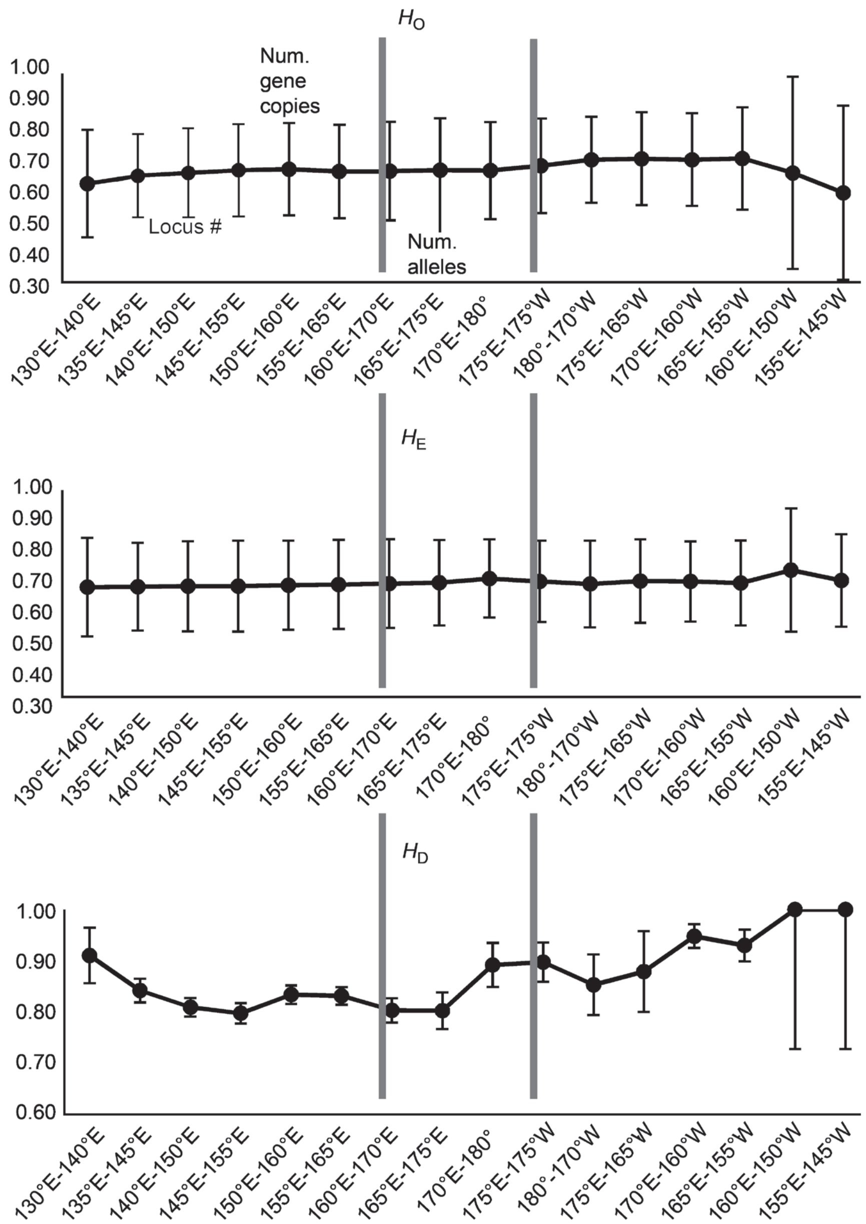


Fig. 3. Genetic diversity relative to longitude of sample origin (calculated for 5° intervals; plotted as moving averages over 10° intervals). The vertical grey lines indicate the management boundaries.

The following strata were considered: sub-area 1W, sub-area 1E, and sub-area 2 separately, sub-area 1, combination of sub-area 1E and sub-area 2, total (combination of sub-area 1 and sub-area 2).

Table 3 summarises the results of cross-comparison of several estimates of genetic divergence (i.e. for micro-satellites F_{ST}; for mtDNA F_{ST} and p-values of an exact test of population differentiation (i.e. test of non-random distribution of haplotypes into population samples under the hypothesis of panmixia).

Fig. 3. and Fig. 4. illustrate the diversity and DAPC data by longitude. Further details are provided in Annex E.

With regard to sampling strategy, the Workshop noted that:

(a) the sample number is highest in sub-area 1W, and much lower in sub-area 2;
(b) the temporal spread in sampling is larger in areas of former commercial whaling (sub-area 1); and
(c) 5 samples assigned to sub-area 2 actually originated from east of sub-area 2 (between 155°W and 145°W).

The possible implications of these issues were discussed and the Workshop **recommends** that prior to SC/67a, analyses are conducted to test for the effect of inclusion *vs* exclusion of:

(a) the old samples from commercial whaling; and
(b) samples east of 155°W.

It is not expected that these issues will substantially change the plausibility of the stock structure hypotheses.

With respect to statistical power, Pastene *et al.* (2016b) had evaluated the power to detect population structure using hypothesis testing (i.e. F_{ST}). The Workshop noted that power analysis confirms high statistical power to detect population structure for migration rates up to 0.01 (translating into an F_{ST} of about 0.005), but power drops considerably with higher migration rates (power is below 10% at migration rate 0.1). Actual power to detect structure on feeding grounds may be lower if breeding stocks mix on feeding grounds (stock structure hypothesis 3 to 5), in particular, if mixing proportions are uneven.

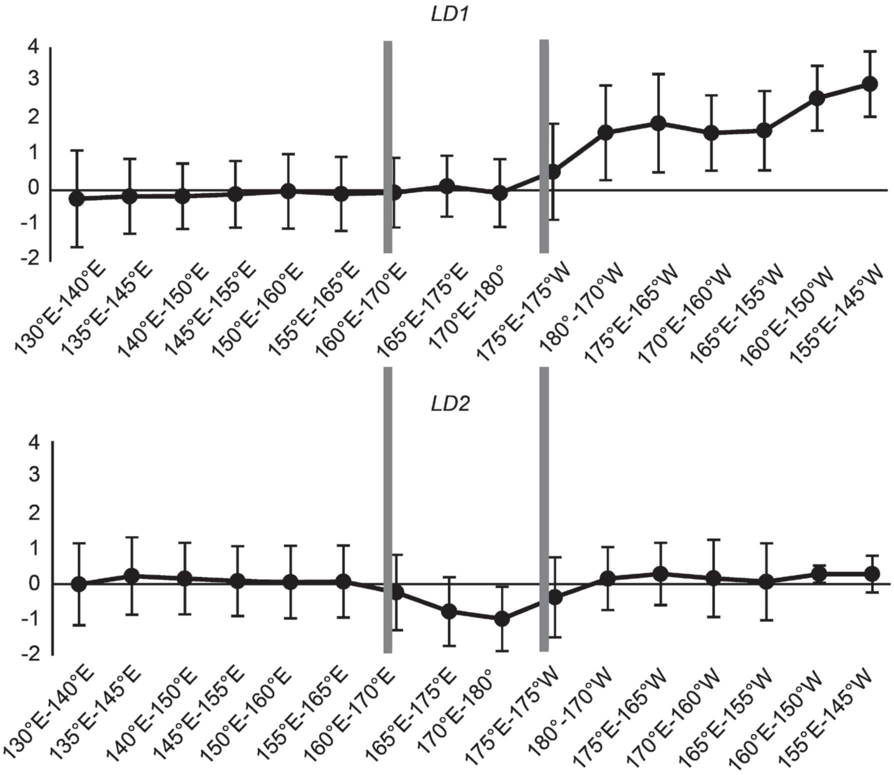


Fig. 4. Mean values of the first two principal components of the DAPC, conditional on longitude (calculated for 5° intervals; plotted as moving averages over 10° intervals). The vertical grey lines indicate the management boundaries.

Table 4

General summary of the information useful to assess plausibility of alternative stock-structure hypotheses (*cf* Fig. 2). A '+' indicates evidence in favour of a hypothesis, '-' indicates evidence against a hypothesis, '(+)' indicates weak evidence in favour of a hypothesis, '(-)' indicates weak evidence against a hypothesis, a ((+/-)) indicates ambigous information, and 'NIW' indicates that the evidence is not inconsistent with the hypothesis. Note that the designation NIW often reflects the asymmetrical nature of information on stock structure (i.e., existence of differences can be viewed as positive evidence for multiple stocks, but absence of differences provides no information, and cannot be viewed as positive evidence for a single stock).

Evidence	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4	Hypothesis 5 (new)
mtDNA-HD	-	-	(+)	-[a]	+
mtDNA-F_{ST}	-	+	-	-[a]	(+)
mtDNA-haplotype distribution (exact test)	-	+	NIW	-[a]	(-)[d]
Microsatellite H_O/H_E	NIW[b]	(-)[b]	-[b]	-[a,b]	(-)[b]
Microsatellite-F_{ST}	-	+	-	-[a]	(+)[c]
Microsatellite DAPC	-	+	(-)	NIW	NIW
Overall assessment	-	+	-	-[a]	(+)[d]

[a]Assumes two stocks in SA1, one predominantly feeding in SA1W, the other in SA1E, with mixing. With small divergence among these stocks/high mixing rates, this hypothesis will become indistinguishable from hypothesis 2. [b]Heterozygosity estimates were almost identical across all strata, even if stratified by longitude and were considered uninformative with regard to stock structure. [c]Under the assumption of uneven mixing proportions in SA1E, biased towards the more western stock. [d] If mixing proportions are strongly biased towards the more western stock, difficult to distinguish from hypothesis 2.

3.1.4 Conclusions

The genetic information used in the evaluation of the five stock structure hypotheses is summarised in Table 4.

HYPOTHESIS 1

This hypothesis constitutes the null hypothesis of no stock structure. It was rejected with high statistical support by various divergence measures indicative of genetic structure. It is further contradicted by increased haplotype diversity, when combining strata (Table 2).

The Workshop **recommends** that Hypothesis 1 is not considered further.

HYPOTHESIS 2

This hypothesis was supported by all statistical analyses of genetic divergence, both for mtDNA and microsatellites. It can however not fully explain the stratum-specific pattern of haplotype diversity, i.e., increased HD when sub-area 1W and sub-area 1E are combined (Table 2), nor the increase in HD east of 175°E (i.e., within sub-area 1E).

The Workshop **recommends** that Hypothesis 2 is included in the *Implementation Simulation Trials*. However, it also **recommends** that sensitivity to the position of the border between sub-area 1 and sub-area 2 is investigated in the trials.

HYPOTHESIS 3

This hypothesis did not receive explicit support by any of the performed analyses. There is no indication for a mixing of stocks in sub-area 2.

The Workshop **recommends** that Hypothesis 3 is not considered further.

Table 5

Potential abundance estimates for consideration for use in the *Implementation Review.*

Area	Date stamp	Range of years	Estimate	CV	Approx. 95% CI	IWC reference	Original reference	Status/notes
1W	1995	1988-96	8,152	0.329	4,300-15,500	IWC (2007)	Kitakado *et al* (2005); Kitakado *et al* (2007)	See 1
1E	1995	1988-96	10,814	0.342	5,500-21,100	IWC (2007)	As for 1W	See 1
2	1995	1988-96	2,860	0.372	1,400-5,900	IWC (2007)	As for 1W	See 1
1+2	1995	1988-96	21,826	0.295	11,000-38,000	IWC (2007)	As for 1W	Add SD of 0.673
1W	2000	1998-2002	4,957	0.398	2,300-10,800	IWC (2009a, pp.6-7)	Kitakado *et al* (2008); Shimada *et al* (2008)	See 2
1E	1999	1998-2002	11,213	0.498	4,200-29,800	As for 1W	As for 1W	See 2
2	2002	1998-2002	4,331	0.553	1,500-12,800	As for 1W	As for 1W	See 2
1+2	2000	1998-2002	20,501	0.337	11,000-38,000	As for 1W	As for 1W	See 2
1W	2012	2008-14	16,511	0.25	10,200-26,800	This report	SC/M17/RMP02	See 3
1E	2012	2008-15	7,074	0.24	4,500-11,200	As for 1W	As for 1W	See 3
2 extended	2014	2013-15	4,861	0.24	3,100-7,700	As for 1W	As for 1W	See 3

Notes:

[1]The 1988-96 surveys were not oversighted. The estimates were used for conditioning the *Implementation* but have not been agreed for use in an actual application of the RMP.

[2]1998-2002 estimates agreed for use in conditioning and for use in an actual application of the RMP.

[3]2008-15 estimates: status to be confirmed – see discussion in main text.

HYPOTHESIS 4

The inference from age data previously taken to support this hypothesis is no longer considered valid (see Item 3.1.2). Furthermore, the genetic data do not provide any indication for three stocks, one each feeding in sub-area 1W, sub-area 1E, and sub-area 2, with an unknown degree of mixing of the first two stocks. While recognising that the existence of two stocks occurring in sub-area 1 cannot be formally disproved, the Workshop **agrees** that the lack of specific support suggests that if two stocks exist in sub-area 1, they are genetically very similar and/or mix at high rates, such that the emerging stock structure may sufficiently approximated by Hypothesis 2.

The Workshop **recommends** that Hypothesis 4 is not considered further.

HYPOTHESIS 5

While the genetic data are not indicative of an equal mixing of two stocks in sub-area 1E, Hypothesis 5 may explain some of the genetic patterns not reconciled by Hypothesis 2, namely the increased HD when combining sub-area 1W and sub-area 1E. Maximum likelihood estimates of mixing proportions in sub-area 1E based on mtDNA haplotype frequencies (Annex F) suggest mixing proportions of 80-100% for the western stock, depending on whether the JARPN II/POWER or commercial samples are used to specify the haplotype frequencies for sub-areas 1E (at 100%, the pattern becomes identical to Hypothesis 2). As for Hypothesis 2, the evidence for Hypothesis 5 was not unequivocal, but it was noted that: (a) it is always difficult to prove given very uneven mixing proportions and shallow divergence between stocks (as here); and (b) it provides an explanation for genetic patterns not captured by Hypothesis 2.

The Workshop **recommends** that Hypothesis 5 is included in the *Implementation Simulation Trials*. However, it also **recommends** that sensitivity to the position of the border between sub-area 1 and sub-area 2 is investigated in the trials.

3.2 Abundance

There are three series of abundance estimates (see Table 5) to consider and evaluate:

(1) the original series used in the *Implementation* were collected during 1988-96 and time stamped at 1995;

(2) a series agreed to by the Committee (IWC, 2009b) for use in the *CLA* was collected during 1998-2002 (Kitakado *et al*., 2008) and time stamped at 2000; and

(3) a new series using data collected during 2008-15, which was the focus of discussions at this Workshop.

These three series of estimates will be used for conditioning trials and potentially for actual applications of the RMP.

SC/M17/RMP02 presents abundance estimates for the new time series using data from the recent IWC-POWER and JARPN II line transect surveys. The IWC-POWER series of surveys that detected Bryde's whales were conducted during three surveys, 2013-15 which were in sub-areas IE, 2 and 20° longitude farther west of the original sub-area 2 (referred to as 'sub-area 2 extended'). The JARPN II series of surveys was conducted during 2008, 2012 and 2014 and were in sub-areas 1W and 1E. The two series were analysed separately using the Multiple Covariate Distance Sampling (MCDS) module in the DISTANCE program, where the potential covariates were group size, Beaufort and Year. Based on the best models, abundance estimates were 16,511 (CV=0.25), 7,074 (CV=0.24) and 4,861 (CV=0.24) for sub-areas 1W, 1E, and 2 extended, respectively.

The Workshop thanked the authors and discussed the additional work that would be needed to finalise abundance estimates for the entire surveyed area for the recent time series and for the sub-areas as defined in the *Implementation*. It requested additional details on the methodology and results, many of which were provided during the meeting (see Annex G).

The Workshop **recommends** that a new paper be provided to the Scientific Committee meeting in May 2017. This must include more details on the survey collection modes and data used (e.g. how were group sizes confirmed in independent observer (IO) mode, distance and angle corrections), analytical methods (e.g. how were the CV's calculated, model averaging, use of alternative covariates) and reported results (such as the complete maps of track lines along with on-effort and off-effort Bryde's whale sightings, estimates of the effective half strip width or $p(0)$, average group sizes).

More substantially, the Workshop **recommends** that the paper includes the additional analyses that need to be undertaken before the estimates can be agreed. These additional analyses relate to:

(a) including sightings that were identified as 'Bryde's like' and 'unidentified large baleen whales'; and
(b) attempting to estimate $g(0)$.

A previous IWC-POWER Technical Advisory Group (TAG) meeting (IWC, 2017b), had **agreed** that, since so few other positively identified baleen whales were detected in the 2014 and 2015 IWC-POWER cruises (only one sighting of a blue whale and one of a sei whale in 2014), the unidentified large baleen whale sightings during these two years were very probably Bryde's whales. The Workshop **concurs** with this view, and **recommends** that these sightings be included for comparison with estimates where they are excluded.

The Workshop also **concurs** with the TAG that the 2015 and 2016 IWC-POWER surveys that used the IO data collection mode should be analysed to attempt to estimate $g(0)$ for Bryde's whales using the MRDS module in the DISTANCE program. The TAG had noted that a preliminary analysis (although with low sample size) had suggested that $g(0)$ might be considerably below 1.

The Workshop also discussed the additional analyses that would be needed to develop abundance estimates to be used in the conditioning and for simulated application of the *CLA* in the trials. It is important that the three sets of abundance estimates are as consistent as possible to avoid 'spurious' trends being considered. The Workshop **recommends** that the abundance paper presented to SC/67a also includes:

(1) abundance estimates for the recent series of surveys for the sub-areas that correspond to the stock structure hypotheses above[2];
(2) estimation of additional variance at the sub-area level using all three series; and
(3) consideration of whether the value of $g(0)$ estimated for the most recent series of cruises is appropriate for application to the earlier surveys.

With respect to (1), the Workshop **agreed** that the post-stratified components from the updated abundance estimates developed for the entire survey area in a revised SC/M17/RMP02 could be used to develop estimates for the sub-areas needed to condition the *Implementation Simulation* trials. For example, use sub-area specific estimates of the encounter rate (n/L) and group size, together with the pooled estimate of $g(0)$ to estimate abundance for the desired sub-areas. Although spatial modelling was discussed as another potential method to derive the required abundance estimates, the Workshop noted spatial modelling techniques and guidelines for their use will be discussed at SC/67a. It will be appropriate, after these discussions, to evaluate whether such techniques would result in more precise and accurate abundance estimates for the sub-areas needed. However, at least for the conditioning, the Workshop **agreed** that the simpler post-stratification method was sufficient.

With respect to (2), the Workshop **agreed** that multiple abundance estimates for common blocks are required. The previous two series of surveys met this requirement, and so the additional variance was estimated using block-wise abundance estimates from those surveys and are reflected in the CVs of the abundance estimates (Kitakado *et al.*, 2008). The abundance estimates for all series of surveys should be examined to allow an evaluation of comparability.

With respect to (3), the nature of the earlier series of cruises (methods, vessels, etc.) should be examined to see if the recent estimate of $g(0)$ is applicable for one or more series. The Workshop also **recommends** that a more general discussion of the use data from series for which correction factors (e.g. estimates of $g(0)$) are available only for more recent surveys and not for historical surveys.

The Workshop **agreed** to establish an Advisory Group to assist in the work on abundance (Palka [Chair], Hakamada, Kitakado, Donovan, Butterworth, Allison, Miyashita).

3.3 Removals data

3.3.1 Catch data

Allison reported that there are no changes to the catch series developed for the 2007 *Implementation* except for some minor revisions over the 1938-45 period and the addition of catches for the 2006-16 period.

3.3.2 Bycatch data

Four incidental catches between 1975 and 2003 were identified in the 2007 *Implementation* (see *pre-Implementation assessment* Workshop report, (IWC, 2006, p.338), of which one (in October 2003 from a trap net in Shizuoka) was identified as an offshore type Bryde's whale based on DNA analysis (L. Pastene, pers. comm.). The remaining three (in August 1978 from Oita, April 1988 from Hyogo and March 1995 from Kochi [released]) are all thought to have been inshore forms, although no DNA data are available to confirm this.

Yoshida reported that a Bryde's whale caught in a trap net at Nagasaki in 2004 was from the East China Sea stock; one offshore type was caught in a stationary uncovered pound net at Mie in 2010.

The Workshop **agreed** that there was no evidence to suggest that any appreciable number of Bryde's whales is caught incidentally, so that (as in the 2007 *Implementation*) there is no need to model incidental catches in the *Implementation Simulation Trials*.

3.3.3 Ship strikes data

Kato informed the Workshop that there were no confirmed ship strikes of Bryde's whales in Japan with 'normal' vessels for the period 2003-16 according to the website of the Japanese Coast Guard[3]. On the other hand, there have been 25 records of hydrofoil collisions with large marine organisms for that period including eight cases confirmed as large cetaceans (five common minke whales, one humpback whale and two sperm whales).

As hydrofoils operate only in close coastal waters, The Workshop **agreed** that there was no need to model ship strikes in the revised *Implementation Simulation Trials*.

3.4 Future likely whaling operations

Future harvesting of Bryde's whales by Japan (Annex H) is proposed from May to September in Japanese coastal waters and high seas but excluding:

(1) 40 n.mile zone off the coast of southern Japan west of 140°E;
(2) the 200 n.mile zone round countries other than Japan; and
(3) the area south of 20°N.

The proposed timing will avoid both the expected breeding (December-April) and calving (October-March) seasons (Ohsumi, 1995). The proposed harvest area (see Fig. 1) ensures that catches will be taken from the offshore form only. The main area that Japan wishes to operate for whaling is sub-area 1 (especially sub-area 1W).

[2]Following the guidelines developed for *Implementations*, the appropriate time stamps for the abundance estimate for each sub-area should be the average year of the surveys that covered that sub-area i.e. 2011 for sub-area 1W, 2011 for sub-area 1E and 2014 for sub-area 2.

[3]*http://www6.kaiho.mlit.go.jp/info/marinesafety/jikojouhou.html.*

3.5 Other data that might assist in the *Implementation Review*

3.5.1 Biological data

SC/M17/RMP03 reported on progress in earplug-based age determination and on the estimation of biological parameters for Bryde's whales sampled during the 2000 to 2014 JARPN II surveys. The apparent pregnancy rate over a whole year was estimated to be 0.615. von Bertalanffy growth curves were estimated separately for males and females, with their respective ages at sexual maturity estimated to be 9.99 and 8.72 years.

Matters related to the age readings relevant to stock structure were considered under Item 3.1.2.

The meeting noted that an analysis of the existing Kato-Bando pairs of age readings (see Annex D) would not be appropriate for evaluating ageing errors as the methods used by the two readers had differences. The Workshop **agrees** that undertaking such an analysis (similar to that undertaken for Antarctic minke whales, see Butterworth and Punt, 2009, and Kitakado and Punt, 2010) was important and Bando advised that Japan was planning such an exercise, which was hoped to be completed by SC/67b in 2018.

With respect to biological parameters, the Workshop received a revised estimate (Annex I) of the age-at-50%-maturity for females from application of the method of Punt (2008) to the JARPN II data, for the ages obtained by Bando. This resulted in a value of 8.6 years compared to the value of 6 years used for previous *Implementation Simulation Trials*. This change was primarily ascribed to differences in age readings as detailed above, and the Workshop **agreed** to use the higher new value in revised *Implementation Simulation Trials*, although it will be advisable to take ageing error into account when the appropriate experiment has taken place. However, the Workshop **agrees** that the lack of sensitivity to age at sexual maturity in the trials means that the lack of an analysis including ageing error will not influence the choice of variants.

4. CONSIDERATION OF THE NEED FOR NEW TRIALS

4.1 Need for new trials

The Workshop conclusions with respect to stock structure hypotheses are given under Item 3.1.4, i.e. that Hypotheses 2 and 5 (a new hypothesis) should be considered in the trials. Variant 2 was considered 'unacceptable' in the 2007 *Implementation* due to its poor performance for three trials based on stock structure Hypothesis 4 (IWC, 2008b, pp.91-115).

The Scientific Committee agreed in 2013 that $MSYR_{1+}$=1% be adopted as a pragmatic and precautionary lower bound for use in trials (IWC, 2014). In contrast, $MSYR_{mat}$=1% was considered during the 2008 *Implementation*.

The Workshop **agreed** that the new information and its implications warranted the development and running of new trials.

4.2 Trial specifications

Table 6 lists the factors considered in the new trials. Compared to the 2007 *Implementation*, the new trials explore a new factor, the boundary between sub-areas 1E and 2, and eliminate two factors: stochastic mixing (included in the earlier trials owing to lack of data), and age-dependent mixing (dropped owing to the lack of difference in age structure within sub-area 1). The new trials are based on two rather than four stock structure hypotheses (hypotheses 2 and 5; see Item 3.1.4 and Fig. 5). Table 6 lists the set of factors on which the new trials are based and their levels.

Table 6

Factors considered in the revised trials.
The values in bold are the baseline values.

Factor	Values considered
Stock structure hypotheses	**2**, **5**
MSYR	***MSYR*$_{1+}$ = 1%; *MSYR*$_{mat}$=4%**
Catch series	Low, **Best**, High
Additional variance	**Baseline**, Upper 5%ile
1W/1E boundary	160°E, **165°E**, 170°E
1E/2 boundary	175°E, **180°**, 175°W

Table 7 summarises the revised set of trials (see Annex J for full technical specifications). Most of the trials are based on stock structure hypothesis 5 because stock structure hypothesis 2 is a bounding case of stock structure hypothesis 5, with the mtDNA haplotype data supporting a high proportion of stock 1 (the stock found in sub-area 1W) in sub-area 1E. Other modifications to the 2008 trials are:

(1) the age-at-maturity has been updated (see Item 3.5)
(2) the set of catches and abundance estimates used for conditioning and when applying the *CLA* has been updated (see Item 3.3);
(3) age and marking data are no longer used for conditioning as they pertained to stock structure hypothesis 4, which is no longer considered plausible (see Item 3.1.4);
(4) the data on mixing proportions are used when conditioning the trials based on stock-structure hypothesis 5 (see Annex F);
(5) the plan for future surveys has been updated (see Annex H); and
(6) The southern boundary of sub-area 1 was changed from 10°N to 20°N in order to avoid the breeding grounds.

The Workshop noted that the trials assumed *g*(0)=1. Additional trials may be needed if estimates of *g*(0) are calculated and approved by the Scientific Committee (see Item 3.2).

5. CONCLUSIONS AND WORK PLAN

5.1 Summary

The Workshop made considerable progress with the *Implementation Review.* The major conclusions are summarised below.

(1) The new information relevant to stock structure was reviewed and the Workshop agreed to take forward two stock structure hypotheses (see Fig. 5) - one of the four considered at the 2007 *Implementation* and one new hypothesis. These are:
   (a) Hypothesis 2: there are two stocks, one feeding in sub-area 1 and one feeding in sub-area 2.
   (b) Hypothesis 5: there are two stocks, one feeding in sub-area 1 and one feeding in sub-area 2 with mixing occurring in sub-area 1E. There are more stock 1 than stock 2 animals in the mixing area.

(1) The Workshop reviewed new information on abundance estimates and developed a workplan to try to obtain agreed abundance estimates (including additional variance) for use in conditioning and the *CLA*.
(2) The Workshop developed a new set of simulation trials for the *Implementation Review* that involve testing for uncertainty in stock structure, stock boundaries, MSYR, removals and additional variance.
(3) The Workshop developed an ambitious workplan to try to complete the *Implementation Review* at SC/67a in May 2017.

Table 7

The *Implementation Simulation Trials* for the Western North Pacific Bryde's whales.

Trial	Stock structure hypothesis	MSYR[1]	Additional variance	Catch series	1W/1E boundary	1E/2 boundary	Comment
Br1-1	2	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 2
Br1-4	2	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 2
Br2-1	5	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br2-4	5	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br3-1	5	1	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br3-4	5	4	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br4-1	5	1	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br4-4	5	4	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br5-1	5	1	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br5-4	5	4	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br6-1	2	1	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 2 with alternative boundaries 1[2]
Br6-4	2	4	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 2 with alternative boundaries 1[2]
Br7-1	5	1	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br7-4	5	4	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br8-1	5	1	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br8-4	5	4	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]

[1]MSYR=1% is related to the 1+ component; MSYR =4% is related to mature component. [2]Based on alternative mixing proportion data.

Table 8

Work plan to try to complete the *Implementation Review* at SC/67a in May 2017. If this is not possible, the Workshop agrees that it should be possible to complete the *Implementation Review* at SC/67b without the need for an additional Workshop.

Item	Responsibility	Time
Develop new abundance estimates for the most recent surveys	Hakamada with assistance from the advisory group chaired by Palka	24/04/17
Develop additional variance estimate	Kitakado with assistance from the advisory group chaired by Palka	24/04/17
Code the *Implementation Simulation Trials*	Allison and de Moor with assistance from Punt	By SC/67a
Condition and run the *Implementation Simulation Trials*	Allison and de Moor with assistance from the Bryde's whale steering group	By SC/67a

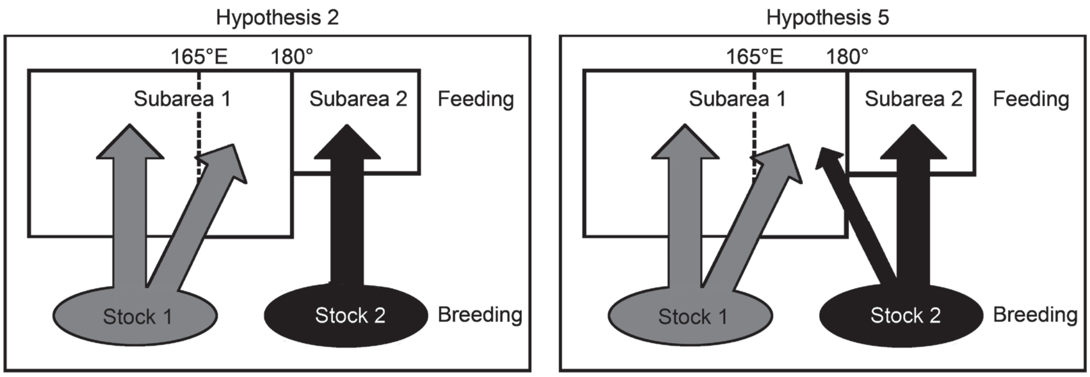


Fig. 5. The two hypotheses that will be considered in the *Implementation Simulation Trials.*

5.2 Work plan

The work plan is shown in Table 8. The Workshop recognises:

(a) that the work plan is ambitious; and
(b) the abundance estimates will need to be adopted formally by the Scientific Committee.

If it is not possible to meet the work plan, the Workshop believes that it should be possible to complete the *Implementation Review* at SC/67b without the need for an additional workshop.

6. ADOPTION OF REPORT

The Workshop finished its work at 13:00 on 25 March 2017. Apart from editorial corrections the report was adopted at that time. Donovan thanked the participants for their positive co-operation and hard work, especially in terms of carrying out additional analyses during the meeting. He also thanked the rapporteurs for their conscientious work that enabled a painless adoption of the report and the interpreters who worked so effectively. Finally, he thanked the Government of Japan for the excellent facilities. The participants thanked the Chair for his usual fair and effective Chairing.

REFERENCES

Allison, C. 2008. Report of the second Intersessional Workshop on the western North Pacific Bryde's whale *Implementation*, Yokohama, 10-14 December 2006. Annex C. Catch series for western North Pacific Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 10: 457-67.

Butterworth, D.S. and Punt, A.E. 2009. Report of the Scientific Committee. Annex G. Report of the sub-committee on in-depth assessment (IA). Appendix 4. Proposed further work to aid resolution of questions concerning ageing of Antarctic minke whales. *J. Cetacean Res. Manage. (Suppl.)* 11: 209.

International Whaling Commission. 2006. Report of the Workshop on the *pre-Implementation assessment* of western North Pacific Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 8:337-55.

International Whaling Commission. 2007a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 9:88-128.

International Whaling Commission. 2007b. Western North Pacific Bryde's *Implementation*: Report of the First Intersessional Workshop, 25-29 October 2005, Shizuoka, Japan. *J. Cetacean Res. Manage. (Suppl.)* 9:407-27.
International Whaling Commission. 2008a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1-74.
International Whaling Commission. 2008b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:90-120.
International Whaling Commission. 2008c. Report of the second Intersessional Workshop on the western North Pacific Bryde's whale *Implementation*, Yokohama, 10-14 December 2006. *J. Cetacean Res. Manage. (Suppl.)* 10:449-510.
International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.
International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.
International Whaling Commission. 2010. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.
International Whaling Commission. 2014. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 15.
International Whaling Commission. 2017a. Report of the Expert Panel of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:527-92.
International Whaling Commission. 2017b. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 7-9 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:459-76.
Kanda, N., Goto, M., Kato, H., McPhee, M.V. and Pastene, L. 2007. Population genetic structure of Bryde's whales (*Balaenoptera brydei*) at the inter-oceanic and trans-equatorial levels. *Cons. Genet.* 8: 853-64.
Kishiro, T. 1996. Movements of marked Bryde's whales in the western North Pacific. *Rep. Int. Whal. Comm.* 46: 421-28.
Kitakado, T., Butterworth, D.S. and Okamura, H. 2007. Western North Pacific Bryde's *Implementation*: Report of the First Intersessional Workshop, 25-29 October 2005, Shizuoka, Japan. Annex H. An integrated approach for the estimation of abundance through a random-effects model. *J. Cetacean Res. Manage. (Suppl.)* 9: 424-25.
Kitakado, T. and Punt, A.E. 2010. Examination of the period/reader effect on the age-determination for the Antarctic minke whales and its implications to the statistical catch-at-age analyses. Paper SC/62/IA2 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 12pp. [Paper available from the Office of this Journal].
Kitakado, T., Shimada, H., Okamura, H. and Miyashita, T. 2005. Update of additional variance estimate for the western North Pacific stock of Bryde's whales. Paper SC/O05/BWI6 presented to the First Intersessional Workshop on the western North Pacific Bryde's whale *Implementation*, Shizuoka, Japan, 25-29 October 2005 (unpublished). 16pp. [Paper available from the Office of this Journal].
Kitakado, T., Shimada, H., Okamura, H. and Miyashita, T. 2008. CLA abundance estimates for western North Pacific Bryde's whales and their associated CVs with taking the additional variance into account. Paper SC/60/PFI3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 27pp. [Paper available from the Office of this Journal].
Murase, H., Tamura, T., Otani, S. and Nishiwaki, S. 2016. Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008. *Fish. Sci.* 82(1): 35-45.
Ohsumi, S. 1995. A review of population studies of the North Pacific Bryde's whale stocks (revised). Paper SC/47/NP14 presented to the IWC Scientific Committee, May 1995, Dublin, Ireland (unpublished). 35pp. [Paper available from the Office of this Journal].
Pastene, L.A., Goto, M. and Taguchi, M. 2016a. Additional genetic analyses on stock structure in North Pacific Bryde's and sei whales. Paper SC/66b/SD01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].
Pastene, L.A., Goto, M., Taguchi, M. and Kitakado, T. 2016b. Updated genetic analyses based on mtDNA and microsatellite DNA suggest possible stock differentiation of Bryde's whales between management sub-areas 1 and 2 in the North Pacific. Paper SC/F16/JR44 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].
Punt, A.E. 2008. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. Appendix 4. The specification for the *Implementation Simulation Trials* for western North Pacific Bryde's whales (final). Adjunct 3. Estimation of age-at-maturity for female Brude's whales. *J. Cetacean Res. Manage. (Suppl.)* 10: 114.
Shimada, H., Okamura, H., Kitakado, T. and Miyashita, T. 2008. Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and CLA application. Paper SC/60/PFI2 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 34pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

JAPAN

T. Bando
M. Goto
T. Hakamada
S. Inoue
T. Kitakado
H. Kumakiri
K. Matsuoka
T. Miyashita
H. Morita
N. Okazoe
L.A. Pastene
H. Yoshida
S. Iwai (Interpreter)
H. Yasokawa (Interpreter)

LOCAL SCIENTIST

H. Kato

INVITED PARTICIPANTS

D.S. Butterworth
D. Palka
A.E. Punt
R. Tiedemann

IWC

C. Allison
G.P. Donovan

Annex B

Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair and appointment of rapporteurs
   - 1.3 Adoption of agenda
   - 1.4 Review of documents and data available
2. The initial *Implementation*
   - 2.1 Overview of hypotheses
   - 2.2 Results and conclusions
3. Review of new information
   - 3.1 Stock structure and movements
   - 3.2 Abundance
   - 3.3 Removals data
     - 3.3.1 Catch data
     - 3.3.2 Bycatch data
     - 3.3.3 Ship strikes data
   - 3.4 Future likely whaling operations
   - 3.5 Other data that might assist in the *Implementation Review*
     - 3.5.1 Biological data
     - 3.5.2 Operational data
4. Consideration of the need for new trials
   - 4.1 Need for new trials (if yes, specify)
5. Conclusions and work plan
6. Adoption of Report

Annex C

List of Documents

SC/M17/RMP

1. Taguchi, M., Goto, M., Takahashi, M., Kitakado, T., Pastene, L.A. DAPC analysis for Bryde's whales in the North Pacific using microsatellite DNA data.
2. Hakamada, T., Takahashi, M., Matsuoka, K. and Miyashita, T. Abundance estimate for western North Pacific Bryde's whale by sub-areas based on IWC-POWER and JARPN II sighting surveys.
3. Bando, T. and Kato, H. Report on progress in earplug-based age determination and estimation of biological parameters of Bryde's whales collected during 2000 to 2014 JARPN II surveys.

Annex D

Further Investigations of Age Data

T. Bando

1. COMPARISON OF AGE DATA OF BRYDE'S WHALES READ BY TWO READERS

Earplug age reading of Bryde's whales collected by 2000-03 JARPN II was conducted by Kato (Reader-K) and analyses using these age data were presented to the *Implementation* meeting (Bando *et al*., 2005). Subsequently the task of earplug reading switched to Bando (Reader-B). In order to reduce the influence of inter-reader variability, all (2000-14) samples including the previously read 2000-03 samples were read by Reader-B. This Annex summarises age data read by two readers.

Table 1

Age data of Bryde's whales read by two readers (K and B).

		Age				Age				Age				Age	
Year	No	K	B	Year	No	K	B	Year	No	K	B	Year	No	K	B
2000	B001	6	6	2001	B001	-	-	2002	B001	16	18	2003	B001	2	-
2000	B002	6	7	2001	B002	6	11	2002	B002	13	16	2003	B002	15	20
2000	B003	6	6	2001	B003	5	5	2002	B003	5	9	2003	B003	20	26
2000	B004	8	-	2001	B004	-	12	2002	B004	16	18	2003	B004	3	5
2000	B005	-	-	2001	B005	-	-	2002	B005	17	18	2003	B005	-	-
2000	B006	9	14	2001	B006	1	-	2002	B006	-	-	2003	B006	5	-
2000	B007	29	30	2001	B007	3	3	2002	B007	11	11	2003	B007	12	-
2000	B008	9	16	2001	B008	3	-	2002	B008	10	9	2003	B008	14	-
2000	B009	7	9	2001	B009	-	1	2002	B009	6	8	2003	B009	-	-
2000	B010	7	-	2001	B010	-	-	2002	B010	-	5	2003	B010	6	8
2000	B011	-	5	2001	B011	-	-	2002	B011	17	19	2003	B011	18	13
2000	B012	3	3	2001	B012	13	20	2002	B012	22	30	2003	B012	6	6
2000	B013	11	21	2001	B013	22	33	2002	B013	7	11	2003	B013	7	-
2000	B014	9	10	2001	B014	32	32	2002	B014	-	-	2003	B014	4	5
2000	B015	15	21	2001	B015	-	-	2002	B015	3	5	2003	B015	8	13
2000	B016	-	-	2001	B016	17	23	2002	B016	5	-	2003	B016	15	18
2000	B017	10	12	2001	B017	-	-	2002	B017	7	9	2003	B017	11	13
2000	B018	10	26	2001	B018	16	-	2002	B018	39	45	2003	B018	-	-
2000	B019	-	-	2001	B019	19	27	2002	B019	3	5	2003	B019	6	16
2000	B020	-	7	2001	B020	20	19	2002	B020	8	8	2003	B020	-	-
2000	B021	-	6	2001	B021	-	-	2002	B021	14	16	2003	B021	12	14
2000	B022	16	16	2001	B022	2	3	2002	B022	21	7	2003	B022	-	-
2000	B023	21	21	2001	B023	6	17	2002	B023	13	10	2003	B023	-	-
2000	B024	-	-	2001	B024	13	13	2002	B024	10	13	2003	B024	16	17
2000	B025	4	-	2001	B025	-	-	2002	B025	-	-	2003	B025	-	-
2000	B026	32	27	2001	B026	-	-	2002	B026	15	10	2003	B026	11	19
2000	B027	7	10	2001	B027	8	-	2002	B027	8	11	2003	B027	18	31
2000	B028	28	31	2001	B028	-	-	2002	B028	4	6	2003	B028	4	6
2000	B029	12	11	2001	B029	-	-	2002	B029	-	-	2003	B029	-	-
2000	B030	29	18	2001	B030	-	-	2002	B030	-	-	2003	B030	14	26
2000	B031	14	14	2001	B031	-	-	2002	B031	17	24	2003	B031	-	-
2000	B032	11	16	2001	B032	-	-	2002	B032	10	12	2003	B032	-	-
2000	B033	10	22	2001	B033	-	-	2002	B033	14	21	2003	B033	31	41
2000	B034	-	-	2001	B034	-	-	2002	B034	-	-	2003	B034	5	5
2000	B035	6	8	2001	B035	-	-	2002	B035	4	-	2003	B035	14	27
2000	B036	20	25	2001	B036	4	4	2002	B036	-	-	2003	B036	-	-
2000	B037	14	15	2001	B037	8	10	2002	B037	12	10	2003	B037	-	4
2000	B038	15	17	2001	B038	16	20	2002	B038	-	-	2003	B038	3	6
2000	B039	-	-	2001	B039	15	23	2002	B039	-	-	2003	B039	3	4
2000	B040	12	15	2001	B040	10	19	2002	B040	-	-	2003	B040	18	-
2000	B041	4	5	2001	B041	-	-	2002	B041	-	-	2003	B041	22	23
2000	B042	11	13	2001	B042	-	-	2002	B042	13	13	2003	B042	-	18
2000	B043	10	16	2001	B043	-	-	2002	B043	5	-	2003	B043	20	18
				2001	B044	9	11	2002	B044	10	13	2003	B044	-	-
				2001	B045	-	17	2002	B045	10	11	2003	B045	4	5
				2001	B046	-	-	2002	B046	4	4	2003	B046	29	26
				2001	B047	9	9	2002	B047	26	21	2003	B047	-	12
				2001	B048	9	9	2002	B048	-	4	2003	B048	8	13
				2001	B049	-	-	2002	B049	16	26	2003	B049	-	15
				2001	B050	1	-	2002	B050	-	-	2003	B050	11	17

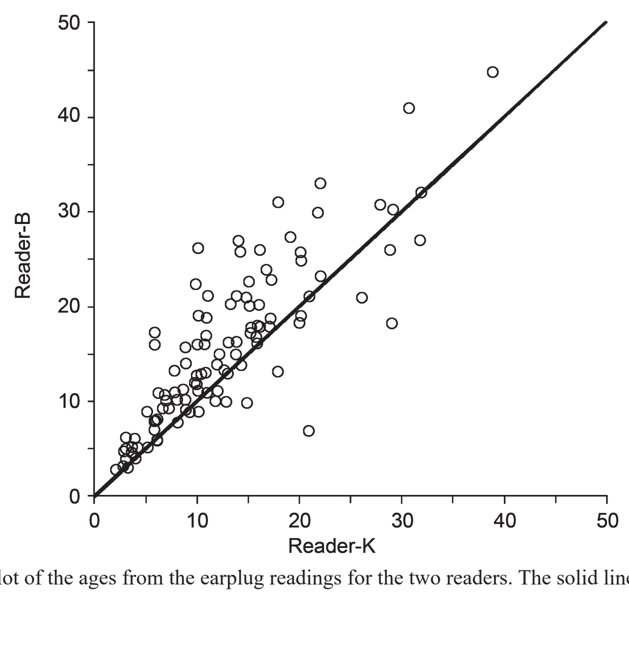


Fig. 1. Scatter plot of the ages from the earplug readings for the two readers. The solid line shows the 45° line.

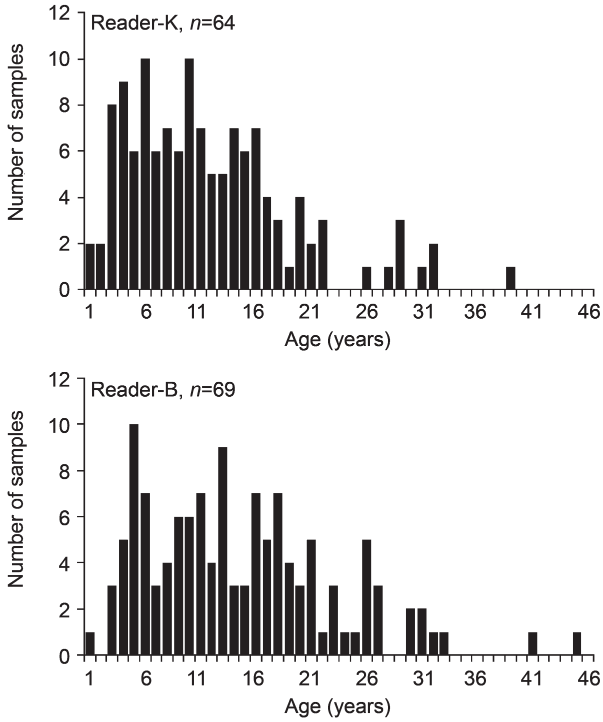


Fig. 2. Age distribution of Bryde's whales collected by 2000-03 JARPN II read by Reader-K (upper) and Reader-B (lower).

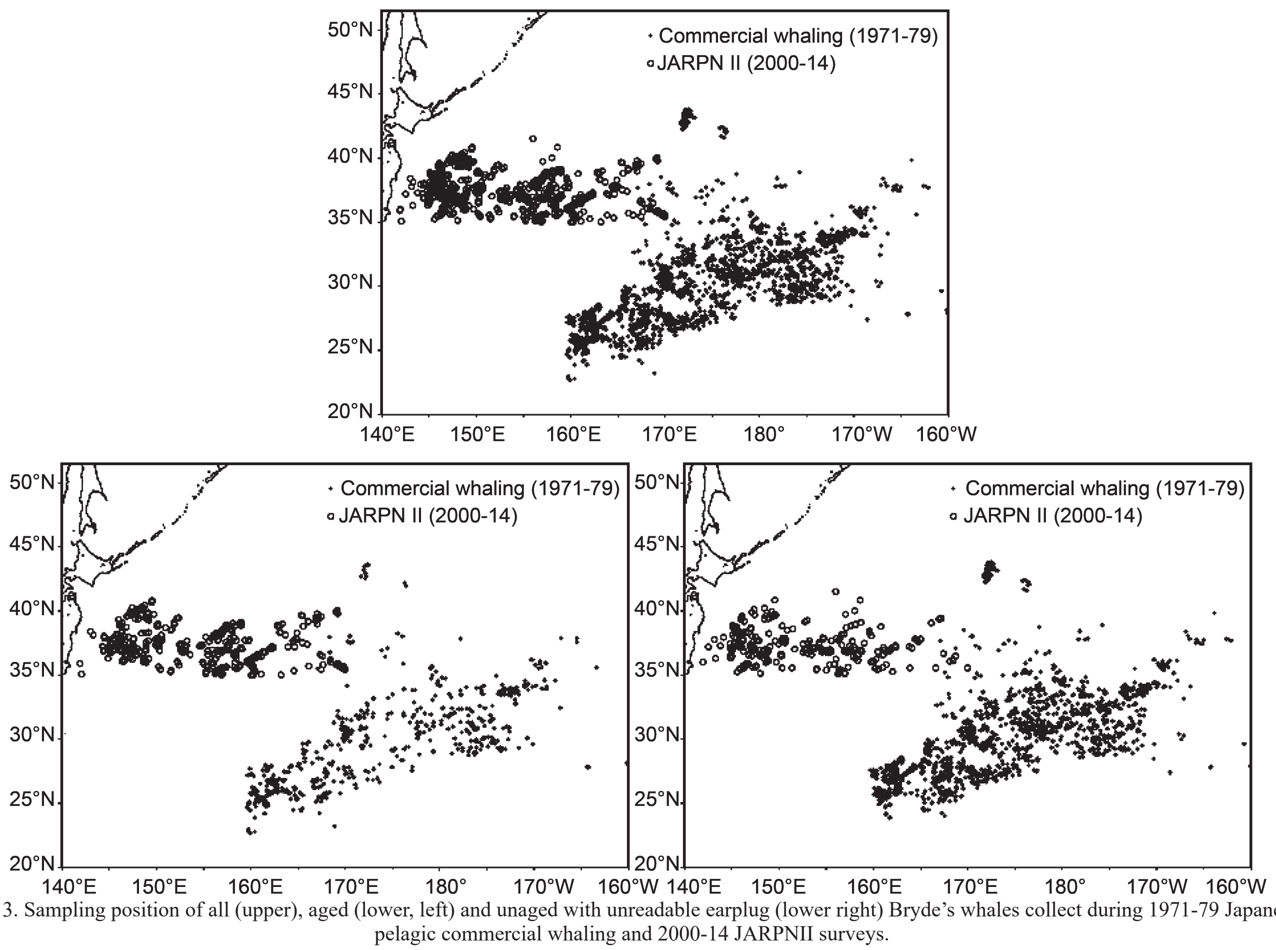


Fig. 3. Sampling position of all (upper), aged (lower, left) and unaged with unreadable earplug (lower right) Bryde's whales collect during 1971-79 Japanese pelagic commercial whaling and 2000-14 JARPNII surveys.

2. FURTHER ANALYSIS OF AGE DISTRIBUTION OF BRYDE'S WHALES BETWEEN SUB-AREAS

In order to investigate stock structure of western North Pacific Bryde's whales, the following analyses were performed using age and other biological data obtained by 1971-79 Japanese pelagic commercial whaling and 2000-14 JARPNII samples.

REFERENCE

Bando, T., Kishiro, T., Ohsumi, S., Zenitani, R. and Kato, H. 2005. Estimation of some biological parameters of western North Pacific Bryde's whales by age distribution. Paper SC/O05/BWI7 presented at the Bryde's whale *Implementation* workshop, Tokyo, 25-29 October 2005. 10pp. [Paper available from the Office of this Journal].

Table 2

Age distribution of Bryde's whales collected by JARPN II and commercial whaling by 5° longitude sector.

Longitude	Source	Ages					Age>9			
		10-11	12-13	14-15	16-20	21+	*n*	Mean	SD	SE
140°E-145°E	JARPNII	1	1	0	1	3	6	20.00	8.00	3.27
145°E-150°E	JARPNII	7	9	12	26	44	98	21.00	7.84	0.79
150°E-155°E	JARPNII	5	8	0	9	17	39	20.87	9.60	1.54
155°E-160°E	JARPNII	13	5	5	35	54	112	22.45	9.27	0.88
160°E-165°E	JARPNII	3	5	7	6	21	42	21.93	8.80	1.36
165°E-170°E	JARPNII	0	3	2	8	26	39	23.59	7.42	1.19
Total	JARPNII	29	31	26	85	165	336	21.87	8.62	0.47
155°E-160°E	Commercial	4	0	1	4	7	16	19.56	8.33	2.08
160°E-165°E	Commercial	14	14	9	26	49	112	20.71	8.79	0.83
165°E-170°E	Commercial	9	9	9	24	24	75	19.23	7.62	0.88
170°E-175°E	Commercial	16	8	9	19	23	75	18.67	8.24	0.95
175°E-180°	Commercial	11	6	7	17	11	52	17.31	6.79	0.94
180°-175°W	Commercial	8	9	9	17	36	79	21.04	8.88	1.00
175°W-170°W	Commercial	7	8	7	24	27	73	21.04	9.61	1.13
170°W-165°W	Commercial	2	1	2	4	9	18	21.78	9.98	2.35
165°W-160°W	Commercial	0	1	0	1	4	6	25.50	16.43	6.71
Total	Commercial	71	56	53	136	190	506	20.00	8.69	0.39

Table 3

Results of χ^2 test in age distribution of Bryde's whales between western and eastern (split at 155°E) sample of JARPNII (upper) and western and eastern (split at 180°) sample of commercial whaling. Age data were pooled and ages 0-9 were ignored because of the selectivity of commercial whaling following the method at previous *Implementation* meeting (IWC, 2007). P-value of χ^2 test is shown.

Area	Ages							
	10-11	12-13	14-15	16-20	21-25	26-30	31+	Total
JARPNII: West *vs* East of 155E (p=0.5381; df=6)								
Sample size	13	18	12	36	23	23	18	143
West of 155E	16	13	14	49	37	30	34	193
East of 155E	29	31	26	85	60	53	52	336
Expected age-frequencies under the null hypothesis of independence								
West of 155E	12	13	11	36	26	23	22	143
East of 155E	17	18	15	49	34	30	30	193
Total	29	31	26	85	60	53	52	336
Commercial whaling: West *vs* East of 180° (p=0.1763; df=6)								
Sample size	54	37	35	90	54	24	36	330
West of 180°	17	19	18	46	30	24	22	176
East of 180°	71	56	53	136	84	48	58	506
Expected age-frequencies under the null hypothesis of independence								
West of 180°	46	37	35	89	55	31	38	330
East of 180°	25	19	18	47	29	17	20	176
Total	71	56	53	136	84	48	58	506

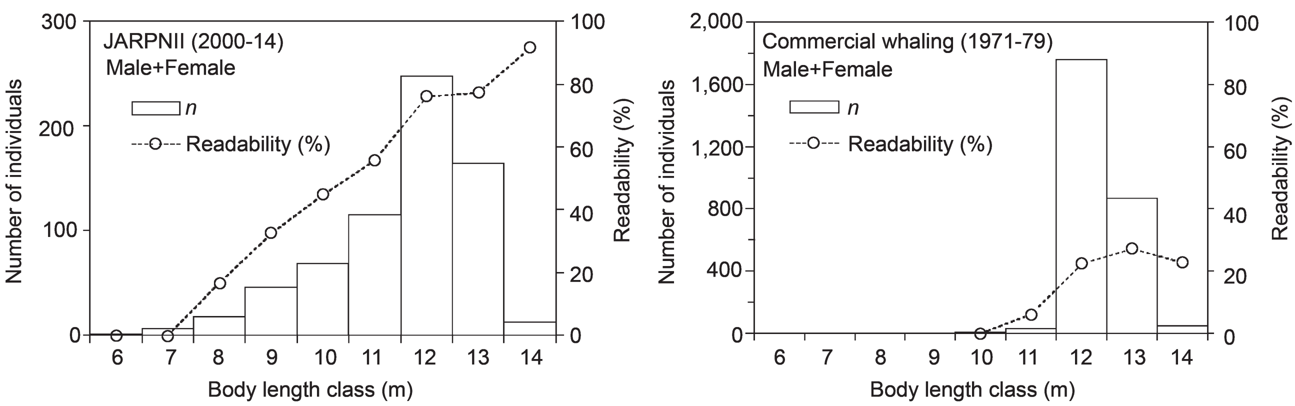


Fig. 4. Earplug age readability of Bryde's whales collected by JARPNII (left) and commercial whaling (right) by body length class.

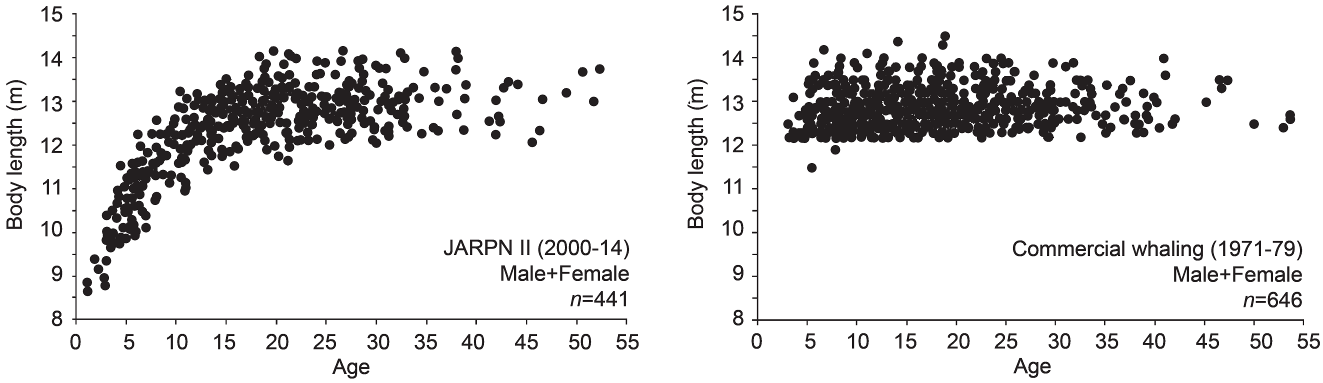


Fig. 5. Relationship between age and body length of Bryde's whales collected by JARPNII (left) and commercial whaling (right).

Annex E

Additional Analyses of Genetic Diversity

M. Taguchi, M. Goto, L.A. Pastene and R. Tiedemann

Table 1

Results of the heterogeneity test for sub-areal differentiation by year.

	Microsatellites				Mitochondria			
	Sample size				Sample size			
Year	SA1	SA2	*P*-values	F_{ST}	SA1	SA2	*P*-values	F_{ST}
1979	97	53	**0.001**	0.003	112	53	**0.001**	0.038
1983	21	53	0.151	0.003	20	53	0.066	-0.008
1984	81	53	**0.000**	0.002	83	53	**0.000**	0.061
2000	43	53	**0.001**	0.005	39	53	**0.007**	0.069
2001	50	53	**0.014**	0.005	43	53	**0.003**	-0.001
2002	50	53	**0.004**	0.008	50	53	**0.000**	0.071
2003	50	53	**0.008**	0.006	50	53	**0.004**	0.024
2004	50	53	**0.016**	0.003	50	53	0.160	0.000
2005	50	53	**0.015**	0.004	49	53	**0.000**	0.051
2006	50	53	**0.000**	0.005	50	53	0.044	0.035
2007	50	53	**0.000**	0.007	50	53	**0.005**	0.028
2008	50	53	**0.009**	0.003	50	53	**0.013**	0.040
2009	50	53	**0.012**	0.004	50	53	0.144	-0.001
2010	50	53	**0.007**	0.002	50	53	0.094	0.011
2011	50	53	**0.000**	0.005	50	53	**0.006**	0.014
2012	76	53	**0.005**	0.002	75	53	**0.000**	0.059
2013	28	53	0.258	0.000	28	53	0.078	-0.011
2014	70	53	**0.003**	0.003	70	53	**0.018**	0.026

Bold text indicates statistical significance at alpha=0.05 after FDR correction.

Table 2

Results of the heterogeneity test for alternative boundaries.

	Microsatellites				Mitochondria			
	Sample size				Sample size			
Year	SA1	SA2	*P*-values	F_{ST}	SA1	SA2	*P*-values	F_{ST}
150E	390	629	**0.017**	0.000	382	643	0.094	0.003
155E	493	526	0.111	0.000	485	540	**0.011**	0.001
160E	706	313	0.144	0.000	698	327	**0.018**	0.008
165E	847	172	**0.001**	0.001	855	170	**0.001**	0.011
170E	936	83	**0.000**	0.002	942	83	**0.000**	0.029
175E	954	65	**0.000**	0.002	960	65	**0.000**	0.026
180	966	53	**0.000**	0.004	972	53	**0.000**	0.039
175W	981	38	**0.000**	0.005	987	38	0.056	0.034

Bold text indicates statistical significance at alpha=0.05 after FDR correction.

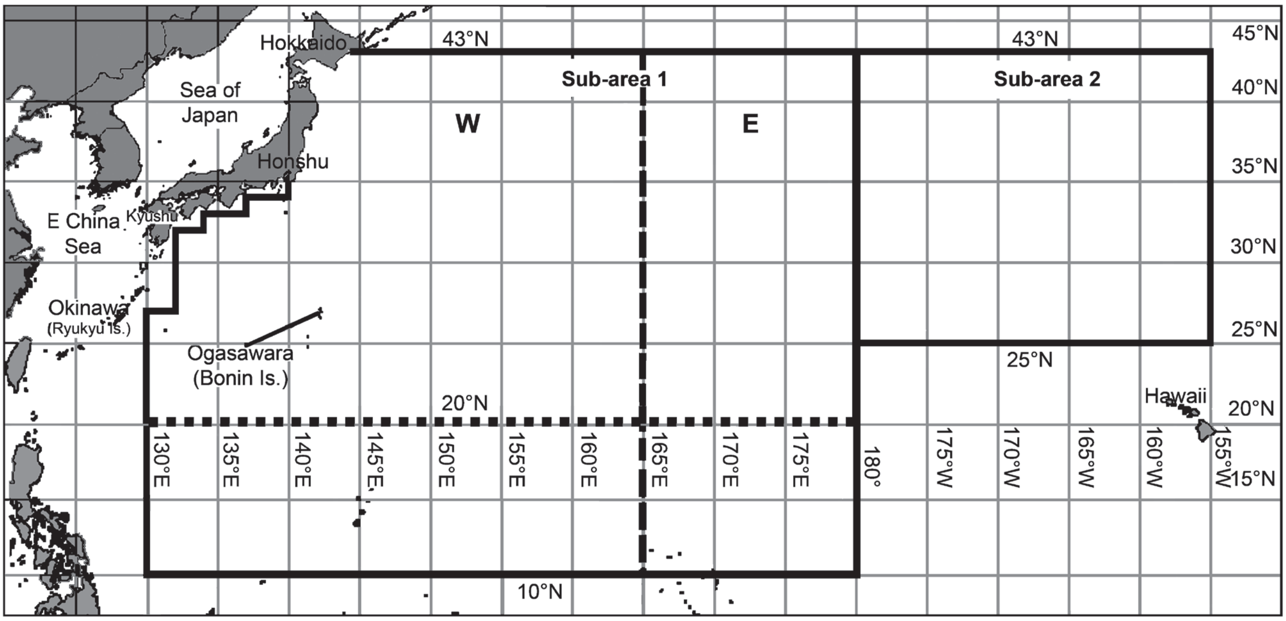


Fig. 1. Sub-areas of North Pacific Bryde's whale used in the 2007 RMP *Implementation.*

Table 3

Results of the HWE in each subarea (*P*-values).

Sub-area	HWE
SA1W	0.716
SA1E	0.106
SA2	0.371

Table 4

Results of the HWE for each alternative boundary in sub-areas 1 and 2 (*P*-values).

Microsatellite loci	150°E		155°E		160°E		165°E		170°E		175°E		180°		175°W	
	SA1	SA2	SA1	SA2	SA1	SA2	SA1	SA2	SA1	SA2	SA1	SA2	SA1	SA2	SA1	SA2
GATA98	0.60242	0.27889	0.78179	0.22538	0.79754	0.25931	0.56644	0.07416	0.64036	0.02507	0.60326	0.16121	0.63534	0.30919	0.64773	0.05752
EV104	0.69765	0.86664	0.61492	0.79479	0.76145	0.71276	0.86222	0.27564	0.90435	0.36500	0.90313	0.17021	0.90630	0.22488	0.80763	0.48440
GT011	0.90052	0.21796	0.57953	0.41133	0.75651	0.35425	0.70344	0.35766	0.36332	0.16985	0.35789	0.06666	0.34793	0.13861	0.29787	1.00000
GATA53	0.34814	0.31662	0.41515	0.47868	0.50430	0.57589	0.35374	0.46229	0.56272	0.05043	0.65399	0.08728	0.55881	0.14591	0.58716	0.15290
GATA417	0.16197	0.34113	0.45865	0.11445	0.34449	0.33794	0.49949	0.13747	0.30542	0.83837	0.33437	0.88742	0.29090	0.95416	0.21869	0.92122
DlrFCB14	1.00000	0.16673	1.00000	0.15245	0.70158	0.19876	0.62407	0.15171	0.42254	0.36676	0.29061	1.00000	0.32406	0.77522	0.32846	0.72606
DlrFCB17	0.83873	0.87329	0.86118	0.88084	0.84603	0.91995	0.77433	0.70125	0.85722	0.53221	0.80153	0.30300	0.76763	0.26350	0.83068	0.30423
GT23	0.36225	0.94815	0.63420	0.88577	0.43216	0.91086	0.33120	0.87266	0.65397	0.55805	0.67207	0.13364	0.61683	0.31634	0.57562	0.71666
EV14	0.35760	0.75080	0.52927	0.90978	0.63168	0.91173	0.58396	0.25982	0.69776	0.39905	0.67366	0.39273	0.75952	0.11219	0.76408	0.10111
GT310	0.29831	0.87821	0.24514	0.51597	0.67875	0.39946	0.79069	0.49146	0.58389	0.48425	0.64074	0.28743	0.64254	0.36302	0.60714	0.67449
EV1	0.05756	0.12852	0.01057	0.32321	0.09472	0.43816	0.10174	0.14180	0.04345	0.48785	0.07163	0.29883	0.03675	0.31781	0.07229	0.24058
EV94	0.20998	0.07935	0.26377	0.03463	0.77314	**0.00001**	0.69287	0.00312	0.48669	0.09118	0.36154	0.27729	0.42536	0.25342	0.39228	0.27178
GGAA520	0.14162	0.14858	0.10111	0.33195	0.04603	0.56309	0.05356	0.51697	0.02393	0.32093	0.02552	0.64817	0.02983	0.44626	0.01708	0.34020
EV21	0.19225	0.68899	0.27271	0.56053	0.34380	0.85232	0.44028	0.93955	0.25848	0.91696	0.24429	0.69424	0.23370	0.64893	0.29194	0.56210
GT575	0.69701	0.75404	0.86217	0.49615	0.92112	0.34821	0.78889	0.64863	0.66683	0.26822	0.62273	0.08310	0.59543	0.36945	0.60348	0.42483
GATA28	0.17757	0.88116	0.19077	0.83644	0.35126	0.76563	0.21977	0.78705	0.18704	0.71893	0.26491	0.48948	0.29199	0.54819	0.32300	0.75857
TAA31	0.62201	0.50635	0.79005	0.47341	0.58812	0.74591	0.40034	0.97904	0.45782	0.91787	0.46085	0.87340	0.50707	0.86805	0.56242	0.79360
Overall	0.38754	0.61350	0.45837	0.54621	0.82415	0.12307	0.71359	0.15043	0.42388	0.25081	0.45264	0.16941	0.41399	0.37060	0.41067	0.58437

Bold text indicates statistical significance at a=0.05 after FDR correction.

Table 5

Measures of genetic diversities and haplotype frequency for several combinations of sub-areas.

Genetic diversities	SA1W	SA1E	SA1	SA2	SA1E+SA2	Total
H_O	0.67±0.15	0.68±0.16	0.67±0.15	0.70±0.14	0.68±0.15	0.67±0.15
H_E	0.68±0.15	0.69±0.14	0.68±0.15	0.68±0.14	0.69±0.14	0.68±0.15
HWE	0.713	0.111	0.419	0.370	0.157	0.407
HD	0.82± 0.01	0.82±0.03	0.90±0.02	0.82± 0.01	0.85±0.02	0.83±0.01
Sample size for msDNA	847	119	966	53	172	1019
Haplotype frequency						
3	333	47	380	13	60	393
4	87	3	90	3	6	93
6	81	11	92	1	12	93
7	37	7	44	5	12	49
9	33	11	44	6	17	50
8	31	5	36	4	9	40
2	20	3	23	0	3	23
19	18	2	20	3	5	23
28	18	1	19	3	4	22
11	17	3	20	0	3	20
18	16	2	18	0	2	18
16	14	0	14	0	0	14
13	13	1	14	2	3	16
14	13	1	14	0	1	14
1	11	2	13	0	2	13
15	11	1	12	0	1	12
23	11	0	11	0	0	11
27	10	1	11	0	1	11
21	9	4	13	2	6	15
33	7	2	9	0	2	9
29	6	1	7	0	1	7
17	6	0	6	0	0	6
31	6	0	6	0	0	6
5	5	2	7	0	2	7
25	5	0	5	1	1	6
20	4	1	5	0	1	5
26	4	0	4	1	1	5
32	3	1	4	0	1	4
39	2	1	3	5	6	8
47	2	1	3	0	1	3
22	2	0	2	1	1	3
30	2	0	2	0	0	2
45	2	0	2	0	0	2
46	2	0	2	0	0	2
36	1	0	1	1	1	2
10	1	0	1	0	0	1
12	1	0	1	0	0	1
24	1	0	1	0	0	1
34	1	0	1	0	0	1
35	1	0	1	0	0	1
37	1	0	1	0	0	1
40	1	0	1	0	0	1
41	1	0	1	0	0	1
42	1	0	1	0	0	1
43	1	0	1	0	0	1
44	1	0	1	0	0	1
48	1	0	1	0	0	1
51	1	0	1	0	0	1
49	0	2	2	0	2	2
38	0	1	1	0	1	1
50	0	0	0	2	2	2
Total	855	117	972	53	170	1,025

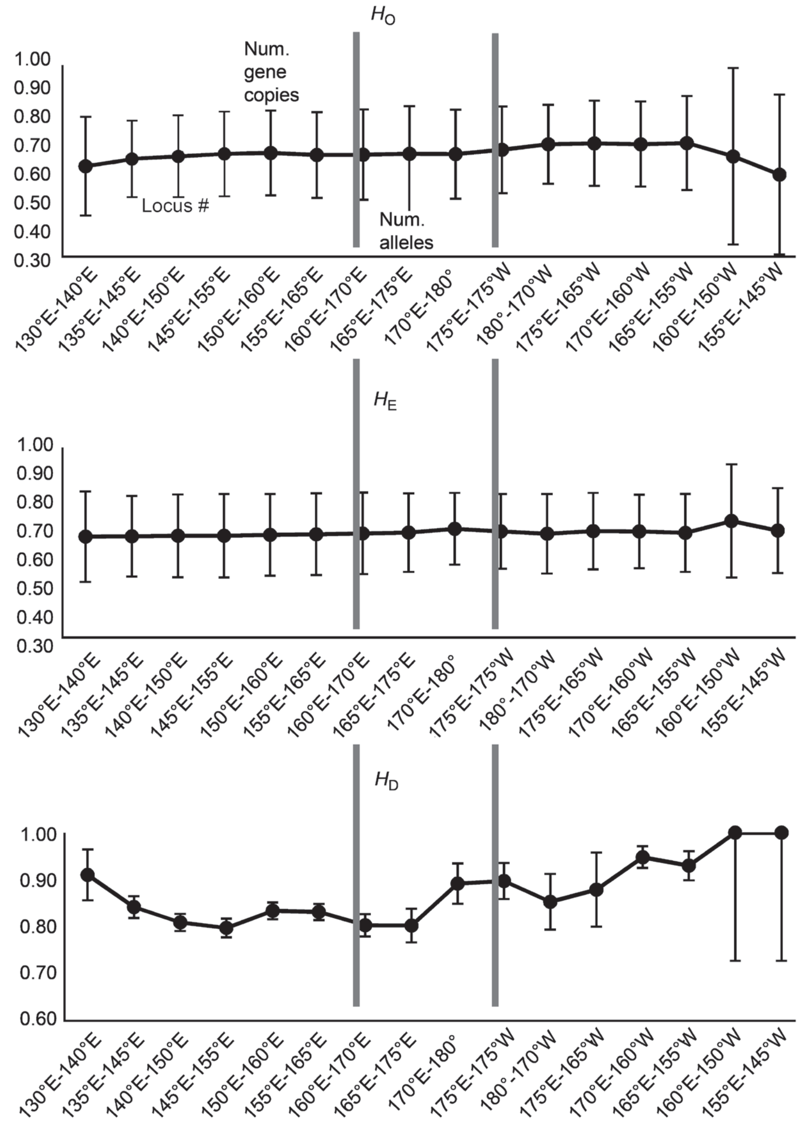


Fig. 2. Genetic diversity relative to longitude of sample origin (calculated for 5° intervals; plotted as moving averages over 10° intervals). H_O: observed heterozygosity; H_E: expected heterozygosity; *HD*: haplotype diversity.

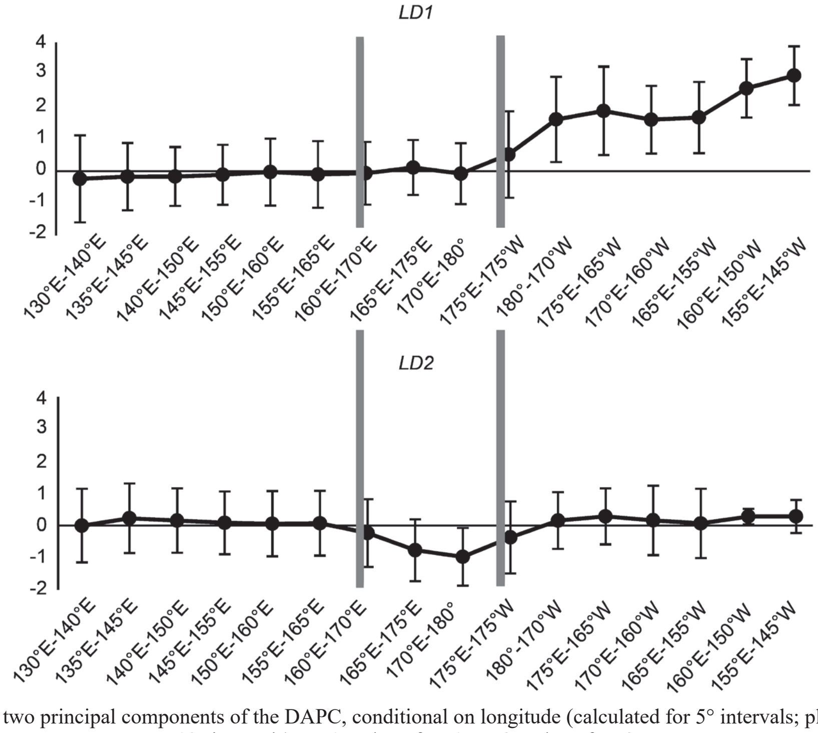


Fig. 3. Mean values of the first two principal components of the DAPC, conditional on longitude (calculated for 5° intervals; plotted as moving averages over 10° intervals). *LD*1: value of PC1; *LD*2: value of PC2.

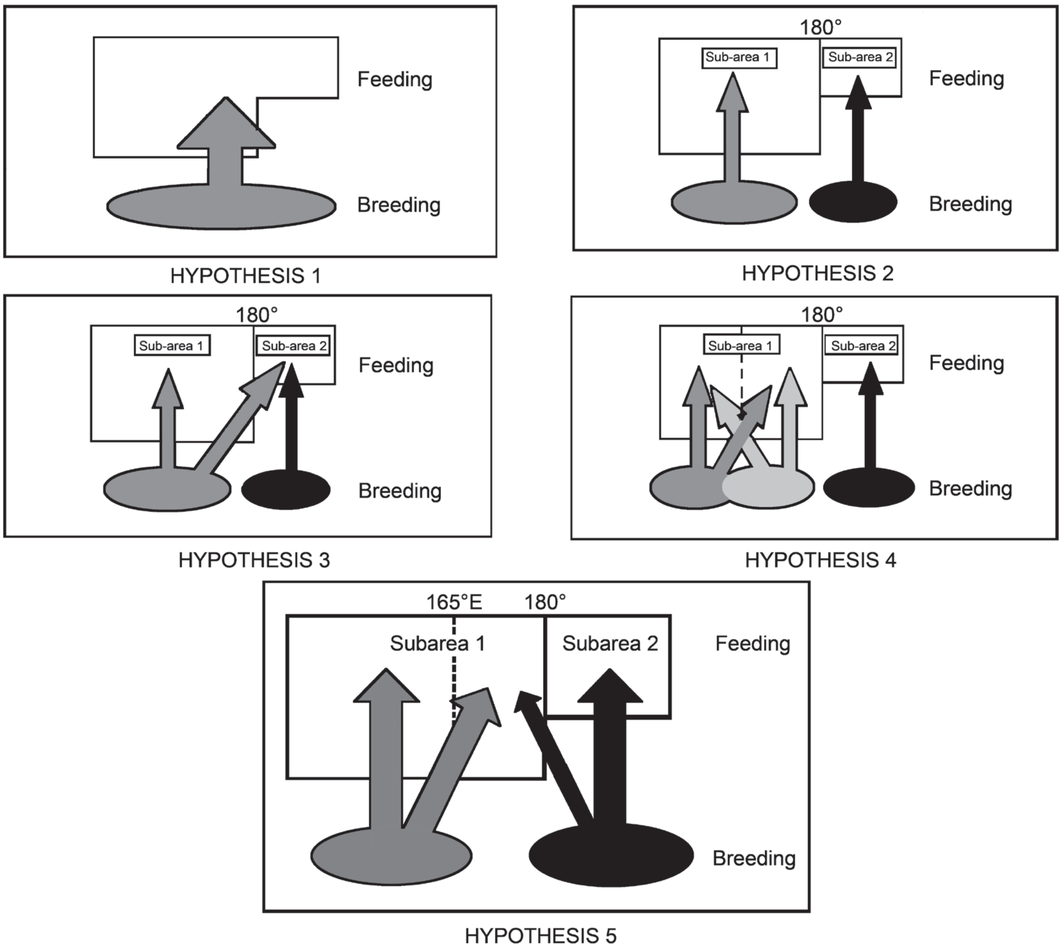


Fig. 4. The stock structure hypotheses: Hypotheses 1-4 were used in the 2007 *Implementation.* Hypothesis 5 is the hypothesis newly developed for this *Implementation*.

Table 6

Sample size for the analysis of genetic diversities in alternative boundaries (moving boundaries) in sub-areas 1 and 2.

Sectors	Microsatellites	Mitochondria
130°E-140°E	21	20
135°E-145°E	133	134
140°E-150°E	369	362
145°E-155°E	360	351
150°E-160°E	316	316
155°E-165°E	354	370
160°E-170°E	230	244
165°E-175°E	107	105
170°E-180°	30	30
175°E-175°W	27	27
180°-170°W	25	25
175°W-165°W	14	14
170°W-160°W	22	22
165°W-155°W	19	19
160°W-150°W	3	3
155°W-145°W	5	3

Table 7

Genetic divergence (F_{ST}) for different groupings of Bryde's whales in sub-areas 1 and 2.

F_{ST}	SA1W *vs* SA2	SA1W *vs* SA1E+SA2	SA1W *vs* SA1E	SA1 *vs* SA2
Microsatellites	0.004	0.001	0.000	0.004
Mitochondria	0.023	0.011	0.002	0.022

Table 8

Results of Exact Tests for different groupings of Bryde's whales in sub-areas 1 and 2.

Grouping of sub-areas	*P*-values
SA1W *vs* SA1E *vs* SA2	0.001±0.001
SA1W+SA1E *vs* SA2	0.000±0.000
SA1W *vs* SA2	0.000±0.000
SA1W *vs* SA1E+SA2	0.000±0.000

Suggested revision of the original hypotheses (see main report)

Hypothesis 1: deletion suggested because this hypothesis is no longer supported by the DNA analyses.

Hypothesis 2: keep this hypothesis because both mtDNA and microsatellite DNA suggest higher F_{ST} values around longitude 180°, and mixing proposed under 'new' hypothesis 1 can be proved only with samples from breeding grounds.

Hypothesis 3: keep this hypothesis because sample size in SA 2 is still low to reject this possibility.

Hypothesis 4: deletion suggested because new genetic data are better explained by the existence of two stocks. No significant genetic differences were found when SA 1W was compared with SA 1E, for both genetic markers (high statistical power was estimated). Significant differences only emerge when samples from SA 2 are included.

Hypothesis 5: Alternative 'new' hypothesis proposed based on the additional analyses of genetic diversity.

Annex F

Estimates of Mixing Proportions for Sub-area 1E using mtDNA Haplotype Data

André E. Punt

Mixing proportions for sub-area 1E (defined here as the proportion of stock 1 in sub-area 1E) are required to condition the trials based on Stock Structure Hypothesis 5. These proportions can be estimated by assuming that sub-area 1E is a mixing area and the mtDNA haplotype frequencies for sub-areas 1W and 2 are respectively representative of stocks 1 and 2. The mixing proportion of stock 1 in sub-area 1E can be estimated by maximising the following log-likelihood:

$$LnL = \sum_i O_i \ln(p_i) \quad (1)$$

where O_i is the number of animals in sub-area 1E with haplotype i, and p_i is the estimate of the proportion of animals with haplotype i in sub-area 1E, i.e.:

$$p_i = \chi p_i^1 + (1-\chi) p_i^2 \quad (2)$$

where χ is the proportion of the animals in sub-area 1E that are from stock 1, and $p_i^{1/2}$ are the proportions of animals in stocks 1 and 2 that have haplotype i.

The above algorithm was applied for two cases: (a) the haplotype proportions for stocks 1 and 2 and the numbers of animals in sub-area 1E with each haplotype are based on the JARPN/POWER data; and (b) the numbers of animals in sub-area 1E with each haplotype are based on the commercial samples for sub-area 1E. Results are provided for three definitions for sub-area 1E (165°E-180°; 160°E-175°E; 170°E-175°W).

Fig. 1 shows likelihood profiles for the two cases and three definitions for sub-area 1E. Table 1 lists the estimates and their asymptotic standard errors. The estimate of χ for two combinations of sub-area 1E definition and data source are 1.00. It is not possible to estimate a standard error for these combinations because the estimates are on a boundary. An approximate standard error can be derived by calculating a lower 95% confidence bound for the proportion using the likelihood profile, which if equated to 1.96 standard errors, allows the calculation of a standard error.

Table 1

Estimates and asymptotic standard errors for the mixing proportion for sub-area 1E.

	Basis for analysis	
Sub-area definition	JARPN/POWER	Commercial
165°E-180°	1.000 (0.114*)	0.851 (0.132)
160°E-175°E	0.900 (0.065)	0.933 (0.057)
170°E-175°W	0.644 (0.144)	1.000 (0.467*)

*Calculated using the likelihood profile.

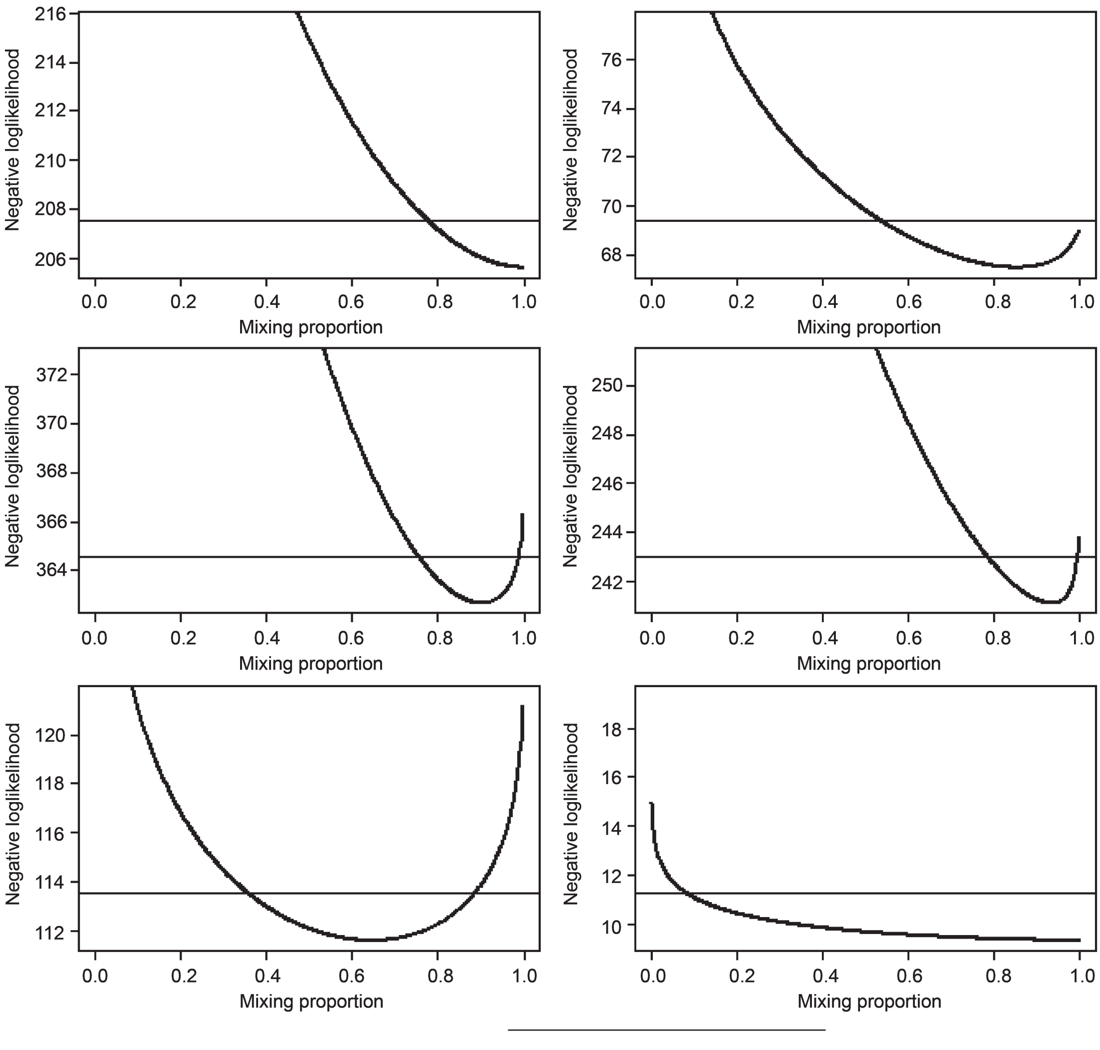


Fig. 1. Likelihood profiles for the proportion of sub-area 1E animals that are from stock 1 for cases: (a) [left panel]; and (b) [right panel]. Results are shown for three definitions for sub-area 1E: 165°E-180° (upper panels); 160°E-175°E (centre panels); 170°E-175°W (lower panels).

Annex G

Additional Information on Abundance Estimate in SC/M17/RMP02

T. Hakamada, M. Takahashi, K. Matsuoka and T. Miyashita

This Annex gives supplemental information on abundance estimates in response to questions and comments made during discussions regarding paper SC/M17/RMP02.

Parameter estimates on detectability

Table 1 shows coefficients and their standard errors for the best models of detection function for POWER and JARPN II data. For JARPN II, the effect of covariates on detectability can be seen from the table. Table 2 shows average $p(z_i)$ over all detection and effective search half width within 3 n.miles of perpendicular distance. Table 3 shows the expected mean school size and its CV for each stratum for both POWER and JARPN II.

Table 1

Coefficients for the best models of detection function for IWC-POWER (left) and JARPN II (right) data.

Parameter	Estimate	SE	Parameter	Estimate	SE
a	1.940	0.298	*a*	0.862	0.121
			Size	0.328	0.107
			Beaufort: bad	-0.196	0.083
			Year: 2012 and 2014	0.302	0.094

Table 2

Average $p(z_i)$ over all detections and effective search half width (ESW) for the best model of the detection function for IWC-POWER (left) and JARPN II (right) data.

Average *p*	ESW	CV	Average *p*	ESW	CV
0.712	2.135	0.088	0.550	1.649	0.034

Table 3

Expected mean school size and its CV by strata for POWER (left) and JARPN II (right).

Year	*E(s)*	CV	Year	Stratum	*E(s)*	CV
2013	1.00	0.000	2008	7	1.39	0.038
2014W	1.22	0.057	2008	8	1.53	0.204
2014E	1.12	0.064	2008	9W	1.42	0.048
2015E	1.38	0.121	2008	9E	1.36	0.053
2015W	1.14	0.125	2012	W	1.00	0.000
			2012	E	-	-
			2014	SW	1.17	0.053
			2014	SE	1.17	0.007
			2014	NW	1.30	0.035
			2014	NE	1.17	0.053

Weighted average of abundance estimate

Average weighted abundance estimate by Akaike weight was calculated for POWER and JARPN II over 16 abundance estimates. The average weighted abundance in the POWER survey area was 9,059 (CV=0.173). The difference from the abundance estimate using the best model is 1.6% of the abundance estimate for the best model (8,919). Table 4 shows abundance estimates and weight used for calculation. The average weighted abundance in the JARPN II survey area was 19,573 (CV=0.193). The difference from the abundance estimate using the best model is 0.2% of the abundance estimate for the best model (19,528). Table 5 shows abundance estimates and weight used for calculation.

Table 4

Abundance estimate in POWER 2013-15 survey areas for each detection functions examined in SC/M17/RMP02 with weight (w_i).

Model	Covariates	*P*	CV(*P*)	AIC	ΔAIC	w_i
HR	S+B+Y	9,052	0.207	245.31	6.95	0.01
	S+B	8,961	0.209	243.24	4.89	0.02
	S+Y	8,994	0.199	244.26	5.90	0.01
	B+Y	8,771	0.191	245.51	7.16	0.01
	S	8,985	0.207	241.35	2.99	0.06
	B	8,731	0.197	242.62	4.26	0.03
	Y	8,737	0.190	243.69	5.33	0.02
	None	8,719	0.195	240.62	2.26	0.08
HN	S+B+Y	9,511	0.187	242.36	4.01	0.03
	S+B	9,328	0.183	240.60	2.24	0.08
	S+Y	9,455	0.181	242.26	3.91	0.04
	B+Y	8,993	0.174	242.57	4.21	0.03
	S	9,331	0.181	238.79	0.43	0.20
	B	8,913	0.173	240.18	1.83	0.10
	Y	9,013	0.170	241.99	3.64	0.04
	None	**8,919**	**0.171**	**238.36**	**0.00**	0.25

Table 5

Abundance estimates in JARPN II 2008, 2012 and 2014 survey areas for the detection functions examined in SC/M17/RMP02 with weight (w_i).

Model	Covariates	*P*	CV(*P*)	AIC	ΔAIC	w_i
HR	S+B+Y	20,404	0.229	1,005.18	4.15	0.08
	S+B	19,818	0.221	1,011.56	10.53	0.00
	S+Y	19,690	0.227	1,006.17	5.14	0.05
	B+Y	23,850	0.250	1,015.72	14.70	0.00
	S	19,149	0.215	1,016.43	15.40	0.00
	B	23,082	0.241	1,019.73	18.70	0.00
	Y	22,438	0.247	1,016.91	15.88	0.00
	None	21,427	0.214	1,024.26	23.23	0.00
HN	S+B+Y	**19,528**	**0.225**	**1,001.03**	**0.00**	0.67
	S+B	19,115	0.219	1,009.14	8.11	0.01
	S+Y	19,284	0.224	1,003.70	2.67	0.18
	B+Y	21,526	0.238	1,012.41	11.38	0.00
	S	18,637	0.217	1,016.94	15.91	0.00
	B	20,836	0.231	1,017.29	16.26	0.00
	Y	21,151	0.238	1,013.43	12.41	0.00
	None	20,089	0.228	1,022.38	21.35	0.00

Response to recommendations on TAG report.

Preliminary analysis of $g(0)$ is planned to be conducted based on IO data in POWER 2015 and 2016 using MRDS (Mark Recapture Distance Sampling) engine in program DISTANCE (Thomas *et al.*, 2010) following the recommendation in the TAG report (IWC, 2017), hopefully, by next IWC/SC meeting. TAG agreed that the unidentified large baleen whale sightings were very probably Bryde's whales; this option should be considered in the analyses of the sightings data (IWC, 2017). Given this, an abundance estimation will be conducted treating 'unidentified whales' as Bryde's whale as a sensitivity analysis by next IWC/SC meeting.

REFERENCES

International Whaling Commission. 2017. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 7-9 October 2015, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 18:459-76.

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P. 2010. Distance software design and analysis of distance sampling surveys for estimating population size. *J. Appl. Ecol.* 47: 5-14.

Annex H

Future Survey Plans and Proposed Management Variants

Future survey plans

Japan plans to cover sub-areas 1W, 1E and 2 by a multi-year sighting survey every 6 years (considering the cycle of *Implementation Reviews*). However, because the main area which Japan wishes to operate for whaling is sub-area 1 (especially 1W), Japan will cover only sub-areas 1W and 1E if surveys in sub-area 2 would not be conducted; this would be in circumstances where any 'acceptable' variants excluding sub-area 2 from the *Small Area* or *Combination Area* outperform those including sub-area 2 as a part of a *Combination Area*.

Management variants

Japan considers the management variants outlined in Table 1 (the same as in the *Implementation*) as appropriate in terms of current knowledge of stock structure and for a more organisationally convenient whaling operation.

Table 1

Management variants considered in the 2007 *Implementation.*

Variant	Description
Variant 1	Sub-areas 1W, 1E and 2 are *Small Areas.*
Variant 2	Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area.*
Variant 3	Sub-area 2 is taken as a *Small Area* and sub-area 1 is a *Combination Area*. Sub-areas 1W and 1E are *Small Areas*, with catch-cascading applied.
Variant 4	Sub-areas 1 and 2 (combined) are a *Combination Area*, and sub-areas 1W, 1E and 2 are *Small Areas*, with catch-cascading applied.

Annex I

Estimation of Age-at-Maturity for Female Bryde's Whales

T. Kitakado, S. Inoue and T. Bando

A maturity ogive is estimated for female Bryde's whales using age-maturity data sampled during JARPN II (see Table 1). The following general formula (Eqn 1) used in Punt (2008) was assumed:

$$y_a \sim Bin(N_a, p_a), \qquad p_a = \left[\frac{\alpha}{1+\exp\left[-(a-a_{50})/\delta\right]}\right]^{\beta} \qquad \text{(Eqn.1)}$$

where:

p_a is the proportion of animals of age a which are mature;
a_{50} is the age-at-50%-maturity (if α=β=1);
δ is the parameter determines the width of the maturity ogive;
α is asymptotic fraction of animals which are mature; and
β is a shape parameter.

Four variant models of the general formula (see Table 2) were used and compared via AIC. The results of maximum likelihood estimation showed that the simplest model is best in terms of AIC though, as shown in Fig. 1, there are negligible differences among models.

The estimated age-at-50%-maturity was about 6 years old in the previous analysis by Punt (2008), while that is around 8.6 in this analysis. This difference might be partly due to difference in the sample size and partly due to the difference in the age-reader (see discussion under Items 3.1.2 and 3.5 of this report).

Table 1

Data employed in the last *Implementation* (JARPNII 2000-03) and this *Implementation Review* (JARPNII 2000-14). Ages greater than 30 were excluded.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	All
Last *Implementation*																																
Immature	1	1	1	2	4		2	2	1													1										
Mature						1	2	2	4	4	6	6	3	4	3	1	6	2	3		3	1	2				1			3		72
This *Implementation Review*																																
Immature		1	4	1	6	10	12	7	3	2	1																					
Mature								1	1	2	10	8	10	14	9	7	11	9	14	12	8	10	7	5	9	3	10	6	8	2	6	229

Table 2

Comparison of the four variant models.

Model	Ass.	a50	δ	α	β	No. of parameters	-Loglike	AIC	Age-at-50%-maturity
Last *Implementation*									
1	$\alpha=\beta=1$	5.93	2.07	1	1	2	21.04	-	5.93 (0.89)
2	$\beta=1$	6.21	0.915	0.978	1	3	15.66	-	6.21 (0.55)
3	$\alpha=1$	-23.40	2.33	1	212031	3	19.64	-	5.99 (N/A)
4		-7.42	1.25	0.999	30066	4	15.62	-	5.90 (0.51)
This *Implementation Review*									
1	$\alpha=\beta=1$	8.65	0.598	1	1	2	12.16	28.33	8.65 (0.32)
2	$\beta=1$	8.65	0.598	1.000	1	3	12.16	30.33	8.65 (0.32)
3	$\alpha=1$	8.72	0.579	1	0.935	3	12.15	30.29	8.72 (N/A)
4		9.44	0.378	1.000	0.421	4	12.03	32.06	8.89 (0.55)

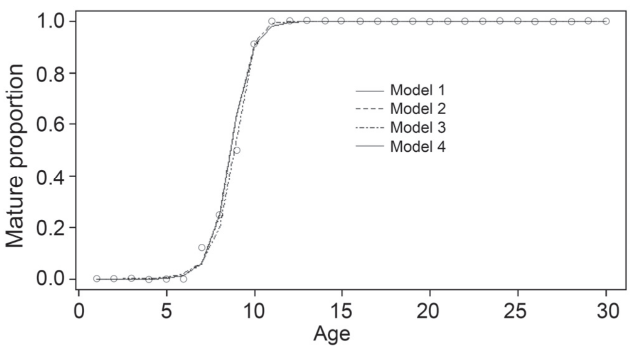


Fig. 1. Fits of the four models to the age-maturity data.

REFERENCE

Punt, A.E. 2008. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. Appendix 4. The specifications for the *Implementation Simulation Trials* for western North Pacific Bryde's whales (final). Adjunct 3. Estimation of age-at-maturity for female Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 10:114.

Annex J

Specifications for the *Implementation Simlation Trials* for Western North Pacific Bryde's Whales

A. Basic concepts and stock-structure

The trials detailed below consider the implications of alternative variants of the RMP for Bryde's whales in sub-areas 1 and 2 of the western North Pacific (Fig. 1). Sub-area 1 is further sub-divided into sub-areas 1W and 1E at 165°E. The trials model two stocks (Stocks 1 and 2) and explore alternative placements of the boundary between them. The sub-areas are further divided into smaller 'Component areas' (see Fig. 1 and Table 1) to enable these alternatives to be tested.

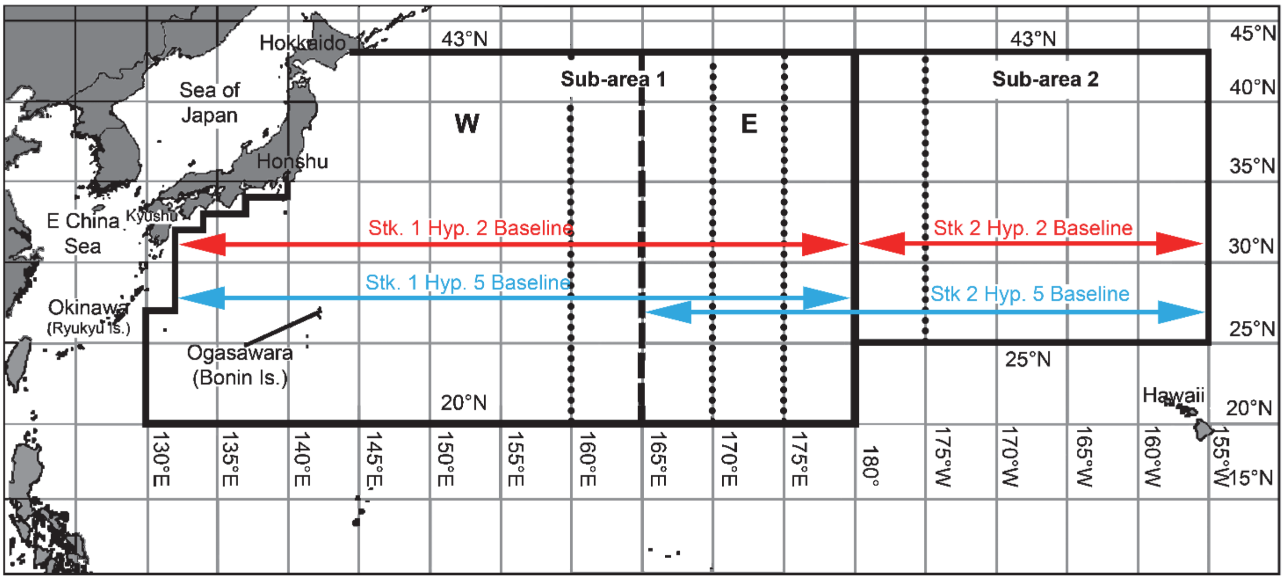


Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales. The ranges of the stocks for Hypotheses 2 and 5 (baselines) are also shown. The boundary between the 1W and 1E sub-areas at 165°E, indicated by a dashed line, is a management boundary (used by the RMP). The dotted lines at 160°E, 170°E, 175°E and 175°W denote the boundaries between 'Component areas' and are used for trials in which the true boundary between the stocks differs from the boundary on which the RMP is based. The staggered border to the South of Japan is used to ensure that no catches of the inshore form occur. The southern boundary of sub-area 1 was revised from the 10° line used in the 2008 trials, in order to avoid the breeding grounds.

There are two general hypotheses regarding stock structure[1]:

(1) Stock structure hypothesis 2. There are two stocks of Bryde's whales in sub-areas 1 and 2. One stock is found in sub-area 1 and the other is found in sub-area 2. The trials investigate sensitivity to the position of the boundary between the stocks.

(2) Stock structure hypothesis 5. There are two stocks of Bryde's whales in sub-areas 1 and 2. One stock is found in sub-area 1W and the other is found in sub-area 2. Sub-area 1E is a region of mixing. The trials explore various assumptions regarding the regions of mixing.

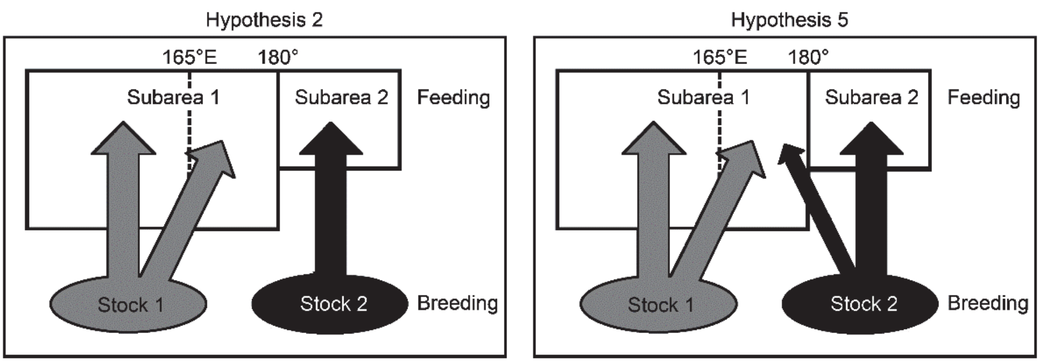


Fig. 2. The two hypotheses considered in the *Implementation Simulation Trials*.

[1]Note that stock structure hypotheses 1, 3 and 4 developed in the previous *Implementation* are not carried forward here; for consistency the hypothesis numbers have not been changed.

B. Basic dynamics

The dynamics of the animals in stock *j* are governed by equation B.1:

$$N_{t+1,a}^{g,j} = \begin{cases} 0.5\, b_{t+1}^{j} & \text{if } a=0 \\ (N_{t,a-1}^{g,j} - C_{t,a-1}^{g,j})\tilde{S}_{a-1} & \text{if } 1 \le a < x \\ (N_{t,x}^{g,j} - C_{t,x}^{g,j})\tilde{S}_{x} + (N_{t,x-1}^{g,j} - C_{t,x-1}^{g,j})\tilde{S}_{x-1} & \text{if } a = x \end{cases} \tag{B.1}$$

where

$N_{t,a}^{g,j}$ is the number of animals of gender *g* and age *a* in stock *j* at the start of year *t*;

$C_{t,a}^{g,j}$ is the catch (in number) of animals of gender *g* and age *a* in stock *j* during year *t* (whaling is assumed to take place in a pulse at the start of each year);

b_t^j is the number of calves born to females from stock *j* at the start of year *t*;

$\tilde{S}_a$ is the survival rate = e^{-M_a} where M_a is the instantaneous rate of natural mortality (assumed to be independent of stock, time, and gender); and

x is the maximum age (treated as a plus-group);

Note that *t*=0, the year for which catch limits might first be set, corresponds to 2017.

C. Births

For most trials (including the baseline trials), density-dependence is assumed to act on the female component of the 'mature' population. The convention of referring to the mature population is used here, although this actually refers to animals that have reached the age of first parturition.

$$b_t^j = B^j N_t^{\mathrm{f},j}\{1 + A^j(1 - (N_t^{\mathrm{f},j} / K^{\mathrm{f},j})^{z^j})\} \tag{C.1}$$

where

B^j is the average number of births (of both sexes) per year for a mature female in stock *j* in the pristine population;

A^j is the resilience parameter for stock *j*;

z^j is the degree of compensation for stock *j*;

$N_t^{\mathrm{f},j}$ is the number of 'mature' females in stock *j* at the start of year *t*:

$$N_t^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{t,a}^{\mathrm{f},j} \tag{C.2}$$

a_m is the age-at-first-parturition; and

$K^{\mathrm{f},j}$ is the number of mature females in stock *j* in the pristine (pre-exploitation written as *t*=-∞) population:

$$K^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{-\infty,a}^{\mathrm{f},j} \tag{C.3}$$

The values of the parameters A^j and z^j for each stock are calculated from the values for $MSYL^j$ and $MSYR^j$ (Punt, 1999). Their calculation assumes harvesting equal proportions of males and females.

D. Catches

It is assumed that whales are homogeneously distributed across a Component-area. The catch limit for a Component-area is therefore allocated to stocks by gender and age relative to their true density within that Component-area and a mixing matrix *V* (that is independent of year, gender and age in these trials), i.e.:

$$C_{t,a}^{g,j} = \sum_k F_t^{g,k} V^{j,k} S_{t,a}^k N_{t,a}^{g,j} \tag{D.1}$$

$$F_t^{g,k} = \frac{C_t^{g,k}}{\sum_{j'} V^{j',k} \sum_{a'} S_{t,a'}^k N_{t,a'}^{g,j'}} \tag{D.2}$$

where

$F_t^{g,h}$ is the exploitation rate in Component-area *k* on recruited animals of gender *g* during year *t*;

$S_{t,a}^k$ is the selectivity on animals of age *a* in Component-area *k* during year *t*;

$C_t^{g,k}$ is the catch of animals of gender *g* in Component-area *k* during year *t*; and

$V^{j,k}$ is the fraction of animals in stock *j* that is in Component-area *k* during year *t*.

The historical (pre-2017) catches by Component-area and year are set to one of three series (see IWC, 2008) which will be updated to include catches since 2006); or, in the future, are determined using the RMP. There are no incidental catches. The sex ratio for future catches is assumed to be 50:50.

E1. Mixing

The entries in the mixing matrix *V* are selected to model the distribution of each stock at the time when the catch is removed. Mixing is deterministic. Table 1 lists the mixing matrices for each of the stock structure hypotheses.

Table 1

The catch mixing matrices. The γs indicate that the entry concerned is to be estimated during the conditioning process. The shaded areas show the areas in which the stocks mix.

		Sub-Area						
		1W		1E			2	
Stock structure hypothesis	Component Area	1Wa 130-160°E	1Wb 160-165°E	1Ea 165-170°E	1Eb 170-175°E	1Ec 175°E-180°	2a 180°-175°W	2b 175-155°W
2. Baseline.	Stock 1	4	1	γ_1	γ_1	γ_1	0	0
	Stock 2	0	0	0	0	0	1	4
2. Trial 6	Stock 1	4	1	γ_1	γ_1	0	0	0
	Stock 2	0	0	0	0	Y	1	4
5. Baseline	Stock 1	4	1	γ_1	γ_1	γ_1	0	0
	Stock 2	0	0	γ_2	γ_2	γ_2	1	4
5. Trials 7	Stock 1	1	γ_3	γ_3	γ_3	0	0	0
	Stock 2	0	γ_4	γ_4	γ_4	Y	1	4
5. Trials 8	Stock 1	4	1	1	$Y\gamma_5$	$Y\gamma_5$	γ_5	0
	Stock 2	0	0	0	$Y\gamma_6$	$Y\gamma_6$	γ_6	1

Notes

The 4:1 ratios used in sub-area 1W are calculated from the ratio of the areas of sub-areas 1Wa and 1Wb, but ignoring the area to the South of Japan between 130-140°E as very few Bryde's whales are seen there.

Y is calculated using the ratio of the number of degrees of latitude covered by the two areas 1Ec and 2a, i.e. Y=23/18.

For Hypothesis 2, the number of Stock 1 whales in sub-area 1W and 1E is estimated during conditioning using the relative abundance in the two sub-areas. In Trial 6, the boundary between the two stocks changes from 180° to 175°E.

For Hypothesis 5, the density of each stock is assumed to be uniform across the mixing area band.

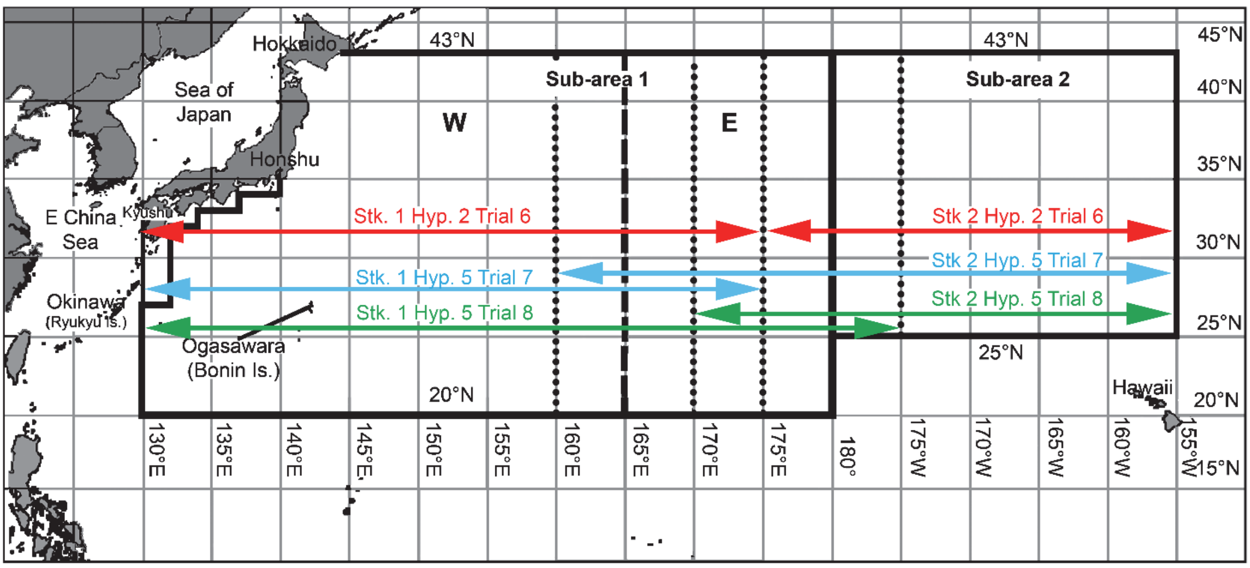


Fig. 3. The ranges of the stocks tested in Trials 6, 7 and 8.

E2. Boundary

In the baseline trials, the boundary between sub-areas 1W and 1E and between 1E and 2 used when modelling the true population dynamics is the same as that used when applying the RMP and is at 165°E and 180°, respectively. However, a different boundary is used for some of the trials based on stock structure hypothesis 5 that assumes mixing between stocks 1 and 2 in an inter-mediate area. This inter-mediate area corresponds to Sub-area 1E for the baseline hypothesis 5. In Trial 7 the boundaries between the true stock and stock-mixing areas are 5° further west than for the baseline, while in Trial 8 the boundaries are 5° further east (Fig. 3).

The management boundaries are fixed at 165°E and 180° for all trials.

F. Generation of data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the RMP are listed in Table 2. Future surveys are assumed to cover each of sub-areas 1W, 1E and 2 in their entirety in a single survey. This is a slight simplification of reality; the entire area will actually be covered in four years (see Table 3 for the proposed survey plan), but the westernmost part of sub-area 1W contains very few Bryde's whales so the two surveys in sub-area 1W are treated as one for the purposes of trials. The trials assume that it takes two years for the results of a sighting survey to become available to be used by the management procedure, i.e. a survey conducted in 2020 could first be used for setting the catch limit in 2022.

The future estimates of abundance for a survey area E are generated using the formula:

$$\hat{P} = P\,Y\,w\,/\,\mu = P^*\,\beta^2\,Y\,w \tag{F.1}$$

where

Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_\varepsilon^2)$ and $\sigma_\varepsilon^2 = \ell\mathrm{n}(\alpha^2+1)$;

w is a Poisson random variable with $E(w) = \mathrm{var}(w) = \mu = (P/P^*)/\beta^2$, Y and w are independent;

P is the current total (1+) population size in survey area E:

$$P = P_t^E = \sum_{k\in E}\sum_j V_t^{j,k}\sum_g\sum_{a\geq 1} N_{t,a}^{g,j} \tag{F.2}$$

and

P^* is the reference population level, and is equal to the expected total (1+) population size in the survey area prior to the commencement of exploitation in the area being surveyed (where the expectation is taken with respect to inter-annual variation in the mixing matrix).

Note that under the approximation $CV^2(ab) \cong CV^2(a) + CV^2(b)$, $E(\hat{P}) \cong P$ and $CV^2(\hat{P}) \cong \alpha^2 + \beta^2 P^*/P$.

For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; IWC 1994, pp.85-6), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

$$CV^2(\hat{P}) = \tau(0.12 + 0.025P^*/P) \tag{F.3}$$

The value of τ is calculated from the survey sampling CV's of earlier surveys in survey-area E. If $\overline{CV^2}$ is the average value of CV^2 estimated for each of these surveys, and $\overline{P}$ is the average value of the total (1+) population sizes in area E in the years of these surveys, then:

$$\tau = \overline{CV^2}\,/\,(0.12 + 0.025P^*/\overline{P} \tag{F.4}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \quad \beta^2 = 0.025\tau \tag{F.5}$$

The above equations apply in the absence of additional variance. In these trials, an additional variance CV_{add}, is incorporated by making the following adjustment:

$$\sigma_\varepsilon^2 = \ell n\left(1 + \alpha^2 + CV_{add}^2\right) \tag{F.6}$$

$CV_{add} = 0.335$ in the baseline trials (SC/67a/RMP04).

An estimate of the CV is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2\chi^2/n \tag{F.7}$$

where

$\sigma^2 = \ell n\left(1 + \alpha^2 + \beta^2 P^*/\hat{P}\right)$, and

χ^2 is a random number from a Chi-square distribution with n degrees of freedom (where n=10 as used for the North Pacific minke whale *Implementation Trials*; IWC, 2004).

Table 2

The estimates of abundance and their sampling errors.

Sub-area	Year	Estimate	Sampling CV
1W	1995	5,110	0.192
	2000	4,222	0.317
	2011	15,422	0.289
1E	1995	7,246	0.479
	2000	9,251	0.295
	2011	6,716	0.216
2	1995	2,262	0.300
	2000	3,711	0.337
	2014	4,161	0.264

Table 3

Sighting survey plan (the results from surveys in the westernmost part of sub-area 1W are combined in the trials - see section F).

	Sector			
Season	130°-145°E	145°-165°E	165°E-180°	180°-160°W
Sub-Area	1W		1E	2
2017				Yes
2018		Yes		
2019			Yes	
2020	Yes			
2021				Yes
2022		Yes		
2023			Yes	
2024	Yes			
2025				Yes
2026		Yes		
2027			Yes	
2028	Yes			
2029				Yes
2030		Yes		
2031			Yes	
2032	Yes			
and so on in this pattern				

Table 4

The values for the biological and technological parameters that are fixed.

Parameter	Value
Plus group age, *x*	15 yrs
Natural mortality, *M*	0.08yr^{-1}
Age-at-first-parturition, a_m	9 years (see Annex I of this report: calculated as 8.6)
Selectivity (historical)	
Sub-area 1W:	Knife-edged at age 5 (IWC, 2000; 2005b)
Sub-areas 1E and 2:	Knife-edged at age 9 (IWC, 2000; 2005b)
Selectivity (future)	Knife-edged at age 5 (IWC, 2007, p.415)
Maximum Sustainable Yield Level, *MSYL*	0.6 in terms of mature female component of the population

G. Parameters and conditioning

The values for the biological and technological parameters are listed in Table 4. In relation to selectivity, historically a 35ft (10.7m) legal minimum size limit applied to coastal whaling and a 40ft (12m) limit applied to pelagic operations. These size limits correspond to ages of five and nine years respectively (Ohsumi, 1977). The size limits are implemented by making selectivity depend on sub-area. Historically, pelagic whaling occurred in sub-areas 1E and 2, and coastal whaling in sub-area 1W. Therefore, selectivity is assumed to be knife-edged at age five for sub-area 1W, while selectivity for sub-areas 1E and 2 is assumed to be knife-edged at age nine. All future catches are assumed have a knife-edged selectivity at age five (hence the *t*-subscript on *S* in Equations D.1 and D.2).

The 'free' parameters of the above model are the initial (pre-exploitation) sizes of each of the stocks and the values that determine the mixing matrices. The process used to select the values for these 'free' parameters is known as conditioning. The conditioning process involves first generating 100 sets of 'target' data, detailed in steps (a) and (b) below, and then fitting the population model to each (in the spirit of a bootstrap). The number of animals in Component-area *k* at the start of year *t* is calculated starting with guessed values of the initial population sizes and projecting the operating model forward to 2017 to obtain values of abundance by stock and mixing proportions for comparison with the generated data.

(a) The 'target' values for the historical abundance by survey-area are generated using the formula:

$$P_t^E = O_t^E \exp[\mu_t^E - (\sigma_t^E)^2 / 2]\,;\ \mu_t^E \sim N[0;(\sigma_t^E)^2] \tag{G.1}$$

where

P_t^E is the abundance for survey-area *E* in year *t*;

O_t^E is the actual survey estimate for survey-area *E* in year *t* (Table 4); and

σ_t^E is the CV of O_t^E.

(b) The 'targets' for the mixing proportion in the mixing area trials based on stock structure hypothesis 5 are generated from normal distributions (Table 5), truncated at 0 and 1.

Table 5

Estimates and asymptotic standard errors for the mixing proportions between Stocks 1 and 2 in Hypothesis 5 trials.

Area	Average proportion of Stock 1 between 2004-14 (from JARPNII/POWER samples)	Standard error	Proportion of Stock 1 in 1978 (from commercial samples)	Standard error
Baseline: 165°E-180°	1.000	0.114	0.851	0.132
Trial 7: 160°E-175°E	0.900	0.065	0.933	0.057
Trial 8: 170°E-175°W	0.644	0.144	1.000	0.467

Calculation of the likelihood

The likelihood function consists of two components. Equations G.2 and G.3 list the negative of the logarithm of the likelihood for each of these components so the objective function minimised is L_1+L_2, where L_2 only applies for Hypothesis 5. An additional penalty is added to the likelihood if the full historical catch is not removed.

Abundance estimates

$$L_1 = 0.5\sum_n \frac{1}{(\sigma_n)^2} \ell n\left(P_n / \hat{P}_n\right)^2 \tag{G.2}$$

where $\hat{P}_n$ is the model estimate of the 1+ abundance in the same year and survey-area as the n^{th} estimate of abundance P_n (the target abundances).

Mixing proportions

$$L_2 = 0.5\frac{1}{\sigma_{78}^2}\left(p_{78} - \hat{p}_{78}\right)^2 + 0.5\frac{1}{\sigma_{04}^2}\left(p_{04} - \hat{p}_{04}\right)^2 \tag{G.3}$$

where

$\hat{p}_{78}$ is the model estimate of the proportion of stock 1 animals in the mixing area[2] in 1978;

$\hat{p}_{04}$ is the average of the model estimate of the proportion of stock 1 animals in the mixing area over 2004 to 2014; and

p_{78} and p_{04} are the 'target' mixing proportions from commercial samples in 1978 and JARPNII/POWER survey samples between 2004-2014, respectively, given in Table 5.

H. Trials

The *Implementation Simulation Trials* for the western North Pacific Bryde's whales are listed in Table 6. All of the trials are based on the assumption $g(0)$=1. Table 7 lists the factors used in the trials.

Table 6

The *Implementation Simulation Trials* for the Western North Pacific Bryde's whales.

Trial	Stock structure hypothesis	MSYR[1]	Additional variance	Catch series	1W/1E boundary	1E/2 boundary	Comment
Br1-1	2	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 2
Br1-4	2	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 2
Br2-1	5	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br2-4	5	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br3-1	5	1	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br3-4	5	4	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br4-1	5	1	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br4-4	5	4	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br5-1	5	1	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br5-4	5	4	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br6-1	2	1	Baseline	Best	165°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1[2]
Br6-4	2	4	Baseline	Best	165°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1[2]
Br7-1	5	1	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br7-4	5	4	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br8-1	5	1	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br8-4	5	4	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br9-1	?	1	Baseline	Best	165°E	180°	Density dependent M
Br9-4	?	4	Baseline	Best	165°E	180°	Density dependent M

[1]MSYR=1% is related to the 1+ component; MSYR =4% is related to mature component. [2]Based on alternative mixing proportion data.

[2]The mixing area is sub-area 1E (165°E-180°E) for the baseline trials, but changes to 160°E-175°E for Trial 7, and 170°E-175°W for Trial 8.

Table 7

Factors considered in the revised trials. The values in **bold** are the baseline values.

Factor	Values considered
Stock structure hypotheses	**2**, 5
MSYR	**$MSYR_{1+}$ = 1%; $MSYR_{mat}$=4%**
Catch series	Low, **Best**, High
Additional variance	**Baseline**, Upper 5%ile
1W/1E boundary	160°E, **165°E**, 170°E
1E/2 boundary	175°E, **180°**, 175°W

I. Management options

In all cases, the boundary between sub-areas 1W and 1E is defined as 165°E and that between sub-areas 1E and 2 at 180° irrespective of the true boundary used to define the structure of the populations in the operating model. The following five management options will be considered.

V1 Sub-areas 1W, 1E and 2 are *Small Areas* and catch limits are set by *Small Area*.

V2 Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area*. For this management option, all of the future catches in sub-area 1 are taken from sub-area 1W.

V3 Sub-area 2 is taken to be a *Small Area* and sub-area 1 is taken to be a *Combination area*. Sub-areas 1W and 1E are Small Areas, with catch-cascading applied.

V4 Sub-area 1W is taken to be a *Small Area* and sub-areas 1E and 2 (combined) are taken to be a *Combination Area*. Sub-areas 1E and 2 are *Small Areas*, with *catch-cascading* applied.

V5 Sub-areas 1 and 2 (combined) are taken to be a *Combination area*. Sub-areas 1W, 1E and 2 are *Small Areas*, with *catch-cascading* applied.

The simulated application of the RMP is based on using the 'best' catch series (see IWC, 2008).

J. Output statistics

Population-size and continuing catch statistics are produced for each stock and catch-related statistics for each sub-area.

(1) Total catch (TC) distribution: (a) median; (b) 5th value; (c) 95th value.

(2) Initial mature female population size ($P_{initial}$) distribution: (a) median; (b) 5th value; (c) 95th value.

(3) Final mature female population size (P_{final}) distribution: (a) median; (b) 5th value; (c) 95th value.

(4) Lowest mature female population size (P_{lowest}) distribution: (a) median; (b) 5th value; (c) 95th value.

(5) Average catch by sub-area over the first ten years of the 100 year management period: (a) median; (b) 5th value; (c) 95th value.

(6) Average catch by sub-area over the last ten years of the 100 year management period: (a) median; (b) 5th value; (c) 95th value.

Plots are produced showing following types of outputs for all variants and the no-catch scenarios:

(a) the median population size trajectories by stock;

(b) the 5%-ile, median and 95%-ile of the population depletion trajectories by stock from year 2000 to the end of the projection period);

(c) the median catch trajectories from year 2000 onwards; and

(d) ten individual population trajectories for each stock.

In addition, plots and tables are produced summarising the application of the procedure for defining 'acceptable' - A, 'borderline' - B and 'unacceptable' - U performance, by comparison with the equivalent single stock trials - see IWC (2005a).

K. References

International Whaling Commission. 1991. Report of the Sub-committee on Management Procedures, Appendix 4. Report of the *ad hoc* trials subgroup. *Rep. int. Whal. Commn* 41:108-12C.

International Whaling Commission. 1994. Report of the Scientific Committee, Annex D. Report of the Sub-committee on Management Procedures, Appendix 2. Minimum standards trials. *Rep. int. Whal. Commn* 44:85-8.

International Whaling Commission. 2000. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 2: 79-124.

International Whaling Commission. 2004. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 10. North Pacific minke whale *Implementation Simulation Trial* specifications. *J. Cetacean Res. Manage. (Suppl.)* 6: 118-139.

International Whaling Commission. 2005a. Report of the Scientific Committee. Annex D. Report of the Sub-committee on the Revised Management Procedure. Appendix 2. Requirements and Guidelines for *Implementations*. *J. Cetacean Res. Manage. (Suppl.)* 7: 84-92.

International Whaling Commission. 2005b. Report of the Workshop on the *pre-Implementation assessment* of western North Pacific Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 8: 337-355.

International Whaling Commission. 2007. Report of the first intersessional Workshop on the Western North Pacific Bryde's whale *Implementation*. Report of the First Intersessional Workshop, 25-29 October 2005, Shizuoka, Japan. *J. Cetacean Res. Manage. (Suppl.)* 9:407-27.

International Whaling Commission. 2008. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 4. The specifications for the *Implementation Simulation Trials* for Western North Pacific Bryde's whales (final). Adjunct 1. The catch series used in the trials. *J. Cetacean Res. Manage. (Suppl.)* 10: 112-13.

Ohsumi, S. 1977. Further assessment of population of Bryde's whales in the North Pacific. *Rep. int. Whal. Commn* 27:156-60.

Punt, A.E. 1999. Report of the Scientific Committee. Annex R. A full description of the standard Baleen II model and some variants thereof. *J. Cetacean Res. Manage. (Suppl.)* 1: 267-76.

Chair's Summary Report of the First IWC Workshop on the Comprehensive Assessment of North Pacific Humpback Whales

Chair's Summary of the First IWC Workshop on the Comprehensive Assessment of North Pacific Humpback Whales[1]

INTRODUCTION

The first Workshop on the Comprehensive Assessment of North Pacific Humpback Whales was held from 19-21 April 2017 at the kind invitation of the Marine Mammal Laboratory in Seattle. It was convened by Phil Clapham, and Greg Donovan was elected Chair. The Agenda to the meeting is appended to this summary. The Workshop covered an enormous amount of material (see Appendix 1 for the list of documents) and consequently it was not possible to develop a draft report at the meeting. It was therefore agreed that the Chair should develop an executive summary for the Scientific Committee meeting with a focus on key agreements, recommendations and the workplan. Most sections of the full report have initial drafts from the rapporteurs and these are being consolidated before being circulated to the Workshop participants for comments and finalisation.

The objective of the Workshop was to undertake the first steps in assessing humpback whales in the North Pacific (the Comprehensive Assessments of North Atlantic and Southern Hemisphere humpback whales were completed in 2002 and 2014, respectively). It is envisioned that this will be a 2-3 year process. The primary task was to identify and review the available information on stock structure, removals (catches, bycatches and ship strikes), abundance and trends (by stock and area), biological parameters and environmental issues. This information will ultimately be integrated using a population dynamics modelling approach. The important steps that were completed at the Workshop were to confirm available data, develop a series of plausible conceptual models for stock structure, and identify major uncertainties or knowledge gaps.

STOCK STRUCTURE

The Workshop reviewed information on stock structure from a suite of datasets including photo-identification, genetics, telemetry, acoustics, catches and sightings.

The Workshop was fortunate to be able to review and build upon the extensive SPLASH (Structure of Populations, Levels of Abundance and Status of Humpbacks) project. This major international collaborative project was conducted on all then-known winter breeding regions during three seasons (2004, 2005, 2006) and all known summer feeding areas during two seasons (2004, 2005[2]). A total of 7,971 unique individuals were catalogued and a total of 6,178 tissue samples were also collected for genetic studies of population structure, with broadly even representation of wintering and feeding areas.

Updated information, in some cases extensive, was received and reviewed from several regions and research groups including the Russian Pacific, the Bering and Chukchi Seas, Japan and Mexico. Thus, the Workshop had an abundance of data with which to develop stock structure hypotheses.

The Workshop identified the geographic 'building blocks' it would use when describing the various stock structure hypotheses. These are listed in Table 1 and shown in Fig. 1.

The hypotheses considered by the Workshop relating to wintering and feeding grounds (and movements) are summarised in Tables 2 and 3. Note that Hawaii in the central North Pacific is always considered a single wintering area.

The Workshop has established an intersessional Steering Group to consolidate and prioritise these hypotheses from a modelling perspective. That Steering Group will also work on resultant presence/absence and mixing matrices needed for modelling.

REMOVALS

The Workshop examined the existing catch data and has agreed the series for incorporating into the assessment. This will require different allocations of catches for each stock structure hypothesis. It also reviewed the available information on bycatch and ship strikes. This is a more complex issue than direct catches. The Workshop noted that, as for other assessments (e.g. gray whales) there was rather limited information from some areas and that even where there are data, the numbers will likely be underestimated by an unknown (and possibly large) amount. The Workshop agreed that it will follow the approach adopted elsewhere that it will develop several scenarios reflecting both past and likely future removals; these are intended to capture the uncertainty (both in numbers and allocations for the various stock structure hypotheses) for use in the modelling work. These scenarios will be developed by an intersessional Steering Group that will also investigate whether additional data can be tracked down.

ABUNDANCE AND TRENDS

The Workshop examined a comprehensive mark-recapture analysis (still ongoing) using data for the whole North Pacific derived from the SPLASH dataset. Several difficulties were identified, and suggestions were made to address these. In addition, the completed analysis will take into account the revised (since SPLASH) stock structure hypotheses considered at the Workshop and the need for abundance estimates for the areas relevant to these.

The Workshop compiled a list of abundance estimates (or data that could be used to generate such estimates) for the areas that would be needed for the various stock structure hypotheses. It also addressed the future work needed to complete analyses (appended to this summary). The intersessional Steering Group will ensure that progress is made to this end.

BIOLOGICAL PARAMETERS

The Workshop compiled and reviewed the available information on biological parameters for humpback whales in all oceans. It was recognised that these can vary amongst populations. This information will be considered as necessary within the context of the modelling framework, particularly with respect to maximum rates of increase.

[1]Presented to the Scientific Committee meeting as SC/67a/Rep08. The full report of this Workshop will be produced at a later date.

[2]Although coverage in 2005 was much reduced for offshore and Aleutians.

Table 1

Geographic areas used to describe stock structure hypotheses (see Fig.1).

Area	Abbreviation	Area	Abbreviation
Philippines	PHI	Western Gulf of Alaska	wGOA
Ogasawara	OG	Central Gulf of Alaska	cGOA
Okinawa	OK	Northern Gulf of Alaska/Prince William Sound	nGOS-PWS
Hawaii	HI	Southeast Alaska-Northern British Columbia	seAK-nBC
Kuril Islands	KI	Southern British Columbia-Washington State	sBC-WA
Okhotsk Sea	OS	Northern California-Oregon	nCA-OR
Eastern Kamchatka	eKam	Southern and Central California	s&cCA
Western Aleutians	wAI	Mexico Baja	MXBJ
Central Aleutians	cAI	Mexico Mainland	MXMN
Eastern Aleutians	eAI	Mexico Islands (Revillagigedos)	MXIS
Bering Sea	BS	Southern Mexico	sMX
Arctic	Ar	Central America	cAm

Table 2a

Summary of hypotheses under consideration with respect to wintering areas in the eastern North Pacific. Y=final destination breeding ground; T=Transit, i.e. animals found in this area are moving through to their final destination. For areas see Table 1 and Fig.1.

MX BJ	Y		T			Y
MX IS	Y	Y	Y	Y	Y	Y
nMLMX	Y		Y			Y
sMLMX	T					
cAm	Y	Y	Y	Y	Y	Y

Table 2b

Summary of hypotheses under consideration with respect to wintering areas: western North Pacific. Legend as Fig 2a.

Ogasawara	Y		T	
Okinawa	Y		Y	Y
Philippines	Y	Y		
Mariana+	Y		Y	Y

Table 3

Summary of consideration of links between areas used to describe feeding grounds (Y=separate feeding ground on its own). For areas see Table 1 and Fig.1.

Area	Links with			
KI	Y	With eKam	With wAI	
OS	With KI			
eKam	With KI			
wAI	With BS, cAI and eAI	With BS and cAI		
cAI	With BS, wAI and eAI	With BS and wAI	With BS and eAI	
eAI	With BS, cAI and eAI	With BS and eAI		
Ar	With BS			
BS	With A	With wAI, cAI and eAI	With wAI and cAI	With cAI and eAI
wGOA	With aAI and cGOA	With nGOA, eAI, cGOA		
cGOA	With aAI and wGOA	With nGOA, eAI, wGOA		
nGOA-PWS	With nGOA-PWS			
seAK-nBC	T			
sBC-WA	With nCA-OR			
nCA-OR	With s&cCA	With sBC-WA		
c&cCA	Y	T		

ENVIRONMENTAL ISSUES

The Workshop considered this item in the context of potentially changing carrying capacity in the North Pacific. It was agreed that whilst separating the effects of environmental changes from the traditional view of populations approaching carrying capacity is something to strive for, such data are not available. However, the Workshop noted several interesting studies linking humpback whale occurrence and density with environmental factors in parts of the North Pacific and adjacent Arctic, as well as information suggesting changes in numbers, distribution, health and reproduction of humpback whales (e.g. parts of southeast Alaska and Hawaii). Further investigations into the effects of environmental changes in the habitat of humpback whales were encouraged.

MODELLING

The Workshop reviewed an initial sex- and age-structured modelling framework that might be used as the basis for the assessments, and this proved valuable in allowing the Workshop to move forwards. In the light of discussions of the available data it was agreed that future modelling efforts should employ a simpler modelling framework based upon an age-aggregated model; this will allow easier use of priors for the maximum rate of increase, and allow the model to be fitted using a Bayesian estimation approach, in common with the assessments for humpback whale populations in Southern Hemisphere.

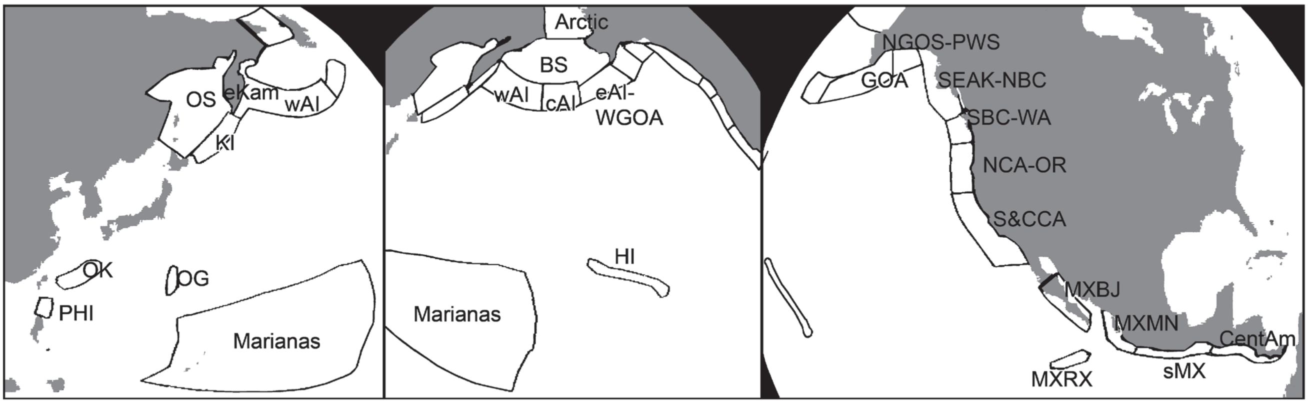


Fig. 1. Geographic areas used to describe stock structure hypotheses (see Table 1).

RECOMMENDATIONS

The Workshop developed several research recommendations that do not have cost implications for the IWC. These include: additional comparisons amongst catalogues; support for the existing work in Russia and expansion of this research; further information and catalogue comparisons with new Japanese data; further consideration of Korea; further information from the Mariana Islands; additional analytical genetic work including further characterisation of the Mexican regions and central California, as well as investigation of population assignment (feeding grounds to breeding units); additional biopsy sampling in particular in Marianas Islands and central Mexico; and additional work on abundance estimates (see Appendix 2).

CONCLUSIONS AND WORK PLAN

The Workshop made considerable progress with the work to develop conceptual stock structure hypotheses and to review the available information on other factors central to completing the Comprehensive Assessment. It recommended that an intersessional Steering Group under Clapham be established to:

(1) consolidate and prioritise the stock structure hypotheses developed at this Workshop from a modelling perspective and develop appropriate draft presence/absence and mixing matrices for consideration at the next Workshop;
(2) facilitate the additional work on abundance estimates; and
(3) finalise plans for the second Workshop in 2018.

Appendix 1

LIST OF DOCUMENTS

SC/A17/NP

01. Punt, A.E. and K.M. Privitera-Johnson. A strawperson age- and sex-structured model for humpback whales in the North Pacific.
02. Filatova, O.A., Titova, O.V., Fedutin, I.D., Ovsyanikova, E.N., Okabe, H., Kobayashi, N., Acebes, J.M. and Hoyt, E. Photo-identification of humpback whales (*Megaptera novaeangliae*) in the Russian Pacific.
03. Ivashchenko, Y.V. and P.J. Clapham. A review of humpback whale catches in the North Pacific.
04. Brower, A.A., Clarke, J. and Ferguson, M. Subarctic cetaceans in the eastern Chukchi Sea, 2008-2016: population recovery, response to climate change, or increased effort?
05. Palacios, D.M. and B.R. Mate. Summary of humpback whale satellite tagging in the North Pacific Ocean, 1995-2016.
06. Pack, A.A. An overview of humpback whale research in Hawaiian waters and a summary of early attempts to estimate whale abundance.
07. Rasmussen, K., Palacios, D.M., Calambokidis, J., Steiger, G. Sighting and environmental characteristics of humpback whale breeding habitat off Pacific Central America: comparison of Northern and Southern Hemisphere populations.
08. Wright, D.L., Grassia, S.L., Berchok, C.L. Acoustic detections of North Pacific humpback whales in the northern Bering and eastern Chukchi Seas; 2008-2015.
09. Barlow, J. Line-transect estimates of humpback whale abundance along the US west coast.
10. Calambokidis, J. and J. Barlow. Trends in the abundance of humpback whales in the North Pacific Ocean from 1980 to 2006.
11. Wade, P.R. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas – revision of estimates in SC/66b/IA21.
12. Straley, J.M., Gabriele, C.M. and Moran, J.R. A review of estimates of humpback whale abundance in southeast Alaska and northern British Columbia.
13. Calambokidis, J., Barlow, J., Flynn, K., Dobson, E., Steiger, G.H. Update on abundance, trends, and migrations of humpback whales along the US west coast.
14. Urbán R., J., A. Frisch, J., Martinez-Aguilar, S. Report on the humpback whale entanglements in the Mexican Pacific (2004-2017).
15. Urbán R., J., Gonzalez-Peral, U. and Baker, C.S. Stock identify and migratory destinations of the humpback whales from the Mexican Pacific.
16. Urbán R., J., Jimenez-Lopez, E., Guzman, H., Martinez-Loustalot, and Viloria-Germora, L. Preliminary report on the humpback whale satellite tagging in Los Cabos, BCS, Mexico 2017.

Appendix 2

Proposed future work related to estimates of abundance and trends in each of the regions delineated to improve the assessment of North Pacific humpback whale.

Absolute abundance	Trends in abundance (relative abundance)
Breeding grounds	
Asia	
- Revise estimate computed from SPLASH data and attempt to compute separate estimates of abundance for Okinawa, Ogasewara and the Phillipines (Wade). - Assess whether the NPAC data can be used to compute abundances for Asia or their sub-regions for the period 1990-93 (Barlow/Calambokidis/Wade). - Check if data exist to compute more recent estimates of abundance for Okinawa from Japanese colleages (Matsuoka). - Assess whether data from Erin Oleson in the Mariana Islands could be used to compute abundance for that region (Calambokidis).	
Hawaii	
- Re-compute abundance estimate from SPLASH (Wade).	- Assess whether estimates in SC/A17/NP10 can be used as indices of relative abundance. - Use relative abundance estimates in SC/A17/NP10 and time series from Mobley *et al.* (2001) to assess trends and as relative abundance indices in the assessment models.
Mexico	
- Update and incorporate additional data for mark-recaptures analyses.	
Central America	
- Re-compute abundance estimate from SPLASH (Wade). - Evaluate whether a longer time series of abundance from Central America can be used in the assessment (for both absolute abundance and trend information) (consult with Calambokidis).	
Feeding grounds	
Arctic	
- Investigate use of SPLASH data to compute abundance estimates in the Gulf of Anadyr (Wade). - Investigate whether sighting data from aerial surveys in the Arctic can be used to compute abundance estimates (Kennedy).	- Investigate whether sighting data from aerial surveys in the Arctic can be used to as indices of relative abundance (Kennedy).
Bering Sea	
- Re-compute abundance estimate from SPLASH (Wade).	- Use time series of abundance estimates from Friday *et al.* (2013) in the assessment models.
Okhotsk	
- Consult with Japanese colleagues to evaluate whether data from their surveys can be used to estimate abundance in the Okhotsk Sea.	
East Kamchatka	
- Evaluate whether it is possible to re-compute abundance estimates from SPLASH (Wade). - Scientists from Russia and elsewhere collaborate and attempt to compute abundance estimates for E Kamchatka (Commander Islands) (Olga/Wade).	
West Aleutians	
- Scientists from Russia and elsewhere collaborate and attempt to compute abundance estimates for the Commander Islands (Olga/Wade). - Evaluate whether Japanese surveys or POWER cruises have data that can be used for estimation of abundance in the northwestern Pacific (Matsuoka).	
Central Aleutians	
- Re-compute abundance estimate from SPLASH (Wade).	
East Aleutians/West Gulf of Alaska	
- Re-compute abundance estimate from SPLASH (Wade). - Assess to what extent the abundance estimates of Riley (2010) for Unalaska Island are informative to the assessment process (for both absolute abundance and trends in abundance).	- Use estimates of abundance in Zerbini *et al.* (2006) as input data in the assessment models.
Central Gulf of Alaska	
- Re-compute abundance estimate from SPLASH (Wade).	- Use estimates of abundance in Zerbini *et al.* (2006) as input data in the assessment models.
North Gulf of Alaska	
- Re-compute abundance estimate from SPLASH (Wade).	- Evaluate whether estimates from Teerlink *et al.* (2015) can be used as indices of relative abundance.
SE Alaska/N British Columbia	
- Re-compute abundance estimate from SPLASH (Wade). - Assess whether other studies can provide information on estimates of absolute abundance and trends (comment from Barlow).	- Combine estimates from SPLISH, SPLASH and NPAC to estimate indices of relative abundance in SE Alaska (comment from Straley).
S British Columbia/WA	
- Re-compute abundance estimate from SPLASH (Wade). - Data used in the estimates computed with the Petersen estimator presented in SC/A17/NP13 would be pooled across 4-year periods and new estimates produced using the Darroch Mth model (these would also inform trends) (Barlow and Calambokidis).	

Absolute abundance	Trends in abundance (relative abundance)
N CA-OR - Re-compute abundance estimate from SPLASH (Wade). - Data used in the estimates computed with the Petersen estimator presented in SC/A17/NP13 would be pooled across four-year periods and new estimates produced using the Darroch Mth model (these would also inform trends) (Barlow and Calambokidis). - Given the considerable exchange within OR and CA, if independence abundance estimates for the N CA-OR and the C&S CA blocks are needed one could consider taking the abundance for the whole region and pro-rate according to the proportion of sightings in the line transect data (Barlow).	
C&S CA - Re-compute abundance estimate from SPLASH (Wade). - Data used in the estimates computed with the Petersen estimator presented in SC/A17/NP13 would be pooled across four-year periods and new estimates produced using the Darroch Mth model (these would also inform trends) (Barlow and Calambokidis). - Given the considerable exchange within OR and CA, if independence abundance estimates for the N CA-OR and the C&S CA blocks are needed one could consider taking the abundance for the whole region and pro-rate according to the proportion of sightings in the line transect data (Barlow).	

References

Friday, N.A., Zerbini, A.N., Waite, J.M., Moore, S.E. and Clapham, P.J. 2013. Cetacean distribution and abundance in relation to oceanographic domains on the eastern Bering Sea shelf: June and July of 2002, 2008 and 2010. *Deep Sea Res.* 94: 244-256.

Mobley, J., Jr., Spitz, S. and Grotefendt, R. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993-2000 aerial surveys. Final Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary and Department of Land and Natural Resources. 16pp.

Riley, H.E. 2010. Humpback whale (*Megaptera novaeangliae*) numbers and distribution on their summer feeding grounds of the eastern Aleutian Islands. MSc thesis, University of Alaska, Fairbanks.

Teerlink, S.F., von Ziegesar, O., Straley, J.M., Quinn, T.J., Matkin, C.O. and Sailitis, E.L. 2015. First time series of estimated humpback whale (*Megaptera novaeangliae*) abundance in Prince William Sound. *Environmental and Ecological Statistics* doi:*10.1007/s10651-014-0301-8.*

Zerbini, A.N., Waite, J.M., Laake, J.L. and Wade. P.R. 2006. Abundance, trends and distribution of baleen whales off Western Alaska and the central Aleutian Islands. *Deep Sea Res. I*, 53:1772-1790.

Report of the Workshop on Harmful Algal Blooms (HABs) and Associated Toxins

Report of the Workshop on Harmful Algal Blooms (HABs) and Associated Toxins[1]

Members: Rowles, Hall (co-Chairs), Baker, Brownell, Cipriano, Glibert, Gulland, Kirkpatrick, Paerl, Schwacke, Simeone, Stimmelmayr, Suydam, Trainer, Van Dolah.

1. CONVENERS' WELCOME AND INTRODUCTIONS

Rowles and Hall welcomed the group to Bled, Slovenia and the participants were introduced. The meeting was held at the Hotel Golf in Bled, Slovenia from 7-8 May 2017. A list of participants is given as Annex A.

2. APPOINTMENT OF CHAIR AND RAPPORTEURS

Rowles (US) and Hall (UK) were appointed co-Chairs of the meeting and Simeone was appointed rapporteur.

3. REVIEW AND ADOPT AGENDA

The agenda was adopted by the Workshop participants. The adopted Agenda is given as Annex B.

4. INTRODUCTION AND BACKGROUND

4.1 Harmful algal bloom dynamics and drivers

The majority of algae in marine and fresh waters are not only beneficial but also necessary to the functioning of aquatic ecosystems. They form the base of the food webs and it is this microscopic life that all aquatic life ultimately depends upon for food. Yet, a comparatively small subset of the total known microscopic algal species may produce toxins that directly or indirectly interfere with the growth or survival of other organisms, or may alter ecosystem functioning through their large accumulation, as blooms. These algae are known as harmful algae, and their associated proliferation events are referred to as harmful algal blooms (HABs). HABs are found in all parts of the world, in all types of waters and they are expanding both in global distribution and in their harmful impacts. Not all harmful algae cause large blooms; some can pose an ecosystem threat even when their relative abundance in the overall algal assemblage remains low compared to other algae. The HAB problem is significant. It poses a major threat to public health, ecosystem function, fisheries sustainability and health, and increasingly may be a threat to cetacean health (Fig. 1).

There are many species of harmful algae, each of which may have different ecological drivers and ecological impacts, resulting in different HAB species being predominant in different parts of the world or at various times. Although some of the factors contributing to the global expansion are natural, such as biological species dispersal, many others are considered to be driven by ever-increasing human population growth and associated urbanisation, agricultural and industrial development (Anderson *et al.*, 2002; Boesch *et al.*, 2001; Glibert *et al.*, 2005; 2014; Heisler *et al.*, 2008; Nixon, 1995; Paerl, 1988). Human activities have altered the nutrient regimes of coastal waters tremendously, primarily as a result of increased applications of chemical fertilizers and generation of wastewater which ultimately enter into the aquatic environment through direct runoff, groundwater or atmospheric deposition (Glibert *et al.*, 2014). Increased nutrient inputs to enclosed and nearshore ecosystems have resulted in widespread coastal eutrophication throughout Europe, USA and Asia (Paerl, 1988; 1997). These nutrients provide the fuel on which these HABs may grow. There are many reports of increases in HABs associated with eutrophication or nutrient loading (Anderson *et al.*, 2002; Heisler *et al.*, 2008), but the complexity of the relationship is far from understood. It is clear that nutrient inputs yield changes in algal biomass (Ryther and Dunstan, 1971), but the impact of these changes on biodiversity are far more complicated. The success of HABs lie at the intersection of the physiological adaptations of the harmful algal species and/or strain (population), the environmental conditions, and interactions with co-occurring organisms (both biogeochemically and trophodynamically) that alter abiotic conditions and/or aggregate or disperse cells (or can alter abiotic conditions in a favourable or unfavourable manner), in turn promoting or inhibiting their growth (Glibert and Burford, 2017).

In addition to increases in nutrient loading, changes in aquaculture practices, overfishing, ballast water discharge, alteration of coastal circulation due to the construction of harbours and confinement areas for aquaculture, and global climate change may all be important drivers of the global increase in HABs. Aquaculture is rapidly increasing globally, while fish supply from capture fisheries has been relatively stable (FAO, 2013). Hence, increases in fish production have come, and will increasingly come, from aquaculture systems. The contribution of aquaculture to global fish supply increased from 4% in 1970 to 25% in 2000 and to 40% in 2010. Over 70% of this production is in developing countries, mostly in Asia (FAO, 2013) and this industrial expansion will continue to contribute to the persistent occurrence of HABs, through nutrient enrichment, habitat alteration and microbial contamination associated with aquaculture operations.

4.2 Global distribution of HABs

It is now well recognised that globally harmful algal blooms are increasing, occurring more often, in new and different places, often lasting longer, and with a range of toxicities. The increase in the occurrence of many of these blooms is often related to an increase in nutrient pollution (Glibert and Burford, 2017; Glibert *et al.*, 2005; 2014; Paerl, 1988), however many of them can occur in pristine areas with little to no influence from anthropogenic nutrient inputs (Trainer *et al.*, 2002). Nutrient loads are changing regionally, in both proportion, and in the dominant form of the nutrient. The fact that nutrient loads have generally increased is, in itself, insufficient for the promotion of HABs. This Workshop reviewed the global trends in plant nutrients entering coastal and inland waters, and then identified some of the physiological adaptations of the different HAB species that make them particularly successful under nutrient-enriched regimes. Using empirical data and modelling examples, these trends were described, using examples from around the world (McCabe *et al.*, 2016).

4.3 Major HABs and their toxins of concern for cetaceans

A diversity of algal toxins with documented impacts on marine mammals are produced by dinoflagellates, diatoms and cyanobacteria (Landsberg *et al.*, 2005). Bloom-forming

[1]Presented to the Scientific Committee meeting as SC/67a/Rep09.

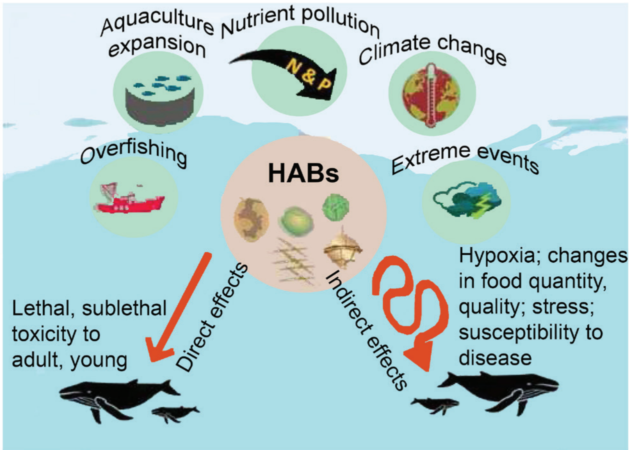


Fig. 1. Harmful algal blooms (HABs) are affected by multiple factors, both natural and anthropogenic. HABs, in turn, have direct (including through *in utero* exposures) and indirect effects on cetaceans.

marine dinoflagellates are prolific producers of polyketide neurotoxins including the alkaloid, saxitoxin, and ladder polyethers, brevetoxin, ciguatoxin, and palytoxin, as well as a diversity of polyketides that cause gastrointestinal or dermal symptoms. Diatoms of the genus *Pseudo-nitzschia* produce the tricarboxylic amino acid neurotoxin domoic acid. Cyanobacterial toxins such as the cyclic peptide, microcystin, generally associated with freshwater systems, can also occur in estuarine or coastal marine waters. The different HAB groups and species have different growth dynamics and factors which drive their life cycles and toxin production, and therefore how they affect marine mammals (through the food chain or via direct contact, inhalation/aspiration, or incidental ingestion) will vary (see Annex C and Table 1).

4.3.1 Cyanobacterial HABs

Cyanobacteria are the Earth's oldest oxygenic phototrophs and they have had major impacts on shaping its biosphere. Their long evolutionary history (~3.5 billion years) has enabled them to adapt to geochemical and climatic changes as well as to recent anthropogenic modifications of aquatic environments, including nutrient over-enrichment (eutrophication), warming, altered precipitation patterns, water diversions, withdrawal and salinisation. Eutrophication has promoted a worldwide proliferation of cyanoHABs that is harmful to ecological and animal (including mammalian) health by outcompeting beneficial phytoplankton, depleting oxygen upon bloom senescence, and producing a variety of toxic secondary metabolites (e.g. cyanotoxins) (Otten and Paerl, 2015). While CyanoHABs are most profound and deleterious in eutrophic freshwater environments, they can also proliferate in brackish estuarine and full-salinity marine ecosystem, especially those that are impacted by excessive nutrient enrichment. Evidence is mounting that cyanotoxins originating from freshwater and estuarine blooms make their way into estuarine and coastal food webs via filter-feeding bivalves and zooplankton, which upon consumption by higher ranked animals including mammals (e.g. sea otters), can lead to adverse health effects and fatalities (Miller *et al.*, 2010). Some cyanotoxins act as skin irritants (contact dermatitis), which impact mammals (e.g. manatees, pets, humans). Lastly, cyanotoxins can contaminate freshwater drinking water supplies as well as waters in bays, sounds, and estuaries, leading to a variety of adverse acute and chronic health effects (e.g. neurological, hepato-digestive, dermatitis) when contaminated water is contacted or ingested (Carmichael, 2001).

4.3.2 Coastal and oceanic HABs

The majority of eukaryotic marine HABs are the dinoflagellates that produce a diverse group of toxins, and include several genera that are represented in Annex C. The dinoflagellates, their toxins, and syndromes (illnesses) caused in humans and marine mammals include *Alexandrium* (saxitoxins that cause paralytic shellfish poisoning), *Karenia* (brevetoxins that cause neurotoxic shellfish poisoning); *Dinophysis* (okadaic acid and the dinophysistoxins that cause diarrhetic shellfish poisoning); *Gambierdiscus* (ciguatoxin that causes ciguatera fish poisoning). For *Alexandrium*, a cyst or 'seed-like' resting stage has been identified (see description below). For *Karenia* and *Dinophysis*, no cyst stage has been identified. The benthic HABs, including *Gambierdiscus*, most typically are found associated with reefs and other hard surfaces. They can be bioaccumulated over many years by benthic feeders including reef fish. The dinoflagellate *Ostreopsis* cf *ovata*, has recently been identified as a producer of palytoxin (Table 1).

The only diatom known to produce a biotoxin is *Pseudo-nitzschia*, a chain-forming diatom. This cell is non-motile but typically is concentrated in near-surface oceanic waters. However, when single *Pseudo-nitzschia* cells or chains run out of nutrients, they become less buoyant and 'rain' out of the surface waters into the benthos as marine snow. These cells can survive and retain toxin for many years where they cause benthic feeders to accumulate domoic acid. For example, sea otters have been known to become ill after ingesting benthic sand crabs in Monterey Bay, California, and the surrounding region.

Although is likely that the majority of HABs initiate in the nearshore coastal region, some HABs such as *Pseudo-nitzschia*, can initiate in offshore oceanic 'hotspot' sites, such as the Juan de Fuca eddy and Heceta Bank (Hickey *et al.*, 2013). These ocean features have retentive circulation that allows natural sources of nutrients to be concentrated at these sites. These highly productive regions support robust food webs, therefore the impacts of HABs originating from these oceanic hotspots on migrating marine mammals should be considered.

4.4 Factors affecting the spread of HABs and their toxins

How environmental factors impact toxin production is the subject of ongoing research, but nutrient [nitrogen (N), phosphorus (P)] supply rates, light, temperature, oxidative stressors, interactions with other biota (bacteria, viruses and animal grazers), and most likely, the combined effects of these factors are all involved (Glibert and Burford, 2017; Paerl and Otten, 2013). Accordingly, strategies aimed at controlling and mitigating harmful blooms have focused on manipulating these dynamic factors, with a focus, to date, on the freshwater HABs. The applicability and feasibility of various controls and management approaches was discussed for aquatic ecosystems (Paerl *et al.*, 2016), including those utilised for fisheries, recreation, drinking water supplies (in the case of cyanobacterial HABs or 'cyanoHABs') and that serve to support the health of coastal, riverine, bay, sound, and estuarine cetaceans. Strategies based on physical, chemical, and biological manipulations of specific factors show promise, in particular for the cyanoHABs, however, a key underlying approach that should be considered in almost all instances is nutrient (both N and P) input reductions, which have been shown to effectively reduce CyanoHAB biomass, at least in inland waters, and therefore limit health risks (Paerl *et al.*, 2016).

HABs can be harmful in several fundamental ways. The HAB problem and its impacts are as diverse as are the causes and underlying ecological factors leading to blooms. HABs may be caused by the explosive growth of a single species that rapidly dominates the water column, but may also be the result of highly toxic cells that do not necessarily accumulate in high numbers. They may cause direct lethal or sublethal effects to all age classes as well as foetuses due to the action of the toxin(s). Some of the algal toxins are among the most potent known, but there is a wide range of potency depending on which algae predominates and the toxin it may synthesise, or the degree of toxicity of that particular algal bloom. These toxins affect cetaceans either directly (inhalation, dermal, aspiration, or through incidentally ingested toxic waters) or because they are transferred through the food chain. Summary figures illustrating the behaviour and food chain transfer for each of the major HAB species and their toxins relevant to cetaceans are given in Appendix 1. A survival and growth strategy that is important to many HAB species is a complex life cycle, or a life cycle involving resting or benthic stages, such as spores or cysts. These life cycle stages provide a recurrent seed source or inoculum for planktonic populations and this characteristic may be a critical factor in determining not only the geographic distribution of species, but also how it may proliferate when future conditions become favourable.

Understanding the interactions between the environmental factors favouring HABs, when, why and which toxins may be produced and how they may affect cetacean health is difficult. Not only is there wide diversity in HAB species and toxin type, rate of production, extent to which it is labile or stable in the environment and how it is transferred through the ecosystem, but there is also large disparity in availability of data about these HABs, the environment, and their toxins upon which relationships can be investigated. Some regions have excellent coverage of HAB abundance but little data on toxicity, or in other cases toxins may be detected in animals but the source of the HAB may be difficult to unravel due to spatial or temporal offsets. More often sampling of all of the relevant parameters, both with respect to the HABs and the cetaceans, has not been made at the appropriate temporal or spatial scale or with the right methodologies to directly assign cause and effect relationships.

A wide array of initiatives, programmes and expertise in the HAB and phytoplankton community is available to cetacean biologists and the IWC regarding the exposure to, risks of, and the impact of HABs to cetaceans. These are summarised in Figure 2.

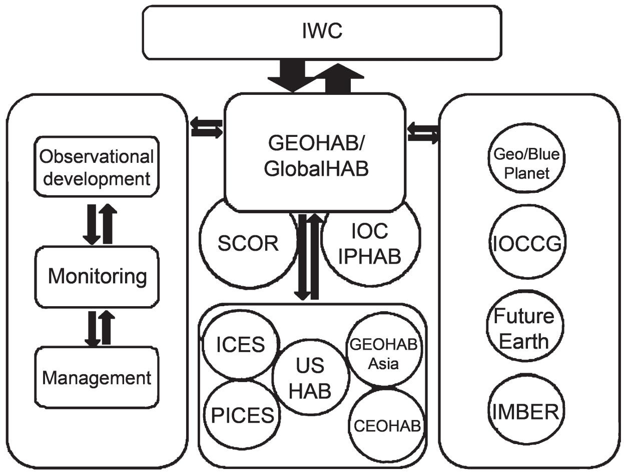


Fig. 2. IWC and contracting governments might interact with the international GlobalHAB Programme (formerly GEOHAB). GlobalHAB/ GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) cooperates and coordinates with other relevant national, regional and international programmes. SCOR=Scientific Committee on Oceanic Research; IOC IPHAB=Intergovernmental Oceanographic Commission Intergovernmental panel on HABS; ICES=International Council for the Exploration of the SEA; PICES=North Pacific Marine Science Organization; IOCCG=International Ocean-Colour Coordinating Council; IMBER= Integrated Marine Biogeochemisty and Ecosystem Research.

4.4.1 Mechanisms underlying toxin production

The regulation of toxin production by HABs is complex because blooms often consist of multiple algal species, with temporal and spatial variation in species dominance that may be driven by changes in nutrient conditions or water mass. The presence of toxic or non-toxic haplotypes within a given species may undergo succession over the course of a bloom (Beversdorf *et al.*, 2016; Erdner *et al.*, 2011). Different algal species may display constitutive or inducible toxin expression, and a complex, dynamic bacterial community that occurs within algal blooms may influence toxin production (Anderson *et al.*, 2012; Kodama *et al.*, 2006; Van Dolah *et al.*, 2009). In spite of these complexities, progress has been made in understanding the regulation of toxin production in HABs. Many cyanobacteria genomes have now been sequenced, revealing toxin biosynthetic gene clusters that may lend themselves to understanding and monitoring bloom toxicity. For example, the regulation of the microcystin gene cluster by the central nitrogen regulator (ntcA) is now understood to link microcystin biosynthesis to high intracellular carbon (C)/nitrogen (N) ratios (Beversdorf *et al.*, 2015). In contrast to cyanobacteria, toxin biosynthesis in many dinoflagellates appears to be more or less constitutive, but different bloom phases may be dominated by clonal haplotypes that may differ in innate toxin levels. Although numerous polyketide synthases have now been identified in brevetoxin and ciguatoxin producing dinoflagellates, their regulation is largely unexplored, due in part to their enormous genomes that to date have prevented genome sequencing (Kellman *et al.*, 2010; Kohli *et al.*, 2017). In blooms of the diatom *Pseudo-nitzschia*, domoic acid toxicity can be quite variable spatially and temporally, in part because of the presence both toxic and non-toxic *Pseudo-nitzschia* species, but possibly also because of co-occurring bacteria that may contribute to domoic acid biosynthesis. Production of domoic acid correlates with a decrease in diversity of the bloom-associated bacterial community, which may indicate that DA selects for specific bacteria or that selected bacteria contribute to toxicity (Sison-Mangus *et al.*, 2014). Current research efforts are directed at unravelling the pathway of DA biosynthesis and the possible role of bacteria. Other factors have been also demonstrated to play a role in DA biosynthesis, such as iron, copper, or silica limitation, and oxidative stress (Lelong *et al.*, 2012), illustrating that multiple, likely interactive, triggers for DA production exist.

4.4.2 Potential issues of toxin exposure for cetacean mortality and morbidity

The HAB toxins of concern for cetaceans, together with the major phytoplankton groups that produce them were reviewed by the Workshop. The most important routes of exposure, health effects and the reported evidence that indicates exposure or mortality in marine mammals are given in Table 1.

4.4.3 Implications of climate change for HABs and their toxins

Climate determines environmental factors regulating algal growth, including water temperature, water transport

Table 1

Summary of HAB toxins of concern for cetaceans, routes of exposure, mechanisms of action, signs and symptoms based on knowledge in other mammals, exposure or mortality evidence and regions where interactions between the various HABs and cetaceans are likely to occur.

Toxin	Causative functional groups and common genera	Route of exposure	Mechanism of action	Target	Likely signs and symptoms in marine mammals	Evidence of exposure in cetaceans	Evidence of mortality in cetaceans	Habitat	Region
Brevetoxins[1]	Dinoflagellates *Karenia brevis*; *Karenia* spp.	Aerosol; oral: shellfish, finfish	Neurotoxic; sodium channel activator	Brain; neuromuscular junctions; pulmonary system; immune system	Listlessness, difficulty righting, acute mortality of robust, healthy individuals	Yes	Yes	Coastal, oceanic	*K. brevis* prevalent in Gulf of Mexico; other *Karenia* spp. present elsewhere in temperate, eutrophic waters
Ciguatoxins[1]	Dinoflagellates *Gambierdicsus* spp.	Oral: reef fish	Neurotoxic; sodium channel activator	Brain; neuromuscular junctions; heart	Acute: nausea, vomiting, dysthermia. Chronic: fatigue, possibly inappetence	No	No	Coral reef	Patchy global distribution in tropics
Domoic acid[2]	Diatoms *Pseudo-nitzschia* spp.	Oral: shellfish, herbivorous fish; benthic inverte-brates	Neurotoxin; glutamate receptor agonist	Brain, heart	Seizure, intense scratching, head weaving; presence in odd locations, cardiomyopathy, abortion, eosinophilia	Yes	Yes	Coastal oceanic; prevalent in upwelling regions	Broad distribution globally; upwelling coasts
Saxitoxins[2]	Dinoflagellates and cyanobacteria *Alexandrium* spp.; *Gonyaulax* spp; *Gymnodinium* spp.	Oral: shellfish; finfish	Neurotoxic; sodium channel blocker	Brain; neuromuscular junctions	Acute mortality	Yes	Yes	Coastal, oceanic	Global
Diarrhetic shellfish toxins[1]	Dinoflagellates *Dinophysis*, *Prorocentrum* spp.	Shellfish	Phosphatase inhibitor	GI tract	Unknown in marine mammals; GI illness in humans	Yes	No	Coastal, oceanic	Global
Microcystins/other cyclic peptides; *Cylindrospermopsin* Nodularin[2]	Cyanobacteria *Microcystis* spp. *Nodularia* spp. *Cylindrospermopsis* *Dolichospermum* spp. *Aphanizomenon* spp.	Water; benthic invertebrates	Phosphatase inhibitor	Liver	Icterus of oral mucous membranes; elevated serum bilirubin; hepatic necrosis	No	No	Usually freshwater, with coastal impacts, in nutrient enriched waters	Global in eutrophic lakes; potential for estuarine/coastal waters; in runoff entering estuarine/coastal waters
Anatoxins	Cyanobacteria *Nodularia* spp. *Cylindrospermopsis* *Dolicho-spermum* spp. *Aphanizomenon* spp. *Planktothrix* spp., *Lyngbya* spp.	Water; benthic invertebrates	Neurotoxic; nicotinic acetylcholine receptor agonist	Brain peripheral nerve function	Unknown in marine mammals	No	No	Usually freshwater, estuarin/coastal waters, in nutrient enriched waters	Global in eutrophic lakes; potential for estuarine/coastal waters; in runoff entering estuarine/coastal waters
Palytoxins[1]	Dinoflagellates *Ostreopsis cf ovata*	Aerosol; benthic invertebrates	Neurotoxic; Na:K pump	Brain; skin	Unknown in marine mammals; neurological symptoms and dermatitis in humans	No	No	Benthic community in rocky substrates	Reefs; emerging issue in Mediterranean
Lyngbya toxins[2]	Cyanobacteria Lyngbyatoxin A Debromoaplysia toxin	Benthic forage	Irritant	Skin	Skin lesions	No	No	Benthic over-growth of reefs, mud and sand flats, seagrass beds	Temperate to tropics

[1]Toxin is lipophilic. [2]Toxin is hydrophilic.

circulation patterns (advection, upwelling and stratification), in turn affecting mixing and stabilisation and thus exposure of photosynthetic organisms to illuminated and nutrient rich layers of the water column. In addition, human activities have altered coastal environments affecting nutrients and circulation patterns. Thus, collectively these climate and anthropogenic changes have affected the composition of the algal community and the trophic structure and function of marine ecosystems at global, regional and local scales. Once a bloom is initiated, physical processes controlling bloom transport are of paramount importance. Coastal currents driven by wind, river inflow, buoyancy or other factors can transport blooms hundreds or even thousands of kilometres along the coast, often from one management area to another. Winds, tides, currents, fronts and other environmental features can create discrete patches or streaks of cells at all scales. The retentive nature of some semi-enclosed coastal systems, such as estuaries, sounds and fjords, can produce long residence times leading to prolonged periods suitable for cells to thrive. Substantial advances have been made over the past decade in unravelling all of these interactions but there is still much that is not understood (Wells *et al.*, 2015).

Cyanobacteria exhibit optimal growth rates and bloom potentials at relatively high water temperatures; hence global warming plays a key interactive role in the expansion and persistence of cyanobacterial blooms (Paerl and Otten, 2013). Additional manifestations of climatic change, including increased vertical stratification, decreased salinity, and intensification of storms and droughts, play synergistic roles in promoting bloom frequency, intensity, geographic distribution and duration. Because we have no immediate control on climatic changes, nutrient input reductions are the key management strategy for mitigating CyanoHABs (Paerl and Otten, 2016). Furthermore, rising temperatures cause shifts in critical nutrient thresholds at which cyanobacterial blooms can develop; thus, nutrient reductions for CyanoHAB control may need to be more aggressively pursued as they respond to climatic changes taking place worldwide ((Paerl *et al.*, 2016).

Eukaryotic marine HABs, including *Pseudo-nitzschia*, recently have been associated with anomalously warm water ocean conditions. An analysis of historical records of shellfish closures due to elevated domoic acid, have shown that the longest closures due to the most intense blooms occur during or immediately following warm water years, including El Niño events and the anomalously warm 'Blob' of 2015 that resulted in a coastwide closure of shellfish harvest along the Pacific coast of North America (McCabe *et al.*, 2016; McKibben *et al.*, 2017). In addition, other climactic factors, such as the reduction of ocean pH known colloquially as 'ocean acidification', will result in a higher domoic acid quota per cell for *Pseudo-nitzschia australis* blooms (Sun *et al.*, 2011; Wingert, 2017).

4.5 Conclusions and recommendations

Following the presentations there was a discussion about mapping and whether a HAB 'hotspot' map would be useful for predicting impacts of HABs on cetaceans, and if so, what should be included. However, it was not clear what spatial or temporal scales to use, what oceanographic, nutrient or HAB occurrence information should be included, nor what quality or type of cetacean data should be overlain on such a map. It was concluded that there were many resources on HAB distribution available online, and thus what would be more useful would be a list of contacts in the HAB community, by country or region, that could be contacted by cetacean scientists and managers who might require advice and guidance during response to an unusual event in cetaceans that they may suspect is associated with exposure to HAB toxins as a causative agent or to evaluate the risks to some populations from HAB impacts.

The Workshop concluded that we need to better understand the risks of HABs for cetaceans through a variety of studies including studies of the contribution of HAB toxins to marine mammal mortality and morbidity. Therefore, data from HAB monitoring, marine mammal strandings and toxin analysis in tissues and environmental samples should be integrated at an appropriate spatial and temporal scale, depending on the particular questions to be addressed. Assistance in this endeavor could be facilitated by the following.

(1) Informing marine mammal scientists of HAB databases by country and region. This will enable them to see real-time data and annual summaries of HAB observations and will allow them to collaborate more closely with HAB scientists who are leading the monitoring programs. Examples of these programs include the Harmful Algal Event Database[2], the SoundToxins database[3]. A 'traffic-light pattern' alerts managers to the real-time threat of HAB toxins in shellfish.
(2) To work with these networks and others to collect routine water samples and prey at sites appropriate for marine mammals, rather than relying on the shellfish monitoring sites that have been set up for human health protection.
(3) To partner with One Health initiatives, such as the database maintained by the CDC[4] which strives to include both human and animal HAB associated illness data.
(4) Include marine mammal scientists in HAB Bulletin (early warning) reporting systems that are developing in the US, Europe and other countries.
(5) Work toward developing integrated programs that integrate monitoring of plankton to use of satellites for bloom detection. This could include data from animal-borne conductivity, temperature and depth sensors that are now being deployed on a variety of marine mammals, including cetaceans such as beluga whales (*Delphinapterus leucas*) (Lydersen *et al.*, 2002).

The Workshop **recommended** cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR and other HAB groups (Fig. 2). This could be done, for example, through the ICES Working Group community. ICES has a Marine Mammal Ecology Working Group and a Working Group on Harmful Algal Bloom Dynamics and PICES has a section on HABs. GlobalHAB (formerly GEOHAB) is an international programme focusing on HAB population dynamics, ecology, as well as development of predictive models and improved understanding of toxins and their effects[5]. The Workshop **recommended** that more communication and active information exchange could be facilitated through these groups and their respective agendas.

The Workshop noted the rapid global expansion of aquaculture systems that enrich nutrients into these environments that trigger phytoplankton blooms, including

[2]HAE-DAT, an annual summary database led by researchers in many countries, *http://www.haedat.iode.org*.
[3]*http://www.soundtoxins.org* that includes real-time HAB data from WA State and Alaska with the State of Oregon to join soon.
[4]*https://www.cdc.gov/onehealth/*.
[5]*http://www.geohab.info*.

HABs that can alter coastal habitats. The Workshop therefore **recommended** that countries using open aquaculture and pond systems near coastal areas consider the ecosystem changes from these industries that might negatively impact cetacean health through enhancement of HABs. The Workshop suggested that development and operation of this industry follow best management practices to reduce impacts of the activities on the local and regional cetacean environment.

5. HEALTH IMPACTS OF HAB TOXINS ON CETACEANS

5.1 Review of health effects of toxins on marine mammals

Harmful algal blooms are increasing globally, and toxins they produce have been conclusively associated with large-scale mortality events in marine mammals (Bossart *et al.*, 1998; Scholin *et al.*, 2000). Effects of toxins on cetaceans are less well-understood, due to more limited opportunities to examine live and freshly dead animals to identify lesions and detect associated toxin. The mere presence of a biotoxin in marine mammal tissue or fluids does not necessarily allow attribution of biotoxin exposure as the sole cause of death; in many instances it is possible that multiple stressors may have contributed to mortality. The first biotoxin suspected to impact marine mammals was ciguatoxin, which was detected in liver samples by mouse bioassay from two Hawaiian monk seals (*Neomonachus schausinlandii*) sampled during a die-off of 50 seals on Laysan Island in 1978 (Gilmartin *et al.*, 1980). Since then ciguatoxin has been detected in blood of 19% of 55 live seals using the Neuro 2A cytotoxicity assay, raising concerns about the potential of sub-clinical impacts (Bottein Dechraoui *et al.*, 2011). In 1987, the deaths of 14 humpback whales (*Megaptera novaeangliae*) off Cape Cod, Massachusetts, USA, was attributed to saxitoxin, as this toxin was detected in stomach contents of two whales and in mackerel from the area (Geraci *et al.*, 1989). In the same year, mass mortality of bottlenose dolphins along the eastern seaboard of the US was associated with brevetoxin exposure, although later analyses revealed cetacean morbillivirus in these animals. Since then, brevetoxin has been associated with multiple mortality events of bottlenose dolphins in the Gulf of Mexico and along the east coast of the US, with epidemics of morbillivirus occurring concurrently in some years (Fire *et al.*, 2015; Flewelling *et al.*, 2005; Twiner *et al.*, 2012). Brevetoxin exposure can alter *in vitro* activity of some lymphocyte populations, suggesting that interactive effects of biotoxin exposure and viral infection likely occur (Gebhard *et al.*, 2015; Walsh *et al.*, 2015). Saxitoxin also alters *in vitro* proliferation of harbour seal (*Phoca vitulina*) T lymphocytes and their susceptibility to morbillivirus infection (Bogomolni *et al.*, 2016). Saxitoxin was associated with a multispecies die off (invertebrates, fish, seabirds, harbour and grey seals, harbour porpoise, beluga and fin whales) in the Gulf of St Lawrence in 2008 (Starr *et al.*, 2017), and with death of Mediterranean monk seals in 1997 (Reyero *et al.*, 1999). It was also detected in gastrointestinal contents from two of over 300 sei whales stranded in the Golfo de Penas in southern Chile in 2015 (Haussermann *et al.*, 2017). However, in these mortality events (Mediterranean monk seal, sei whale, Gulf of St Lawrence cetaceans) no characteristic lesions were identified. Saxitoxin has also been reported in faeces of Northern right whales, raising concerns about potential impacts on reproduction (Doucette *et al.*, 2012). The most detailed information on health effects in marine mammals associated with biotoxin exposure comes from examination of California sea lions (*Zalophus californianus*) stranding during *Pseudo-nitzschtia* blooms. High levels of domoic acid in body fluids have been associated with mortality, neuronal necrosis in the hippocampus and cardiomyopathy. More chronic and latent effects observed in sea lions include epilepsy due to hippocampal atrophy, impaired spatial navigation, memory loss, reproductive failure and circulatory eosinophilia (Brodie *et al.*, 2006; Cook *et al.*, 2015; Goldstein *et al.*, 2008; Thomas *et al.*, 2010). Cetaceans have stranded along the California coast during these blooms, but even though some have high levels of toxin in gastrointestional contents or urine, typical pathological lesions associated with domoic acid toxicity have not been described (De La Riva *et al.*, 2009; Fire *et al.*, 2010). This may be due to the acute neurotoxic effects and rapid death that may be occurring in these animals combined with decomposition state of many stranded cetaceans. A biotoxin recently reported to have caused hepatic necrosis and death in Monterey Bay, California sea otters is microcystin associated with run off of freshwater cyanobacteria blooms (Miller *et al.*, 2010).

5.2 Learning from the effects on human health and linkages to cetacean health

In both humans and marine mammals, the major routes of exposure to HABs are via ingestion, inhalation, and dermal contact[6]. Understanding the way that human HAB associated illnesses present and are investigated, described below, provides insights into approaches for cetacean HAB associated illnesses or mortality investigations. The first, ingestion, is the route of exposure in humans most often caused by the consumption of contaminated shellfish (primarily for PSP, NSP, DSP, ASP, AZP[7]) although some poisonings occur through the consumption of finfish (CFP[2], and perhaps brevetoxin) (Berdalet *et al.*, 2015). However, the only biomarker of exposure is through the recovery of the partially consumed food, which is infrequently recovered by physicians or emergency room attendants. The food poisonings have different rates of onsets, different symptoms, and different resonance time in the body depending on the associated toxin. All of the toxins are tasteless and odourless and resistant to both heat and cold. The second route of exposure is through inhalation (primarily for *Karenia* red tides, cyanobacteria, and *Ostreopsis*) and can have upper respiratory effects such as nasal congestion, rhinorrhea, and cough. *Karenia brevis* aerosols have an impact on the lower airways of people with asthma and can cause decreased pulmonary function and increased symptoms for three-five days after a one-hour exposure. Hospital admissions for both respiratory illness and gastrointestinal illness have been documented during a *Karenia* bloom. Given the unique anatomical and physiological adaptations in the respiratory tract of cetaceans, the inhalation or aspiration of toxin at the air/sea interface is of high concern. The toxin load may be much higher than any air measurements taken on land. Dermal exposure is the third route of exposure and although there have been anecdotal reports of swelling of the mucous membranes and skin rashes, little epidemiology has been conducted to date in humans and no studies in cetaceans.

[6]Two basic definitions when discussing public health are: (a) epidemiology, the application of the scientific method to study the occurrence or risk of adverse health outcomes in populations; and (b) surveillance, the processes of collecting, analysing, and disseminating data on specific health effects.

[7]PSP=Paralytic Shellfish Poisoning, NSP=Neurotoxic Shellfish Poisoning, DSP=Diarrheic Shellfish Poisoning, ASP=Amnesic Shellfish Poisoning, AZP=Azaspiracid Shellfish Poisoning, CFP=Ciguatera Shellfish Poisoning.

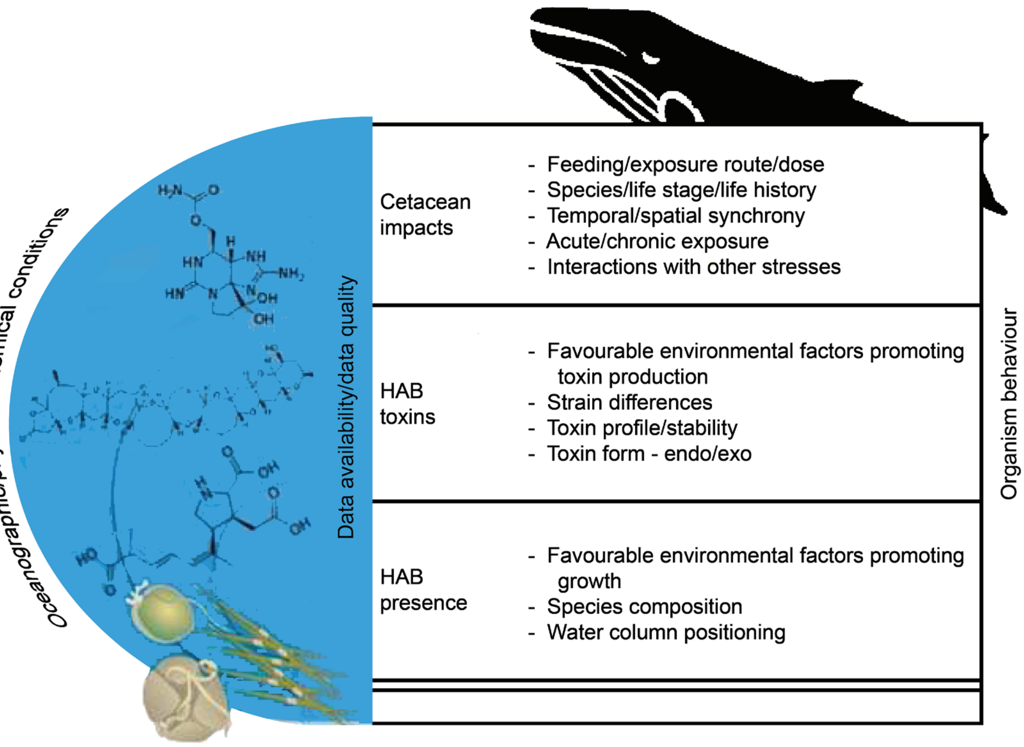


Fig. 3. Summary of factors affecting harmful algal bloom (HAB) presence, HAB toxins and impacts on cetaceans.

Many of the compounding issues when investigating a human exposure to a HAB are also true for marine mammal investigations. Often, little is known about the duration and dose of the exposure, the toxicity of the bloom, overall health prior to the exposure, and exposures to other possible contaminants concurrently (for example, in the case of people with asthma, exposure to pollen, dust and other allergens).

The traditional tool for bloom detection and monitoring has been microscopic enumeration from water grab samples. This requires a skilled microscopist and reporting can be delayed by several days. Remote sensing can also be a useful tool in bloom detection and tracking assuming that the bloom is at the surface and is dense enough to be detected. Given the critical need for an operational and near real time reporting system for beaches and human health, newer methods that are not designed for regulatory purposes but for bloom tracking and intensity assessment are currently in use in some areas (Mote's Beach Conditions Reporting System and HABscope). The Workshop encourages the HAB monitoring community to continue to develop monitoring methods that provide the spatial and temporal coverage needed to adequately understand human and animal exposures.

5.3 Investigative approaches

Linking HABs and their toxins to cetacean impacts is difficult because of the multiple species (HABs and cetaceans) involved, varying oceanographic conditions and organismal biology, and data availability and data quality at all levels (summarised in Fig. 3).

5.3.1 Review of HAB detection methods

To determine the geographic distribution of offshore phytoplankton blooms, satellite chlorophyll imagery (e.g. MODIS) is useful. However, because all phytoplankton cells contain chlorophyll, including chlorophyll a and accessory pigments that have optimal wavelengths for light harvesting, satellite images are generally not useful for distinguishing phytoplankton of different genus or species. However, algorithms have been developed to detect certain phytoplankton that sometimes form visible blooms, such as *Karenia brevis* off the Florida coast and *Pseudo-nitzschia* off the California coast. It is necessary to ground truth these satellite images by collecting field samples to ensure the accuracy of satellite detection. The detection of a genus or species by satellite and algorithm in one geographical region does not ensure that the algorithm developed for this area will work well in another part of the world. In addition, satellite imagery cannot be accessed on cloudy days and is not accurate close to shore where turbidity impacts sensor accuracy.

5.3.2 Review of phytoplankton and toxin exposure detection methods

Detection methods for HAB toxins include ELISA, receptor binding assay and liquid chromatography mass spectrometry. The limitations of each assay should be understood and proper controls must be used prior to their use. For example, ELISAs can be subject to matrix effects (false positives due to compounds in particular tissues or fluids) and must be used at proper dilutions in order to eliminate the possibility of false positive readings. In addition, ELISA results do not always correlate with total toxicity but correlate with affinity of an antibody to a particular toxin structure. For example, a saxitoxin ELISA will not recognise all toxin isoforms equally (e.g. STX, neosaxitoxin, gonyautoxins). In contrast, because domoic acid is the major isomer produced by the various species of *Pseudo-nitzschia*, the domoic acid ELISA assay is effective in estimating total toxicity. Other methods for toxin testing are the receptor binding assay (most typically used for saxitoxin analysis) that measures total toxicity and is based upon the recognition of the toxin by a purified receptor, usually from rat or pig brain. The liquid chromatography mass spectrometry method measures individual toxins with high molecular specificity and detection sensitivity. The choice of method(s) to be used depends upon equipment available, needs for screening large numbers of samples, and the need for absolute quantification or estimation of toxins in a particular sample.

Cell-based detection of organisms is most typically done using light microscopy. The disadvantage of light microscope detection is that often organisms can be detected only to the genus level. Identification to the species level often requires molecular probes or higher magnification to see fine organismal structure, through the use of scanning electron microscopy. Often detection to the genus level using light microscopy is used in conjunction with toxin detection. For example, the genus *Pseudo-nitzschia* has >32 species, each with different cellular toxin levels, therefore toxicity cannot be predicted merely by cell observation. Light microscopy can be used to determine whether a threshold abundance of cells is reached, at which time toxin testing is performed to confirm whether or not domoic acid is present.

An example of how the current detection methods that are being used for surveillance was given in a study to document the exposure of a range of cetaceans inhabiting Scottish waters to the neurotoxin, domoic acid (DA) (SC/67a/E02). Overall, approximately 40% of the individuals screened (n=158) had detectable DA in their urine or faeces. This included 12 different species, such as harbour porpoise, long finned pilot whale, minke whale, white-beaked dolphin and sei whale. DA levels were generally low (median ~2ng/g or ng/ml) but concentrations in excreta were difficult to interpret as time since exposure was not known. One harbour porpoise had a very high level in its urine (~2,500ng/ml) suggesting in at least one case exposure was at acutely toxic levels. However, these results were from stranded animals that, at post mortem examination, died of various causes and were not associated with any obvious signs of neurotoxicity, suggesting the overall exposure is likely to be low level but possibly chronic. *Pseudo-nitzschia* spp. diatoms are now highly prevalent in Scotland throughout the year and may produce large toxic blooms during the summer months. The consequences of prolonged DA ingestion for the health of individuals and cetacean populations in this region remains unknown.

5.3.3 Use of 'omics approaches for health, physiology and biomarker identification in cetaceans

'Omics, or systems biology approaches, have evolved over the past two decades into powerful tools to aid in understanding how biological networks respond to perturbations (Veldhoen *et al.*, 2012). Genomics, transcriptomics, proteomics and metabolomics have been successfully applied to gain insight into physiological processes in marine mammals, such as diving physiology and fasting, and responses to contaminant exposure. The advancement in instrumentation (sequencing, mass spectrometry), bioinformatic algorithms (for analysing genomic and proteomic data), and public databases of DNA sequences, peptide profiles, and metabolites, continues at a rapid pace that will make 'omics approaches increasingly tractable for non-model organisms such as marine mammals. Transcriptomic and proteomic profiles in blood, now routinely used in human medicine to identify prognoses of cancer, heart disease, and other diseases and exposures, make blood a compelling tissue to monitor in accessible marine mammals for exposure and disease status (Morey *et al.*, 2016). However, blood sampling in free ranging cetaceans is problematic, making blubber, skin, and breath the subjects of current research. The use of 'omics to investigate biotoxin exposures is limited to date, but these methods hold promise for the development of biomarkers that can inform us of the role of biotoxins in unexplained mortality events or the extent of chronic exposures within marine mammal populations. Both blood transcriptomes and serum proteomes can identify domoic acid poisoning in California sea lions (Mancia *et al.*, 2012; Neely *et al.*, 2012); however, neither approach has yet been developed into robust tests that can be applied in clinical or field settings. Transcript profiles in blubber and skin biopsies have been interrogated with some success to identify indicators of contaminant exposure (Van Dolah *et al.*, 2015), but require further development and validation, and have not yet been used to investigate biotoxin related events. Metabolomic profiling of volatiles in exhaled breath from bottlenose dolphins shows promising results that this method can identify metabolic responses indicative of oil exposure (Pasamontes *et al.*, 2017); however, sampling techniques for large free ranging cetaceans will require additional development. All 'omics approaches need the establishment of 'healthy' profiles and insight into natural variation that allows the identification of alterations indicative of adverse health. In human medicine, databases of 100's to 1,000's of profiles are used. The investment in such baseline information in marine mammals is needed. Publicly available databases are already in place that can accommodate data sharing.

5.3.4 Strategies to investigate die-offs potentially attributable to HABs

When faced with an unusual cetacean event, it is often unclear what the causative agent(s) might be and in some cases the scientists dealing with the event may suspect that HABs and their toxins may be involved. An unusual event may raise concern because it is higher than expected, or may be different in some way but it is important to have baseline data for comparison.

The major steps in an investigation strategy are given in Table 2. In addition to this strategy, there are other resources available to help guide an investigation such as Canadian Cooperative Wildlife Health Centre (2007).

5.3.5 Chronic, acute and interactive effects

Currently, the best information detailing chronic, acute and interactive health effects of HAB toxins on marine mammals is for domoic acid. California sea lions show acute, chronic and latent effects (Goldstein *et al.*, 2008; Gulland *et al.*, 2012), but there is still a need to characterise developmental effects (Lefebvre *et al.*, 2017). Rodent studies show developmental effects of peri-natal exposure, suggestive of memory loss, demyelination, and ataxia (Doucette *et al.*, 2004). Toxicological effects are dependent upon the day of exposure. In humans, the regulatory levels of 20 ppm is probably insufficient to protect the developing foetus, with suggestions that perhaps pregnant women should be advised to avoid all potential DA ingestion. The effects of HABs and their toxins on the developing foetus in exposed cetaceans needs to be considered and further studies in this area should be encouraged.

Chronic and latent cases are frequently not spatially or temporally associated with HABs (Goldstein *et al.*, 2008) and are difficult to detect and investigate. Mixed exposures are beginning to be investigated (Fire *et al.*, 2011) as are issues of cumulative effects, particularly interactions between pesticides or contaminants and HAB toxins together which may result in synergistic effects (Tiedeken and Ramsdell, 2010).

5.3.6 From concentrations to impacts (including modelling)

The Workshop reviewed a summary of cetacean mortality events in the US that have been attributed to HAB toxins, focusing on the multiple bottlenose dolphin die-offs associated with exposure to brevetoxin in the northern Gulf of Mexico.

Table 2

Main stages in an investigation of die-offs potentially related to HABs and their toxins.

Stage	Description	Comments
Strandings information	Collect basic (level A) data, remembering modifications may be needed if strandings are live	Species, sex, decomposition code, age class structure and/or size
	External and internal exam to rule out trauma, obvious infectious disease and potentially determine lesions (including histopathology)	Photographs
	Nutritional condition	
Sample collection (animal)	Fluids	Urine (preferred), faeces, aqueous humour, cerebrospinal fluid, milk, amniotic/allantoic fluid
	Tissues for analyses	Liver, kidney, foetus
	Presence of GI contents and status of GI tract	GI contents for prey ID – take multiple replicate samples for confirmatory testing
Location	GPS location of carcasses or live stranded animals	
	Geography – site characteristics (tide line, position, etc.)	
Timing/seasonality, duration of event	Environmental information such as wind, currents, weather, visual bloom, other species involved, anthropogenic activities (Navy, fishing fleet, oil spill, contaminant spill, fish farms etc.)	Including personal accounts/observations of the scene and any observed human symptoms
Sample collection (environment)	Water samples, sediment	
	Prey sampling – whole, and ideally at the same time as water sampling	
Environmental sample shipment, analysis and storage (dark, cold options)	Archive for future testing where appropriate	
Remote sensing data (noting limitations of satellite imagery), algal identification, or toxin levels	Contact GlobalHAB for expertise to guide local knowledge, laboratories	A local laboratory may not have capacity for toxin identification – can get connected to ICES/PICES working group or GlobalHAB to identify contacts
Synthesize findings into a report	Even negative findings are important to report	Potentially convene an interdisciplinary team in-person meeting to put all data together and develop report
Post-event monitoring plan	Temporal trophic-level effect	

The Workshop also discussed the findings from live bottlenose dolphin health assessment studies, as well as findings from strandings of multiple cetacean species, in which urine/faeces samples were screened for algal toxins (primarily, brevetoxin and domoic acid). It was concluded that there is evidence that cetaceans along the majority of the US coast have been exposed at some point in time to algal toxins. In some cases (e.g. bottlenose dolphins in Sarasota Bay and St. Joseph Bay, Florida), there is evidence for concurrent exposure to multiple toxins over several years. While the exposures in some cases have led to mortality events and/or sublethal effects, many of the measured toxin concentrations are fairly low and it is unclear whether or not the exposures have been sufficient to lead to adverse health effects. This suggests a need to develop approaches for conducting both individual- and population-level risk assessments. A number of examples of modelling approaches have been previously pursued to better understand pathways for HAB toxin exposure, and for characterising potential risk of mortality and/or morbidity under various exposure scenarios. Examples included a bioenergetic model and a food web model to examine variation in HAB exposure related to life-stage (and associated energetic requirements), and in relation to prey composition and food web dynamics (Bejarano *et al.*, 2008). An example of a spatially-explicit individual-based model to characterise population-level risk was also discussed.

5.4 Conclusions and recommendations

One of the primary information needs for better understanding the health risks for cetaceans from algal toxins is an understanding of the dose-response relationships for both sublethal and lethal effects across the multiple toxin groups. While development of dose-response relationships may be unfeasible for any cetacean species, data could be synthesised from multiple sources including laboratory experiments of other species as well as measured concentrations from marine mammals with confirmed acute toxicosis (both cetaceans and pinnipeds), as well as control cases without evidence of HAB-related disease. The Workshop **recommended** such datasets be identified or developed and synthesis approaches be pursued as a priority.

Other data gaps relate to exposure assessment and include prey preferences and/or composition and range of toxin concentration in important prey species. Cetaceans may be particularly vulnerable to aerosolised toxins at the water-air interface due to their unique respiratory physiology, and currently measurements are lacking for aerosolised toxins. The Workshop **recommended** that toxins in prey species (not fillets) be included in surveillance and research studies, as well as toxins in tissues, as these samples may prove to be more valuable in determining exposure due to the very short half-life of many hydrophilic toxins in tissues and excreta.

Characterising exposure is complex, and data needs will be case-dependent, depending on the algal toxin of concern, its receptor, the local food web, and potentially other environmental variables. Note that many of the observed sublethal effects (e.g. immune system perturbations) may interact with other stressors (such as exposure to intracellular pathogens, or chemical contaminants that may influence the toxin binding to common receptors) so interactive effects of algal toxins with other environmental stressors should be considered.

The Workshop **recommended** sampling on a temporal and spatial scale that is relevant to both human health and coastal cetacean health.

The Workshop **recommended** that the development of biomarkers of exposure and effects in relevant (and obtainable) tissues be pursued as a priority.

In relation to current surveillance approaches using the ELISA approach for DA and STX needs to be confirmed by mass spectroscopy and standardisation of methods are **recommended**. The Workshop **recommends** that appropriate limits of detection and limits of quantification with appropriate uncertainty levels be developed for each approach being used.

6. SUMMARY OF CONCLUSIONS

The Workshop concluded that the global distribution and increasing ubiquity of HABs and their toxins has resulted in an increasing risk of impacts on cetaceans, both at the individual health and population dynamics levels. We need to better understand the contribution of HAB toxins to marine mammal mortality and morbidity and that data from HAB monitoring, marine mammal strandings and toxin analysis in tissues and environmental samples should be integrated at an appropriate spatial and temporal scale, depending on the particular questions to be addressed. Assistance in this endeavor could be facilitated by the following.

(1) Informing marine mammal scientists of HAB databases by country and region. This will enable them to see real-time data and annual summaries of HAB observations and will allow them to collaborate more closely with HAB scientists who are leading the monitoring programs. Examples of these programs include the Harmful Algal Event Database[8], the SoundToxins database[9]. A 'traffic-light pattern' alerts managers to the real-time threat of HAB toxins in shellfish.
(2) To work with these networks and others to collect routine water samples at sites appropriate for marine mammals rather than relying on the shellfish monitoring sites that have been set up for human health protection.
(3) To partner with One Health initiatives, such as the database maintained by the CDC[10] which strives to include both human and animal HAB associated illness data.
(4) Include marine mammal scientists in HAB Bulletin (early warning) reporting systems that are developing in the US, Europe and other countries.
(5) Work toward developing integrated programs that integrate monitoring of plankton to use of satellites with appropriate algorithms for bloom detection. This could include data from animal-borne conductivity, temperature and depth sensors that are now being deployed on a variety of marine mammals.

It was concluded that there were many resources available online and that a list of contacts in the HAB community by country or region that could be contacted by cetacean biologists who might require input during an unusual event that they may suspect is associated with exposure to HAB toxins as a causative agent would be useful.

The Workshop noted the rapid global expansion of aquaculture systems that enrich nutrients into these environments that can be a source of HABs themselves and can alter coastal habitats.

Many of the compounding issues when investigating a human exposure to a HAB are also true for marine mammals. Often, little is known about the duration of the exposure, the toxicity of the bloom, overall health prior to the exposure, and exposures to other possible contaminants concurrently.

Linking HABs and their toxins to cetacean impacts is difficult because of the multiple species involved, varying oceanographic conditions and organismal biology, and data availability and data quality at all levels. In addition, the use of 'omics to investigate biotoxin exposures is limited to date, but these methods hold promise for the development of biomarkers that can inform us of the role of biotoxins in unexplained mortality events or the extent of chronic exposures within marine mammal populations. Whilst the acute, chronic and latent effects of DA on marine mammals is now well documented, the impact of chronic low-level exposure and the impact of other HAB toxins is not known. The effects of HABs and their toxins on the developing foetus in exposed cetaceans needs to be considered and further studies in this area would be encouraged.

7. SUMMARY OF RECOMMENDATIONS

The Workshop **recommended** cetacean biologists should link with GlobalHAB, ICES, PICES, SCOR and other HAB groups. This could be done through the working group community. For example, ICES has a Marine Mammal Ecology Working Group and a Working Group on Harmful Algal Bloom Dynamics and PICES has a Section on HABs. The Workshop **recommended** that more communication and active information exchange could be facilitated through these groups and their respective agendas.

The Workshop noted the rapid global expansion of aquaculture systems that enrich nutrients into these environments that can be a source of HABs themselves and can alter coastal habitats. The Workshop therefore **recommended** that countries using open aquaculture and pond systems consider the ecosystem changes that could negatively impact cetacean health. The Workshop suggested that countries ensure development of this industry is in line with best management practices.

The Workshop **recommended** that more communication and active information exchange could be facilitated through these Intergovernmental ocean management groups and their respective agendas.

The Workshop therefore **recommended** that countries using open aquaculture and pond systems consider the ecosystem changes that could negatively impact cetacean health. The Workshop suggested that countries ensure development of this industry is in line with best management practices.

The Workshop noted that although the climate cannot be changed in the short term, nutrient input can be controlled and it **recommended** that efforts to reduce the global use of nitrogen and phosphorus be supported.

While development of dose-response relationships may be infeasible for any cetacean species, data could be synthesised from multiple sources including laboratory experiments of other species as well as measured concentrations from marine mammals with confirmed acute toxicosis (both cetaceans and pinnipeds), as well as control cases without evidence of HAB-related disease. The Workshop **recommended** such datasets be identified or developed and synthesis approaches be pursued as a priority.

The Workshop **recommended** that toxins in prey species be included in surveillance and research studies as well as toxins in tissues as these samples may prove to be more valuable in determining exposure due to the very short half-life of many hydrophilic toxins in tissues and excreta.

The Workshop **recommended** sampling on a temporal and spatial scale that is relevant to both human health and coastal cetacean health.

[8]HAE-DAT, an annual summary database led by researchers in many countries, *http://www.haedat.iode.org*.
[9]*http://www.soundtoxins.org* that includes real-time HAB data from Washington State and Alaska with the State of Oregon to join soon.
[10]*https://www.cdc.gov/onehealth/*.

The Workshop **recommended** that the development of biomarkers in relevant (and obtainable) tissues, both of exposure and of effects, be pursued as a priority.

In relation to current surveillance approaches using the ELISA approach for DA and STX needs to be confirmed by mass spectroscopy and standardisation of methods should be **recommended**. The Workshop **recommends** that appropriate limits of detection and limits of quantification with appropriate uncertainty levels be developed for each approach being used.

8. ADOPTION OF REPORT

The report was adopted at 15:00 on 9 May 2017.

REFERENCES

Anderson, D.A., Cembella, A.D. and Hallegraeff, G.M. 2012. Progress in understanding harmful algal blooms (HABs): Paradigm shifts and new technologies for research, monitoring and management. *Ann. Rev. Mar. Sci.* 4: 143-76.

Anderson, D.A., Glibert, P.M. and Burkholder, J.M. 2002. Harmful algal blooms and eutrophication: Nutrient sources, composition, and consequences. *Estuaries* 25: 562-84.

Bejarano, A.C., Van Dolah, F.M., Gulland, F.M.D., Rowles, T.K. and Schwacke, L.H. 2008. Production and toxicity of the marine biotoxin domoic acid and its effects on wildlife: a review. *Human and Ecological Risk Assessment* 14: 544-67.

Berdalet, E., Fleming, L.E., Gowen, R., Davidson, K., Hess, P., Backer, L.C., Moore, S.K., Hoagland, P. and Enevoldsen, H. 2015. Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century. *J. Mar. Biol. Assoc*: doi:10.1017/S0025315415001733.

Beversdorf, L.J., Miller, T.R. and McMahon, K.D. 2015. Long-term monitoring reveals carbon–nitrogen metabolism key to microcystin production in eutrophic lakes. *Front. Microbiol.* 6: 456.

Beversdorf, L.J., Miller, T.R. and McMahon, K.D. 2016. mcyA and mcyE gene abundances are not appropriate indicators of microcystin concentrations in lakes. *PLoS ONE* 10(5): e0125353.

Boesch, D.F., Burreson, E., Dennison, W., Houde, E., Kemp, M., Kennedy, V., Newell, R., Paynter, K., Orth, R. and Ulanowicz, R. 2001. Factors in the decline of coastal ecosystems. *Science* 293: 629-38.

Bogomolni, A.L., Bass, A.L., Fire, S., Jasperse, L., Levin, M., Nielsen, O., Waring, G. and De Guise, S. 2016. Saxitoxin increases phocine distemper virus replication upon in-vitro infection in harbor seal immune cells. *Harmful Algae* 51: 89-96.

Bossart, G.D., Baden, D.G., Ewing, R.Y., Roberts, B. and Wright, S.D. 1998. Brevetoxicosis in manatees (*Trichechus manatus latirostris*) from the 1996 epizootic: gross, histologic, and immunohistochemical features. *Toxicological Pathology* 26: 276-82.

Bottein Dechraoui, M.-Y., Kashinsky, L., Wang, Z., Littnan, C. and Ramsdell, J.S. 2011. Identification of ciguatoxins in Hawaiian monk seals *Monachus schauinslandi* from the northwestern and main Hawaiian Islands. *Environ. Sci. Technol.* 45: 5403-09.

Brodie, E.C., Gulland, F., Greig, D.J., Hunter, M., Jaakola, J., Leger, J.S., Leighfield, T.A. and Van Dolah, F.M. 2006. Domoic acid causes reproductive failure in California sea lions (*Zalophus californianus*). *Mar. Mammal Sci.* 22(3): 700-07.

Canadian Cooperative Wildlife Health Centre. 2007. Wildlife Disease Investigation Manual. Canadian Cooperative Wildlife Health Centre: Newsletters and Publications, Paper 52.

Carmichael, W.W. 2001. Health effects of toxin-producing cyanobacteria: 'The CyanoHABs'. *Hum. Ecol. Risk Assess.* 7: 1393-407.

Cook, P.F., Reichmuth, C., Rouse, A.A., Libby, L.A., Dennison, S.E., Carmichael, O.T., Kruse-Elliott, K.T., Bloom, J., Singh, B., Fravel, V.A. and Barbosa, L. 2015. Algal toxin impairs sea lion memory and hippocampal connectivity, with implications for strandings. *Science* 350(6267): 1545-47.

De La Riva, G.T., Johnson, C.K., Gulland, F.M., Langlois, G.W., Heyning, J.E., Rowles, T.K. and Mazet, J.A. 2009. Association of an unusual marine mammal mortality event with Pseudo-nitzschia spp. blooms along the southern California coastline. *J. Wildlife Dis.* 45(1): 109-21.

Doucette, G.J., Midulski, C.M., King, K.L., Roth, P.B., Wang, Z., Leandro, L.F., DeGrasse, S.L., White, K.D., De Biase, D., Gillett, R.M. and Rolland, R.M. 2012. Endangered North Atlantic right whales (*Eubalaena glacialis*) experience repeated, concurrent exposure to multiple environmental neurotoxins produced by marine algae. *Environ. Res. Letters* 112: 67-76.

Doucette, T.A., Bernard, P.B., Husum, H., Perry, M.A., Ryan, C.L. and Tasker, R.A. 2004. Low doses of DAoic acid during post natal development produce permanent changes in rat behaviour and hippocampal morphology. *Neurotox. Res.* 6: 555-63.

Erdner, D.L., Richmin, M., McCauley, L.A.R. and Anderson, D.M. 2011. Diversity and dynamics of a widespread bloom of the toxic dinoflagellate *Alexandrium fundyense*. *PLoS One* 6(7): e22965.

FAO. 2013. FishStatJ - software for fishery statistical time series (release date March 2013). Rome: Fisheries and Aquaculture Information and Statistics Service, Food and Agriculture Organization of the United Nations. [Available at: *http://www.fao.org/fishery/statistics/software/fishstatj/en*]

Fire, S.E., Flewelling, L.J., Stolen, M., Durden, W.N., de Wit, M., Spellman, A.C. and Wang, Z. 2015. Brevetoxin-associated mass mortality event of bottlenose dolphins and manatees along the east coast of Florida, USA. *Mar. Ecol. Prog. Ser.* 526: 241-51.

Fire, S.E., Wang, Z., Berman, M., Langlois, G.W., Morton, S.L., Sekula-Wood, E. and Benitez-Nelson, C.R. 2010. Trophic transfer of the harmful algal toxin domoic acid as a cause of death in a minke whale (*Balaenoptera acutorostrata*) stranding in southern California. *Aquat. Mamm.* 36(4): 342.

Fire, S.E., Wang, Z., Byrd, M., Whitehead, H.R., Paternoster, J. and Morton, S.L. 2011. Co-occurrence of multiple classes of harmful algal toxins in bottlenose dolphins (*Tursiops truncatus*) stranding during an unusual mortality event in Texas, USA. *Harmful Algae* 10: 330-36.

Flewelling, L.J., Naar, J.P., Abbott, J.P., Baden, D.G., Barros, N.B., Bossart, G.D., Bottein, M.Y.D., Hammond, D.G., Haubold, E.M., Heil, C.A. and Henry, M.S. 2005. Brevetoxicosis: red tides and marine mammal mortalities. *Nature* 432(7043): 755-56.

Gebhard, E., Levin, M., Bogomolni, A. and DeGuise, S. 2015. Immunomodulatory effects of brevetoxin (PbTx-3) upon in vitro exposure in bottlenose dolphins (*Tursiops truncatus*). *Harmful Algae* 44: 54-62.

Geraci, J.R., Anderson, D.M., Timperi, R.J., St. Aubin, D.J., Early, G.A., Prescott, J.H. and Mayo, C.A. 1989. Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxin. *Can. J. Fish. Aquat. Sci.* 46(11): 1895-98.

Gilmartin, W.G., DeLong, R.L., Smith, A.W., Griner, L.A. and Dailey, M.D. 1980. An investigation into unusual mortality in the Hawaiian monk seal, *Monachus schauinslandi.* Proceedings on status of resource investigation in the northwestern Hawaiian Islands, University of Hawaii, Honolulu, UNIHI-SEAGRANT-MR-80-04: 32-41.

Glibert, P.M. and Burford, M.A. 2017. Globally changing nutrient loads and harmful algal blooms: Recent advances, new paradigms, and continuing challenges. *Oceanography* 30(1): 58-69.

Glibert, P.M., Manager, R., Sobota, D.J. and Bouwman, L. 2014. The Haber-Bosch-Harmful algal bloom (HB-HAB) link. *Environ. Res. Lett.* 9(105001).

Glibert, P.M., Seitzinger, S., Heil, C.A., Burkholder, J.M., Parrow, M.W., Codispoti, L.A. and Kelly, V. 2005. The role of eutrophication in the global proliferation of harmful algal blooms: new perspectives and new approaches. *Oceanography* 18(2): 198-209.

Goldstein, T., Mazet, J.A.K., Zabka, T.S., Langlois, G., Colegrove, K.M., Silver, M., Bargu, S., Van Dolah, F., Leighfield, T., Conrad, P.A. and Barakos, J. 2008. Novel symptomatology and changing epidemiology of domoic acid toxicosis in California sea lions (*Zalophus californianus*): an increasing risk to marine mammal health. *Proc. R. Soc. Lond. B Biol. Sci.* 275(1632): 267-76.

Gulland, F.M., Hall, A.J., Greig, D.J., Frame, E.R., Colegrove, K.M., Booth, R.K., Wasser, S.K. and Scott-Moncrieff, J.C.R. 2012. Evaluation of circulating eosinophil count and adrenal gland function in California sea lions naturally exposed to domoic acid. *J. Am. Vet. Med. Assoc.* 241: 943-49.

Haussermann, V., Gutstein, C.S., Beddington, M., Cassis, D., Olavarria, C., Dale, A.C., Valenzuela-Toro, A.M., Perez-Alvarez, M.J., Sepulveda, H.H., McConnell, K.M., Horwitz, F.E. and Forsterra, G. 2017. Largest baleen whale mass mortality during strong El Niño event is likely related to harmful toxic algal bloom. *Peer J Preprints.* https://doi.org/10.7287/peerj.preprints.2707v1.

Heisler, J., Glibert, P.M., Burkholder, J.M., Anderson, D.M., Cochlan, W., Dennison, W.C., Dortch, Q., Gobler, C.J., Heil, C.A., Humphries, E. and Lewitus, A. 2008. Eutrophication and harmful algal blooms: a scientific consensus. *Harmful Algae* 8(1): 3-13.

Hickey, B.M., Trainer, V.L., Kosro, M.P., Adams, N.G., Connolly, T.P., Kachel, N.B. and Geier, S.L. 2013. A springtime source of toxic Pseudo-nitzschia on razor clam beaches in the Pacific Northwest. *Harmful Algae* 25: 1-14.

Kellman, R., Stüken, A., Orr, R.J.S., Svendsen, H.M. and Jakobsen, K.S. 2010. Biosynthesis and molecular genetics of polyketides in marine dinoflagellates. *Mar. Drugs* 8: 1011-48.

Kodama, M., Doucette, G.J. and Green, D.H. 2006. Relationships between bacteria and harmful algae. pp.243-55. *In*: Graneli, E. and Turner, J. (eds). *Ecology of Harmful Algae*.

Kohli, G.S., John, U., Smith, K., Fraga, S., Rhodes, L. and Murray, S.A. 2017. Role of modular polyketide synthases in the production of polyether ladder compounds in the ciguatoxin-producing *Gambierduscus polynesiensis* and *G. excentricus* (Dinophyceae). *J. Euk. Microbiol.* Early View.

Landsberg, J., Van Dolah, F. and Doucette, G. 2005. Marine and Estuarine Harmful Algal Blooms: Impacts on Human and Animal Health. pp.165-215. *In*: Belkin, S. and Colwell, R.R. (eds). *Oceans and Health: Pathogens in the Marine Environment*. Springer US, Boston, MA.

Lefebvre, K.A., Kendrick, P.S., Ladiges, W., Hiolski, E.M., Ferriss, B.E., Smith, D.R. and Marcinek, D.J. 2017. Chronic low-level exposure to the common seafood toxin domoic acid causes cognitive deficits in mice. *Harmful Algae* 64: 20-29.

Lelong, A., Hégaret, H., Soudant, P. and Bates, S.S. 2012. Pseudo-nitzschia (Bacillariophyceae) species, domoic acid and amnesic shellfish poisoning: revisiting previous paradigms. *Phycologia* 51: 168-216.

Lydersen, C., Nøst, O.A., Lovell, P., McConnell, B.J., Gammelsrød, T., Hunter, C., Fedak, M.A. and Kovacs, K.M. 2002. Salinity and temperature structure of a freezing Arctic fjord - monitored by white whales (*Delphinapterus leucas*). *Geophys. Res. Lett.* 29: 23.

Mancia, A., Ryan, J.C., Chapman, R.W., Wu, Q., Warr, G.W., Gulland, F.M.D. and Van Dolah, F.M. 2012. Health status, infection and disease in California sea lions (*Zalophus californianus*) studied using a canine microarray platform and machine-learning approaches. *Dev. Comp. Immunol.* 36: 629-37.

McCabe, R.M., Hickey, B.M., Kudela, R.M., Lefebvre, K.A., Adams, N.G., Bill, B.D., Gulland, F.M.D., Thomson, R.E., Cochlan, W.P. and Trainer, V.L. 2016. An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. *Geophys. Res. Lett.* 43: doi:10.1002/2016GL070023.

McKibben, S.M., Peterson, W., Wood, A.M., Trainer, V.L., Hunter, M. and White, A.F. 2017. Climatic regulation of the neurotoxin domoic acid. *PNAS* 114(2): 239-44. DOI: 10.1073/pnas.1606798114.

Miller, M.A., Kudela, R.M., Mekebri, A., Crane, D., Oates, S.C., Tinker, M.T., Staedler, M., Miller, W.A., Toy-Choutka, S., Dominik, C. and Hardin, D. 2010. Evidence for a novel marine harmful algal bloom: cyanotoxin (microcystin) transfer from land to sea otters. *PLoS One* 5(9): e12576.

Morey, J.S., Neely, M.G., Lunardi, D., Anderson, P.E., Schwacke, L.H., Campbell, M. and Van Dolah, F.M. 2016. RNA-Seq analysis of seasonal and individual variation in blood transcriptomes of healthy managed bottlenose dolphins. *BMC Genomics* 17: 720-36.

Neely, B.A., Soper, J.L., Greig, D.J., Carlin, K.P., Favre, E.G., Gulland, F.M., Almeida, J.S. and Janech, M.G. 2012. Serum profiling by MALDI-TOF mass spectrometry as a diagnostic tool for domoic acid toxicosis in California sea lions. *Proteome Sci.* 10: 18.

Nixon, S.W. 1995. Coastal marine eturophication: A definition, social causes, and future concerns. *Ophelia* 41: 199-219.

Otten, T.G. and Paerl, H.W. 2015. Health effects of toxic cyanobacteria in US drinking and recreational waters: our current understanding and proposed direction. *Curr. Envir. Health Rpt.* 2: 75-84.

Paerl, H.W. 1988. Nuisance phytoplankton blooms in coastal, estuarine, and inland waters. *Limnol. Oceanogr.* 33: 823-47.

Paerl, H.W. 1997. Coastal eutrophication and harmful algal blooms: Importance of atmospheric deposition and groundwater as 'new' nitrogen and other nutrient sources. *Limnol. Oceanogr.* 42: 1154-65.

Paerl, H.W., Gardner, W.S., Havens, K.E., Joyner, A.R., McCarthy, M.J., Newell, S.E., Qin, B. and Scott, J.T. 2016. Mitigating cyanobacterial harmful algal blooms in aquatic ecosystems impacted by climate change and anthropogenic nutrients. *Harmful Algae* 54: 213-22.

Paerl, H.W. and Otten, T.G. 2013. Harmful cyanobacterial blooms: causes consequences, and controls. *Environ. Microbiol.* 65: 995-1010.

Paerl, H.W. and Otten, T.G. 2016. Duelling 'CyanoHABs': unravelling the environmental drivers controlling dominance and succession among diazotrophic and non-N2-fixing harmful cyanobacteria. *Environ. Microbiol.* 18: 316-24.

Pasamontes, A., Aksenov, A.A., Schivo, M., Rowles, T., Smith, C.R., Schwacke, L.H., Wells, R.S., Yeates, L., Venn-Watson, S. and Davis, C.E. 2017. Noninvasive respiratory metabolite analysis associated with clinical disease in cetaceans: a Deepwater Horizon oil spill study. *Environ. Sci. Technol.* 51(10): 5737-46.

Reyero, M., Cacho, E., Martinez, A., Vazquez, J., Marina, A., Fraga, S. and Franco, J.M. 1999. Evidence of saxitoxin derivatives as causative agents in the 1997 mass mortality of monk seals in the Cape Blanc peninsula. *Nat. Toxins* 7: 311-15.

Ryther, J. and Dunstan, W. 1971. Nitrogen, phosphorus and eutrophication in the coastal marine environment. *Science* 171: 1008-112.

Scholin, C.A., Gulland, F., Doucette, G.J., Benson, S., Busman, M., Chavez, F.P., Cordaro, J., DeLong, R., De Vogelaere, A., Harvey, J. and Haulena, M. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. *Nature* 403(6765): 80-84.

Sison-Mangus, M.P., Jiang, S., Tran, K.N. and Kudela, R.M. 2014. Host-specific adaptation governs the interaction of the marine diatom, Pseudo-nitzschia and their microbiota. *The ISME Journal* 8: 63-76.

Starr, M., Lair, S., Michaud, S., Scarratt, M., Quilliam, M., Lefaivre, D., Robert, M., Wotherspoon, A., Michaud, R., Menard, N., Sauve, G., Lessard, S., Beland, P. and Measures, L. 2017. Multispecies mass mortality of marine fauna linked to a toxic dinoflagellate bloom. *PLoS ONE* 12(5): 26pp.

Sun, J., Hutchins, D.A., Feng, Y., Seubert, E.L., Caron, D.A. and Fu, F.-X. 2011. Effects of changing pCO2 and phosphate availability on domoic acid production and physiology of the marine harmful bloom diatom Pseudo-nitzschia multiseries. *Limnol. Oceanogr.* 56(3): 829-40.

Thomas, K., Harvey, J.T., Goldstein, T., Barakos, J. and Gulland, F. 2010. Movement, dive behavior, and survival of California sea lions (*Zalophus californianus*) post-treatment for domoic acid toxicosis. *Mar. Mamm. Sci.* 26: 36-52.

Tiedeken, J.A. and Ramsdell, J.S. 2010. Zebrafish seizure model identifies p,p-DDE as the dominant contaminant of fetal California sea lions that accounts for synergistic activity with domoic acid. *Environ. Health Perspect.* 118: 545-51.

Trainer, V.L., B.M., H. and Horner, R.A. 2002. Biological and physical dynamics of domoic acid production off the Washington U.S.A. coast. *Limnol. Oceanogr.* 47: 1438-46.

Twiner, M.J., Flewelling, L.J., Fire, S.E., Bowen-Stevens, S.R., Gaydos, J.K., Johnson, C.K., Landsberg, J.H., Leighfield, T.A., Mase-Guthrie, B., Schwacke, L. and Van Dolah, F.M. 2012. Comparative analysis of three brevetoxin-associated bottlenose dolphin (*Tursiops truncatus*) mortality events in the Florida panhandle region (USA). *PLoS ONE* 7(8): e42974.

Van Dolah, F.M., Lidie, K.B., Monroe, E.A., Bhattacharya, D., Campbell, L., Doucette, G.J. and Kamykowski, D. 2009. The Florida red tide dinoflagellate *Karenia brevis*: New insights into cellular and molecular processes underlying bloom dynamics. *Harmful Algae* 8: 562-57.

Van Dolah, F.M., Neely, M.G., McGeorge, L.E., Balmer, B.C., Ylitalo, G.M., Zolman, E.S., Speakman, T., Sinclair, C., Kellar, N.M., Rosel, P.E., Mullin, K.D. and Schwacke, L.H. 2015. Seasonal Variation in the Skin Transcriptome of Common Bottlenose Dolphins (*Tursiops truncatus*) from the northern Gulf of Mexico. *PLoS ONE* 10: e0130934.

Veldhoen, N., Ikonomou, M.G. and Helbing, C.C. 2012. Molecular profiling of marine fauna: Integration of omics with environmental assessment of the world's oceans. *Ecotoxicol. Environ. Saf.* 76: 23-38.

Walsh, C.J., Butawan, M., Yordy, J., Ball, R., Flewelling, L., de Wit, M. and Bonde, R.K. 2015. Sublethal red tide toxin exposure in free-ranging manatees (*Trichechus manatus*) affects the immune system through reduced lymphocyte proliferation responses, inflammation, and oxidative stress. *Aquat. Toxicol.* 161: 73-84.

Wells, M.L., Trainer, V.L., Smayda, T.J., Karlson, B.S.O., Trick, C.G., Kudela, R.M., Ishikawa, A., Bernard, S., Wulff, A., Anderson, D.M. and Cochlan, W.P. 2015. Harmful algal blooms and climate change: learning from the past and present to forecast the future. *Harmful Algae* 49: 68-93.

Wingert, C. 2017. The Effects of Ocean Acidification on Growth, Photosynthesis, and Domoic Acid Production by the Toxigenic Diatom, Pseudo-nitzschia australis. M.S. Thesis, San Francisco State University.

Annex A

List of Participants

C. Scott Baker
Oregon State University

Bob Brownell
NOAA Fisheries

Frank Cipriano
San Francisco State University

Patricia Glibert
University of Maryland

Frances Gulland
The Marine Mammal Center

Ailsa Hall
Sea Mammal Research Unit,
University of St. Andrews

Barbara Kirkpatrick
Gulf of Mexico Coastal Ocean
Observing System

Hans Paerl
University of North Carolina
Chapel Hill

Teri Rowles
NOAA Fisheries

Lori Schwacke
National Marine Mammal Foundation

Claire Simeone
NOAA Fisheries/
The Marine Mammal Center

Raphaela Stimmelmayr
North Slope Borough

Robert Suydam
North Slope Borough

Vera Trainer
NOAA Fisheries

Fran Van Dolah
NOAA Fisheries

Annex B

Agenda

1. Introductory items
2. Appointment of Chair and rapporteurs
3. Review and adopt Agenda
4. Introduction and background
    - 4.1 Harmful algal bloom dynamics and drivers
    - 4.2 Global distribution of HABS
    - 4.3 Major HABs and their toxins of concern for cetaceans
        - 4.3.1 Cyanobacterial HABs
        - 4.3.2 Coastal and Oceanic HABs
    - 4.4 Factors affecting the spread of HABs and their toxins
        - 4.4.1 Mechanisms underlying toxin production
        - 4.4.2 Potential issues of toxin exposure for cetacean mortality and morbidity
        - 4.4.3 Implications of climate change for HABs and their toxins
    - 4.5 Conclusions and recommendations
5. Health impacts of HAB toxins
    - 5.1 Review of health effects of toxins on marine mammals
    - 5.2 Learning from the effects on human health and linkages to cetacean health
    - 5.3 Investigative approaches
        - 5.3.1 Review of HAB detection methods
        - 5.3.2 Review of phytoplankton and toxin exposure detection methods
        - 5.3.3 Use of ‘omics approaches for health, physiology and biomarker identification in cetaceans
        - 5.3.4 Strategies to die-offs potentially attributable to HABs
        - 5.3.5 Chronic, acute and interactive effects
        - 5.3.6 From concentrations to impacts (including modelling)
        - 5.3.7 Conclusions and recommendations
6. Summary of conclusions
7. Summary of recommendations
8. Adoption of Report

Annex C

Harmful Algal Blooms: Input and Distribution[1]

(1) The HAB taxa *Alexandrium* has a complex life cycle and population dynamics. Its most common toxin is saxitoxin which causes paralytic shellfish poisoning. It has been found to impact harbor seals and humpback whales and to be distributed around the world.

(2) The HAB taxa *Karenia* has complex population dynamics and toxins that are carrier in aerosols and stable in the water column and which cause fish kills. Its most common toxin is brevetoxin which causes neurotoxic shellfish poisoning. It has been found to impact manatees and bottlenose dolphin and to be most common in the Gulf of Mexico, although it can be found on other parts of the world.

(3) The HAB taxa *Dinophysis* has a complex life cycle and population dynamics. Its most common toxin is okadaic acid which causes diarrheic shellfish poisoning. It has been found to impact harbor seals and to be distributed around the world.

(4) The HAB taxa *Pseudo-nitzschia* forms large blooms. Its most common toxin is domoic acid which causes amnesic shellfish poisoning. It has been found to impact California sea lions and harbor porpoise and to be distributed around the world.

(5) Cyanobacteria can form dense blooms in surface waters, as well in benthic systems depending on species. The toxin formed is dependent on species. It has been found to impact sea otters and manatees and to be distributed around the world.

(6) Benthic HABs form on coral reef and other rocky or solid benthic surfaces. There are multiple benthic HAB taxa. The toxin formed is dependent on species; the most common is ciguatoxin which causes ciguatera fish poisoning. It has been found to impact Hawaiian monk seals and to be distributed around the world.

[11]See the online-only supplementary material on the IWC website for further information.

INTERNATIONAL
WHALING COMMISSION

The Red House, 135 Station Road, Impington, Cambridge CB24 9NP UK
Tel: +44 (0)1223 233971 Fax: +44 (0)1223 232876
Web page: http://www.iwc.int