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- direct and indirect exploitation
- environmental changes and threats in the context of cetaceans
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Editorial

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

This supplement covers the IWC Scientific Committee's 'year' May 2017 to May 2018. The major focus is the Report of the Committee's Annual Meeting held from 24 April – 6 May 2018 in Bled, Slovenia (SC67b). The meeting was attended by over 230 participants, including 90 invited participants; 30 member nations were represented. It also contains the reports of the following intersessional meetings:

(1) the report of the Planning Meeting for the 2018 and 2019 IWC-POWER (North Pacific Whale and Ecosystem Research) Cruises in the North Pacific, held in September 2016 in Tokyo, Japan;
(2) the consolidated report of two Workshops on the Development of *Strike Limit Algorithms* for the Greenlandic Hunts and work to update the scientific components of the Aboriginal Whaling Scheme, held in October 2017 and March 2018 in Copenhagen, Denmark;
(3) the report of the Workshop 'Resolving Tursiops Taxonomy Worldwide', held in January 2018 in La Jolla, CA, USA;
(4) the report of the Workshop on Western North Pacific Common Minke Whale Stock Structure in Preparation for the Start of the *Implementation Review*, held in February 2018 in Tokyo, Japan;
(5) the report of the Second *Implementation Review* Workshop on Western North Pacific Bryde's Whales, held in February 2018 in Tokyo, Japan;
(6) the report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales, held in March 2018 in Big Sur, CA, USA;
(7) the report of the Workshop on the Poorly Documented Takes of Small Cetaceans in South America: Including In-Depth Review of the Hunting of the Amazon River Dolphin (*Inia geoffrensis*) for the Piracatinga (*Calophysus macropterus*) Fishery, held in March 2018 in Santos, Brazil;
(8) the report of the Workshop on Identifying Key Research Questions for the Modelling and Assessment of Whale Watching Impacts (MAWI), held in April 2018 in La Spezia, Italy;
(9) the report of the Workshop on Assessing the Cumulative Effects of Multiple Stressors on Cetaceans at the Individual and Population Level, held in April 2018 in Bled, Slovenia.

The biennial Commission meeting associated with the 2017 and 2018 Scientific Committee meetings was held in September 2018 in Florianopolis, Brazil (IWC/67). This report and the report of the previous Scientific Committee meeting (SC67a, published in *J. Cetacean Res. Manage. (Supplement) 19* [2018]) were presented and endorsed at the 2018 Commission meeting.

The 2018 Scientific Committee report continues with the updated format which shows recommendations and agreements more clearly, following the consistent template developed by the Scientific Committee Chair, Vice-Chair and Head of Science. An example and explanation are 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.

As usual, the Scientific Committee and its sub-groups covered a wide range of topics during the meeting 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.

A major piece of work was completed that had taken some two decades at the Scientific Committee meeting regarding management advice for aboriginal subsistence whaling (ASW) and therefore I have included a rather more detailed summary than usual for this work. The Committee had begun its work on developing a robust management procedure for ASW in response to a Resolution passed in 1994 (IWC Resolution 1994-4). The Resolution provided objectives for aboriginal subsistence whaling and, *inter alia*, requested the Committee to give high priority to meeting these objectives as part of a long-term management framework for ASW, taking into account the approach already then developed for the Revised Management Procedure (RMP) for potential future commercial whaling should that occur. In response, the Committee spent considerable time and effort to develop the Aboriginal Subsistence Whaling Management Procedure (AWMP) and, in particular, individual *Strike Limit Algorithms* (*SLA*s) to calculate safe removal levels for each hunt subject to ASW that met the Commission's objectives. Feedback mechanisms (regular *Implementation Reviews)* are an essential part of this process, the framework for which has been recognised around the world as perhaps the most rigorous approach to providing advice on the management of natural resources.

Over the years, the Committee developed *SLA*s for all of the ASW hunts and after the 2017 Annual Meeting, intense work was undertaken to finalise for the remaining *SLA*s originally envisaged – those for West Greenland fin whales and West Greenland common minke whales. The Committee successfully completed this work and in 2018 recommended the *SLA*s to the Commission.

In addition, at the 2018 meeting, the Committee reviewed a complex new management plan developed by the USA for a potential ASW Makah hunt of gray whales off Washington State that contained measures to restrict the number of Pacific Coast Feeding Group (PCFG) whales that could be struck or landed in a given 10-year period and to avoid, to the extent possible, striking or killing a Western Feeding Group (WFG) gray whale. After rigorous testing using the modelling framework developed as part of the range-wide review of gray whales, the Committee concluded that the plan did meet the Commission's objectives for ASW. The Committee also completed an *Implementation Review* of the Bering-Chukchi-Beaufort Seas stock of bowhead whales at its 2018 meeting and concluded that the *Bowhead SLA* remained the best approach for providing advice on strike limits.

The other area of work on ASW completed in 2018 concerned the Committee's update of the scientific aspects of an 'Aboriginal Whaling Scheme (AWS) originally presented in 2002. These scientific components cover carryover, block quotas, interim relief allocation, *Implementation Reviews*, guidelines for abundance estimation and other data).

Carryover is a provision to enable some strikes not used in one year to be used in a subsequent year or years, to allow for the inevitable fluctuations in the success of hunts (e.g. due to environmental conditions and/or whale availability). Carryover does not allow hunts to take more than the total number of strikes agreed by the Commission over a specified period. The Committee reiterated its previous advice, applicable for all *SLA*s, that inter-annual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable. It is also evaluating scenarios that '…. allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit.' The Committee was able to test this using the *Bowhead SLA* and *WG-Humpback SLA* and the Committee found that the Commission's conservation objectives were met under these circumstances. It will test the other SLAs during the next biennium.

The Committee reiterated its previous advice that block quotas of up to 8 years were acceptable and that abundance estimates should be obtained every 10 years. It also recommended an interim relief approach for application in exceptional cases where the recommended period of 10 years for abundance estimates is exceeded. This involves a 'grace period' allowing a one-block extension of the existing limits while a new estimate is approved. This has been tested so far for the Bowhead *SLA* and the *WG-Humpback SLA;* testing of the other *SLA*s is on the Committee's work plan. If, in very exceptional circumstances, no acceptable estimate is achieved during the grace period, this would trigger an immediate *Implementation Review*. Regular *Implementation Reviews* (every 5-6 years) are central to the functioning of the AWMP. They review new information to see if new trials are needed and review information required for the SLA, for example, on catches and abundance.

The excellent work of the Scientific Committee on ASW matters was recognised by the Commission at its 2018 biennial meeting and formed the basis for a long-term agreement on such matters.

The RMP, like the AWMP approach was pioneered by the IWC – its philosophy and frameworks are now also being increasingly used in fisheries management (often termed MSE or management strategy evaluations). The Committee developed general guidelines on how to evaluate the effect of special permit catches on stocks and the levels of information needed to show improved management performance for use in approaches such as the RMP.

With respect to the status and workplan for RMP *Implementation Reviews* the ongoing one for Western North Pacific (WNP) Bryde's whales should completed in 2019. The *Implementation Review* for WNP common minke whales was the subject of a specialist workshop on stock structure issues in early 2018 (included in this volume) and the full review will start in 2019 and is expected to take two years.

In 2018, the Committee formalised a consistent approach to undertaking assessment and the provision of advice to the Commission on the 'status' of stocks (this involves providing using a modelling framework that takes into account uncertainty to provide advice on (a) where populations in a region (say an ocean basin) are now in relation to their unexploited stated, (b) likely future trends and (c) on any conservation and management implications. 'Comprehensive Assessments' – a term used for the first time this is done for a species/region (follow-up assessments are called 'in-depth assessments') are being undertaken for two stocks: North Pacific humpback whales (the next workshop will take place before SC68b in 2019) and North Pacific sei whales (intended to be completed during the next two years).

The 2018 Committee report highlights its considerable work on whale stocks. This work leads detailed recommendations for action by the relevant governments and others. A few issues are highlighted below.

For the Northern Hemisphere, the Committee expressed great concern for the Gulf of Mexico Bryde's whales, a small population with a restricted range and low genetic diversity, listed by IUCN as Critically Endangered, along with North Atlantic right whales and some stocks of North Pacific bowhead and right whales, as well as Indian ocean sperm and humpback whales.

For the Southern Hemisphere, attention was drawn to the Southern Hemisphere right whales. Following the completion of the 2012 global in-depth assessment, Australia is going to be the initial priority for a regional stock assessment. The Committee expressed concern over the population in southeast Australia and recommended an assessment of the effects of fish farms and other developments on population recovery in this region. The need to continue to support the exemplary long-term monitoring programmes for this species in Australian and South African waters was stressed.

The Committee also reviewed scientific issues for stocks that are the subject of actual or potential Conservation Management Plans (CMPs). With respect to Western Pacific gray whales for which there is an existing joint IUCN/IWC CMP, the Committee held the fifth range-wide Workshop on the Status of North Pacific Gray Whales in March 2018 (included here) – the review began in 2014. A small drafting group has been established to update the CMP in light of new information and to develop conservation questions that can be assessed using the new modelling framework for gray whales throughout their range.

The Committee reviewed progress with implementation of the IWC CMP for the Southwestern Atlantic southern right whale and reiterated the importance of continued monitoring of this population and research into threats. Similarly, it reviewed progress on the IWC CMP for the Southeastern Pacific southern right whale and welcomed information on progress on the deployment of Passive Acoustic Monitoring (PAM) devices in two locations along the coast of Chile and Peru as well as additional capacity-building and awareness efforts and training on response to entanglements. The Committee also received a progress report on the IWC CMP for the franciscana. The Committee reiterated that estimating abundance off Buenos Aires Province, Argentina, remained a high priority.

With respect to potential future CMPs, the Committee welcomed important new information on the critically endangered population of Arabian Sea humpback whales. It also welcomed information on a proposed CMP for the Mediterranean population of fin whales, to be undertaken jointly with the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS). ACCOBAMS had endorsed the concept of a CMP for that population in 2016 and encouraged co-operation with the IWC. In light of several action plans for South American river dolphins that had been endorsed by range states, consideration was also given to the development of a CMP.

A central component of conservation work and assessment of status relates to an understanding of stock structure. In 2018 the Committee made considerable progress in developing and updating guidelines for laboratory and analytical methods relating to genetics and stock structure. It also welcomed information provided voluntarily by whaling countries on their DNA registers and encouraged coordination of all genetic registers to ensure they are based on comparable genetic markers.

Similarly, estimation of population abundance and trends is key to assessing status. Since 2016, the Committee had reviewed and classified over 30 cetacean abundance estimates. In 2018 the Committee finalised an updated process for reviewing abundance estimates and it is developing its approach on how best to report on the status of stocks in a more consistent manner.

Non-deliberate human-induced mortality, especially bycatch in fishing gear, can have a major impact on the status of cetacean populations and are regularly examined as part of assessment work. In 2018, the Committee continued to review scientific matters related to bycatch and entanglement of large whales, bycatch of small cetaceans and ship strikes. It provided advice on methods to reduce entanglement and bycatches and endorsed the work of the IWC's new Bycatch Mitigation Initiative and the now well-established Entanglement Response Network, offering its expertise where considered valuable. The Committee continued its work on assessing ship strikes including the IWC's global ship strikes database and on reviewing and developing mitigation measures. It highlighted the importance of cooperation with IMO on the issue of ship strikes and mitigation.

Cetaceans face a number of environmental issues that can affect reproduction and survivorship and thus status and the Committee has been at the forefront of discussions of those for over two decades. In 2018, considerable work on several of these was undertaken, including progress with its Pollution 2020 programme. A web-based user-friendly model to investigate the effects of pollutants on cetacean populations is now accessible through a link on the IWC website (*https://iwc.int/chemical-pollution*). A contaminant mapping tool is scheduled to be completed in 2019, with inclusion of data on mercury as a contribution to assessment of the impact of the Minamata Convention (and see IWC Resolution 2016-4). The Committee reiterated support for international efforts to reduce PCBs in the environment and encouraged the collection of baseline data for cetaceans of the impacts of heavy fuel oils.

With respect to noise, the Committee noted international efforts to address the problem of anthropogenic sound and its impact on cetaceans and commending the IWC's engagement with other international organisations on this issue. The Committee made several recommendations on scientific issues, CMS guidelines, consideration of noise in MPA management, efforts to develop guidance on noise strategies and continued efforts to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise. A workshop on marine debris is planned for 2019 and the Committee continued to review new information on, disease, algal blooms and unusual mortality events (e.g. sei whales in Chile). In particular, the Committee endorsed the IWC strandings initiative and the role it can play in identifying threats to cetaceans as well as providing general scientific information. Anthropogenic factors do not necessarily work in isolation and the Committee held a dedicated workshop on cumulative effects in 2018 (included in this volume). The Committee also continued to advance its work on ecosystem modelling, including the development of scenarios for simulation testing of the RMP, guidelines on the application of species distribution models and progressing co-operation with CCAMLR. The SC discussed how to forward work on scientific aspects relevant to IWC Resolution 2016-3 on 'Cetaceans and Their Contribution to Ecosystem Functioning'. It is unlikely that the goal of reliably determining the contribution of cetaceans to ecosystem functioning can be achieved in under a decade, given the complexity of the issue and the data gaps. Initially, the Committee will focus on a more achievable goal of carrying out of a gap analysis and to develop a plan to address them via a workshop (perhaps jointly with the Convention for Migratory Species).

The Committee continued its work on small cetaceans many populations (and, in the case of the vaquita, a species that are under great threat). Detailed advice to governments for action can be found in the 2018 reports as well as a review of progress with previous recommendations. In 2018, the Committee drew attention to and expressed concerns over declines in abundance and to multiple threats affecting populations of *Inia* and *Sotalia* following on from similar concerns in 2017 for populations of *Platanista* spp., *Orcaella* spp. and *Neophocaena* spp. in rivers, estuaries and restricted coastal habitats in Asia. Serious concern was also reiterated about Lahille's bottlenose dolphins, the vaquita (close to extinction), Yangtze finless porpoise, Maui dolphin, Amazon riverine dolphins and the Taiwanese humpback dolphin; urgent action is required.

For many years, the Committee has worked on scientific issues surrounding whale watching, including any negative effects, and provided advice. This work continued and the SC reviewed the Commission's draft 2018-2024 Whale Watching Strategic Plan and worked jointly with the IWC Conservation Committee on the issue. Of particular interest in 2018 was the development of the IWC's online Whale Watching Handbook (*https://iwc.int/whale-watching-handbook*), a comprehensive, scientifically substantive, user-friendly and well-designed resource.

Matters surrounding the issuance and results from special permit whaling have long been a contentious issue within the IWC. The Committee has developed guidelines (known as 'Annex P') with the Commission on how it should review Special Permits. During 2017 and 2018, in light of Commission advice and instructions (IWC Resolution 2016-2), an updated 'Annex P' procedure was developed that was presented in 2018. The Committee had continued to receive information and review activities in relation to NEWREP-A, NEWREP-NP and JARPN-II, including progress on recommendations made to the proponents by the Expert Panels and the Committee itself and these are presented in the 2018 report.

International co-operation is particularly important for wide ranging species such as cetaceans and especially the large whales. The IWC-POWER cruises in the North Pacific, designed by the Committee with a vessel generously provided by Japan have continued to provide valuable information on areas not surveyed in recent decades. Similarly, the IWC-SORP (Southern Ocean Research Partnership) programme continues to provide important information from the Southern Ocean. Results from those two programmes are presented in the 2018 report.

Finally, it should be noted that at the 2018 biennial Commission meeting, Caterina Fortuna (Italy), completed her final year in office as the Chair of the Scientific Committee. She was an outstanding Chair and made a major contribution to the success and working of the Committee. Robert Suydam (USA), the old Vice-Chair is the new Chair and Alex Zerbini (Brazil) is the new 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 section 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 upon request. All past Journal papers and Supplements are now available online, as are the Annual Reports and Biennial reports of the Commission and the older *Rep. int. Whal. Commn* (see *http://www.iwc.int/publications* and *https//:www.iwc.int/previous-publications*).

Greg Donovan
Editor
Cambridge, 5 April 2019

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Report of the Scientific Committee

The meeting (SC/67b) was held at the Rikli Balance Hotel, Bled, Slovenia, from 24 April-6 May 2018 and was chaired by Caterina Fortuna. The next meeting of the Commission (IWC/67) will take place 4-14 September 2018. The list of participants is given as Annex A (about one-third 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. Although the meeting was not officially hosted by the Slovenian Government, she thanked it for welcoming them back and noted how pleased the Scientific Committee was to be once again in such a beautiful place. She thanked the IWC Secretariat staff for their hard work during the intersessional period, particularly Mark Tandy for organising the meeting under time pressure Stella Duff, Andrea Cooke and Jessica Peers for their assistance with meeting documents and Greg Donovan for all his support intersessionally. She thanked Sava Hotels for providing the meeting facilities and her Slovenian colleagues for helping meeting arrangements run smoothly. Fortuna also thanked the vice-Chair Robert Suydam, the Convenors (including those of intersessional groups) and Committee members for all their hard work since the last meeting.

Rebecca Lent, the new IWC Executive Secretary, welcomed participants to the meeting She noted this was her first IWC meeting, but already knew of its excellent global reputation and looked forward to attending many sessions. She noted her pleasure at joining the IWC at such an exciting time, with a busy year of meetings and several new initiatives. Two new coordinators have joined the Secretariat as part of the IWC work programmes endorsed by the Commission in 2016: Marguerite Tarzia as bycatch coordinator; and Karen Stockin as strandings coordinator. They will lead the Commission's work in these areas and will provide valuable input into the Scientific Committee's work.

Lent noted that the external 'The IWC review – final report' (*https://archive.iwc.int/?r=6890*) undertaken as part of the IWC's Governance Review has recently become available and she noted that the Commission would welcome comments on it from the Scientific Committee, and that in particular, the Commission's Operational Effectiveness Working Group will take into consideration the comments from the Scientific Committee in making its recommendations to the Finance and Administration Committee; that Committee will then make recommendations to the Commission, which will determine the next steps in the governance review. Budget Management has become more challenging in recent years and there is much work to do to make sure the work plan of the Commission and all its subsidiary bodies is affordable going forward and into the long term. Finally, she thanked Scientific Committee members for their scientific input over the next two weeks and wished everyone a successful meeting.

The Committee was saddened to learn of the death of four scientists connected with the Scientific Committee:

(1) Greg Kaufman, a member of the Committee since 2006 and an active member of the sub-committee on whale watching and the Whale watching Working Group of the Conservation Committee;
(2) Doug Coughran, who although he did not attend Scientific Committee meetings, was a participant in numerous IWC workshops on entanglement and stranding response and was a charter member of both the IWC's entanglement and stranding expert (advisory) groups;
(3) Dale Rice, who although he has not attended IWC meetings in recent years, first represented the USA on the Scientific Committee as far back as 1960; and
(4) John Reynolds, who although not a member of the Scientific Committee, was a mentor to many Committee members.

The Committee paused in silence and respect for these scientists who had contributed directly and indirectly to the Committee's work and to whale conservation and management. Short obituaries can be found in Annex AA.

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 on 'Cumulative Effects' from 22-23 April; and
(2) the sub-committee on Whale Watching held a pre-meeting on the IWC's 'Five Year Strategic Plan for Whale Watching' from 22-23 April. 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 – Sub-Committee on Non-Deliberate Human-Induced Mortality of Cetaceans;

Annex K – Sub-Committee on Environmental Concerns;
Annex L – Standing Working Group on Ecosystem Modelling;
Annex M – Sub-Committee on Small Cetaceans;
Annex N – Sub-Committee on Whale Watching;
Annex O – Sub-Committee on Conservation Management Plans;
Annex P – Revised 'Annex P';
Annex Q – Standing Working Group on Abundance Estimates, Stock Status and International Cruises;
Annex R – *Ad hoc* working Group on Sanctuaries;
Annex S – *Ad hoc* Working Group on Photo-ID;
Annex T – *Ad hoc* Group on Global databases and repositories;
Annex U – Statements on Special Permit discussions;
Annex V – IWC-SORP – Southern Ocean Research Partnership;
Annex W – Updated Rules of Procedure;
Annex X – Comments on the 'Governance Review';
Annex Y – Intersessional groups;
Annex Z – Minority Statements on the Agenda.

1.5 Computing arrangements

Donovan 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 Z.

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 to provide (1) a concise summary of information available in member countries and (2) advice on where to find more detailed information if required. In addition, the IWC holds several specialist databases (including, catches, sightings, ship strikes, images – see Item 23).

As agreed at the 2013 Annual Meeting (IWC, 2014), all National Progress Reports were submitted electronically through the IWC National Progress Reports data portal. Encouragingly, 18 countries (Argentina, Australia, Brazil, Croatia, Denmark, France, Germany, Iceland, Italy, Japan, Korea, Mexico, New Zealand, Netherlands, Norway, Spain, UK and USA) submitted reports this year compared to 12 last year. Information was provided on bycatch, entanglement, ship strikes, direct and indirect takes, sampling, sightings and tracking studies.

Nearly all the recommendations identified by the Committee in 2017 (IWC, 2018c) have been implemented although further guidance is required on the appropriate level of aggregation for some records (e.g. strandings) to simplify and accelerate data entry without losing valuable resolution.

Although data entry this year was hampered due to problems with the IWC server, this generic issue has already been resolved by the IWC Secretariat. Several suggestions for improvements, including the removal of default values, were made (see Annex T for full details).

Attention: C, CG, S, SC

Despite the technical issues of the portal, the eighteen Progress Reports submitted to SC67b was an improvement on the twelve submitted to SC67a. Nevertheless, this represents a small proportion of IWC member nations. The Committee ***reiterates*** *that National Progress Reports are required under the Convention and they represent a useful tool and* ***recommends*** *that Contracting Governments to submit them annually through the IWC data portal (http://portal.iwc.int).*

National Progress Reports include records of reported bycatch and ship strikes. The Committee agrees that the data collected in these reports are not intended to replace in-depth studies and they should be considered and used with great caution. However, it also ***agrees*** *the reports have value because much of these data would not otherwise be available and the reporting process can assist in supporting national compilation of cetacean data.*

Table 1

List of data and programs received by the IWC Secretariat since the 2017 meeting.

Date	From	IWC ref.	Details
18/05/17	St Vincent and The Grenadines: J. Cruickshank-Howard	E128 Cat2016	Information from St Vincent and The Grenadines aboriginal hunt 2016-17.
03-10/07/17	S. Kromann and Y. Ivashchenko	E127 C	Individual catch data for Taiyo Gyogyo, Japan in 1943-44. Copy of data held at NMML Seattle.
16/08/17	Y. Ivashchenko	E127	Extra details of North Pacific sei whale catches by the USSR 1963-71.
16/02/18	Japan: K. Matsuoka	CD103	2017 POWER sightings cruise data (except photographs).
16/02/18	Japan: K. Matsuoka	CD104	2017 ICR North Pacific dedicated sighting survey data.
04/04/18	Canada: S. Reinhart	E130 Cat2017	Details of the Canadian bowhead harvest for the 2015-17 seasons and some information on the 2018 quota.
11/04/18	Japan: K. Matsuoka	E131	Data from the 2017-18 NEWREP-A dedicated sighting survey.
18/04/18	Iceland: G. Vikingsson	E130 Cat2017	Individual records of minke whales caught by Iceland 2017 [there was no fin whale catch].
18/04/18	Norway: N. Øien	E130 Cat2017	Individual minke records from the Norwegian 2017 commercial catch. Access restricted (specified 14/11/00).
19/04/18	USA: R. Suydam	E130 Cat2017	Individual records from USA Alaska aboriginal bowhead hunt 2017.
20/04/18	Japan: H.Morita	E130 Cat2017	Individual data for Japan's catch in 2017 in the North Pacific (JARPN II) and 2017/18 in the Antarctic (pdf format).

*To address in part several of the issues and challenges described above the Committee **agrees** to:*

(1) develop a strategy with the Scientific Committee Chair and Secretariat to raise awareness of National Progress Reports and promote reporting by member nations;
(2) produce a short summary explaining the utility of National Progress Reports and suggest including this text in the circular to member nations calling for data submission;
(3) request the Secretariat to issue the first call for data submission in February and repeat the call a few weeks prior to the start of the SC meeting;
(4) develop text acknowledging the likely limitations of the reported data (subsequently this text will be included in all reports and data downloads; and
(5) further explore approaches (using R markdown) to produce PDF- formatted national reports.

This work will be conducted by the GDR Steering Group intersessionally (see Annex Y).

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 2017 meeting.

3.3.2 Progress of data coding projects and computing tasks
On behalf of Allison, Donovan reported that the 2017 catches and Japan coastal records in 1943-44 (data from NMML Seattle) have been added to the database. The changes agreed at the 2017 meeting, in particular to split out the catches taken *en route* to and from the Antarctic whaling grounds, have been implemented. Work on computing tasks with respect to work on the AWMP, RMP and in-depth assessments is reported under the relevant agenda items.

4. COOPERATION WITH OTHER ORGANISATIONS

Attention: C-A

*The Committee **stresses** the value of cooperation 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 II-2017 meeting was held in Helsinki, Finland from 18-20 September 2017. No IWC observer attended 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)
There was no meeting of the Conference of Parties during the intersessional period. The next meeting will take place 10-22 November 2018. The Committee agrees that if possible an IWC observer should attend the next meeting of CBD.

4.4 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
The 36th Meeting of the CCAMLR Scientific Committee was held 16-20 Oct 2017 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.

4.5 Convention on the Conservation of Migratory Species (CMS)
4.5.1 Scientific Council
The Second Meeting of the Sessional Committee of the Scientific Council was held 10-13 July 2017 in Bonn, Germany. No IWC observer attended the meeting.

4.5.2 Conference of Parties
The Conference of Parties met 23-28 October 2017 in Manila, Philippines. No IWC observer attended the meeting.

4.5.3 Agreement on Small Cetaceans of the Baltic and North Seas (ASCOBANS)
The report of the observer to ASCOBANS is given as SC/67b/COMM01E. The following key activities have occurred since the last IWC Scientific Committee meeting:

(1) first Joint Meeting of the 13th Meeting of the Jastarnia Group (Baltic Sea harbour porpoises) and the 6th Meeting of the North Sea Group;
(2) best-practice workshop on 'Fostering Inter-regional Cooperation on Underwater Noise Monitoring and Impact Assessments in waters around Europe, within the context of the European Marine Strategy Framework Directive';
(3) 23rd Meeting of the Advisory Committee; and
(4) 14th Meeting of the Jastarnia Group.

The key ongoing ASCOBANS activities are:

(1) work on the three harbour porpoise Action Plans (Baltic, Belt and North Seas)- in place since February 2018;
(2) web-accessed database on marine mammal stranding and necropsy in preparation (ZSL/IOZ leading), 2018-2020;
(3) preparation of an action plan for common dolphins; and
(4) implementing a change in the national reporting cycle from annual (on all topics) to a four-year cycle (selected topics each year) - the intention is that all the key ASCOBANS working groups and meetings align their agendas to home in on these issues in the respective years of reporting (e.g. covering 2017 in 2018).

The Action Points at the last Advisory Committee meeting included:

(1) preparing a discussion on prey depletion and changes in prey quality on the agenda of the 24th Meeting of the Advisory Committee;
(2) co-organisation of a workshop with ACCOBAMS on strandings and marine debris (the report has been made to the Scientific Committee);
(3) future focuses will include the white-beaked dolphin and the white-sided dolphin.
(4) a draft Action Plan for the Common Dolphin is due to be presented at the 24th Advisory Committee Meeting.

The Committee thanked Simmonds for his report and agrees that he should represent the Committee as an observer 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)

MEETING OF PARTIES

There was no Meeting of the Parties (MoP) to ACCOBAMS during the intersessional period. Donovan will represent the Committee as an observer at the next ACCOBAMS MoP.

SCIENTIFIC COMMITTEE

There was no meeting of the ACCOBAMS Scientific Committee during the intersessional period. Donovan will represent the Committee at the next ACCOBAMS Scientific Committee meeting.

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

No relevant meetings of CITES have taken place during the intersessional period.

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

There was no meeting of The Committee on Fisheries (COFI) during the intersessional period. The next meeting will take place in Rome, Italy 9-13 July 2018.

4.8 Inter-American Tropical Tuna Commission (IATTC)

The 92nd meeting of the Inter-American Tropical Tuna Commission (IATTC) was held in Mexico City, Mexico 24-28 July 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)

There was no meeting of ICMMPA task force during the intersessional period. The 5th International Conference will be held from 8-12 April 2019 in Greece. It will evaluate progress in meeting the ICMMPA's long-standing goal of bringing the MMPA community closer together. A primary goal is to focus on the challenges ahead towards achieving effective place-based protection and management for marine mammals. It will build on previous initiatives to advance our understanding of science, management, and effective biodiversity conservation in protected areas. It will also provide updates on plans for the worldwide Important Marine Mammal Area (IMMA) initiative (*marinemammalhabitat.org*). Rojas-Bracho will represent the Committee at this meeting.

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

The report of the IWC observer documenting the 2017 activities of ICES is given as SC/67b/COMM01A. The ICES Working Group on Marine Mammal Ecology (WGMME) reported on recent information on status of, and threats to, marine mammal populations and briefly reviewed current knowledge of effects of plastics and underwater noise. Criteria for assessment of abundance trends in offshore cetaceans in the context of the Marine Strategy Framework Directive (MSFD) were reviewed, modifying the proposed indicator (previously based solely on the rate of decline) to make specific reference to baseline values. The group also considered the outcomes of the 2016 SCANS III survey[1]. All three SCANS surveys have arisen from individual projects. WGMME recommended that the surveys be co-organised and coordinated by Member States as part of their routine monitoring and that the frequency is increased to once every six years to match the MSFD reporting cycle.

A Workshop on Predator-prey Interactions between Grey Seals and other marine mammals (WKPIGS) focused on predatory behaviour of grey seals towards other grey seals, harbour seals and harbour porpoises in European waters. The workshop aimed to consolidate pathological indicators of grey seal predation events, collate data on the prevalence and distribution and discuss methods to aid in detection of predation events and potential population level consequences of reported incidences. Cases of predation on harbour porpoises peaked in spring months. Reported incidence has increased over the last decade although it is not known if this represents a true increase in prevalence, an increase in seal numbers or an increase in effort/reporting.

Highlights from the 2017 ICES Working Group on Bycatch of Protected Species (WGBYC) included: review of ongoing bycatch mitigation research projects; presentations on interdisciplinary bycatch monitoring programs in the US Northwest Atlantic northeast region; collaborations with other ICES working groups; positive advancements on WGBYC database development working jointly with the ICES Data Centre; and progress on summarising bycatch for the Baltic Sea and Bay of Biscay/Iberia fisheries overviews.

Four cetacean species were reported as bycatch from the 2015 member state reports (common dolphins, white-beaked dolphin, bottlenose dolphin, and harbour porpoise). The WGBYC continues to highlight the inconsistent submission and content of annual reports provided by some member states and the shortcomings to accurately reflect the full magnitude of cetacean bycatch in European fisheries. WGBYC is preparing for the transition away from regular member state reports as the primary source of data on bycatch of cetaceans over to data coming through the ICES regional database.

The 2017 ICES Annual Science Conference (ASC) had no sessions devoted entirely to marine mammals. Nevertheless, some sessions had marine mammals included as an integral part - the most relevant sessions were: 'microbes to mammals: metabarcoding of the marine pelagic assemblage' and 'from iconic to overlooked species: how (electronic) tags improve our understanding of marine ecosystems and their inhabitants'.

More information is available from the ICES website *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 meeting.

4.11 International Maritime Organisation (IMO)

The report of the observer is given as SC/67b/COMM01D. At IWC66, the Commission endorsed recommendations of the IWC Conservation and Scientific Committees for continued engagement with the IMO, including submission of a paper 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 paper was written by an intersessional group appointed

[1]*https://synergy.st-andrews.ac.uk/scans3/*

at SC67a and submitted to the IMO MEPC 72 meeting 9-13 April 2018 (MEPC 72/Inf.9).

The ship strike section of the IWC website now contains a list of the measures that have been put in place globally through IMO or national regulations, to reduce ship strike risks to whales. These include Traffic Separation Schemes, Areas to be Avoided, Recommended Routes, voluntary and mandatory speed restrictions. New measures relevant to ship strikes include three recommendatory areas to be avoided (ATBA) encompassing King Island, Nunivak Island, and St. Lawrence Island in the Bering Sea proposed by the United States (NCSR 5/3/8). The proposal noted that King Island is a biologically important site to the gray whale, while St. Lawrence Island's ATBA would provide protection to bowhead whales, gray whales, and humpback whales. These areas were recommended for adoption (with a reduced size for the St. Lawrence ATBA) by the IMO Navigation, Communications and Search and Rescue sub-committee NCSR 5 in February 2018.

Members of the IWC Scientific Committee have attended IMO meetings in order to discuss how best to provide information on populations of marine mammals relevant to the marine mammal avoidance provisions of the IMO Polar Code. This is discussed further under Item 14.3.

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 report of the observers to IUCN is given as SC/67b/COMM01G. The IUCN Marine Mammal Protected Areas Task Force (*https://www.marinemammalhabitat.org*) held its 3rd regional workshop in Malaysia in March 2018 to identify, describe and map candidate areas for inclusion in the Important Marine Mammal Area (IMMA) e-Atlas (*marinemammalhabitat.org/imma-eatlas*). The 46 candidate IMMAs proposed by the workshop are currently undergoing independent review.

Cetaceans entries on the Red List are in the process of being updated. The first batch of updates covering 19 taxa was published on *redlist.org* in December 2017 and is summarised at *iucn-csg.org/index.php/page/3*. Most of the remaining mysticete species assessments and some subpopulation assessments, as well as around 10 more new assessments of small and medium-sized odontocetes, have been submitted for publication in the next Red List update in June 2018. Most of the remaining taxa are in the pipeline for publication in late 2018.

IUCN continues to convene the Western Gray Whale Advisory Panel (WGWAP), which provides advice to Sakhalin Energy Investment Company (SEIC) and other parties, especially on the mitigation of industrial and other impacts on the gray whales that feed each summer off Sakhalin Island, Russia. Details of the Panel's recent work are given in Annex O, Appendix 3.

Regular news items on activities by members of the IUCN SSC Cetacean Specialist Group are posted on the CSG website, *www.iucn-csg.org*.

4.13 North Atlantic Marine Mammal Commission (NAMMCO)

Scientific Committee

The report of the IWC observer at the 24th meeting of the NAMMCO Scientific Committee (NAMMCO-SC) is given as SC/67b/COMM01B. The NAMMCO-SC discussed a current joint project, 'Exploring marine mammal consumption relative to fisheries removal in the Nordic and the Barents Seas'. Preliminary results suggest that marine mammal consume around 15 million tons ± 50% of prey per year, predominantly targeting low and mid trophic level species (zooplankton and small pelagic fish). Fisheries remove around 4.3 million tons per year, targeting mid and top trophic levels (small pelagic fish and larger demersal and pelagic fish).

The NAMMCO By-Catch Working Group (BYCWG) met in May 2017. Methods used for collection of data and by-catch estimation were reviewed, and both the WG and the SC recommended methodological improvements to be implemented both in the data collection and the analysis before the bycatch estimates could be endorsed. Greenland is an atypical case because marine mammals that are caught, either directly or indirectly, are assumed to be reported as direct catch (with large whales being the exception where bycatch is reported as such). The primary concern is to ensure that any bycatch is included in the total number of removals to be used in population assessments.

The NAMMCO SC noted and appreciated that the IWC *Implementation Reviews* for North Atlantic fin whales and North Atlantic common minke whales are completed. The NAMMCO SC provided advice on sustainable catch levels fro these species in Icelandic waters (from 2018-2025) based upon application of the RMP. The NAMMCO SC also recommended that the *SLAs* that are developed in the IWC SC be used for advice for large whales in Greenland and provided advice on strike limits for West Greenland humpback whales for the 2019-24.

The NAMMCO SC received the results from an updated global review of monodontids and provided updated assessments and advice for white whales and narwhals in Greenland and Canada. It also received a new abundance estimate for bottlenose whales from the Faroese component of the 2007 T-NASS survey that was analysed together with data on deep diving species from the SCANS-II and CODA surveys. Sightings were mainly from the Faroese survey block.

Increased research on harbour porpoises in Norway is being driven by the concerns regarding bycatch. Bycaught harbour porpoises were collected in 2016 and 2017 by Norway for biological sampling, and a food-web model is being developed for the Vestfjord area close to Lofoten to study the role of the species in this area. An abundance estimate is now available from the SCANS-III survey which was extended from 62°N to include Vestfjorden, an area with high bycatch. Preliminary investigations using this new abundance estimate suggest that bycatch levels are within PBR.

NAMMCO's 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 next NASS survey should be in 2022-23. The NAMMCO SC strongly recommended that an attempt be made to conduct again a trans-Atlantic coordinated survey and charged the NAMMCO Secretariat to explore what are the present plans and how much flexibility they encompass.

Council
The report of the IWC observer at the 26th Annual Council meeting of NAMMCO held in Tromsø, Norway 7-8 March 2018 is given as SC/67b/COMM01C. Relevant items discussed at the Council meeting include the following:

(1) A newly established working group on bycatch, entanglements and live strandings has started its work and will gather information on the matter from other organisations and develop recommendations for NAMMCO. The focus is animal welfare associated to non-hunting related activities, and how NAMMCO can best contribute to addressing significant adverse impacts of by-catch, entanglement and live strandings on marine mammals; and
(2) The report of the Global Review of Monodontids (white whales and narwhals) reviewed the conservation status, threats, and data gaps for all stocks globally. The last review was in 1999.

The Committee thanked Moronuki for his report.

4.14 North Pacific Marine Science Organisation (PICES)
The report of the IWC observer at 2017 annual meeting of PICES is given as SC/67b/COMM01F.

The marine birds and mammals section (S-MBM) focussed on 'seasonal and climatic influences on prey consumption by marine birds, mammals and predatory fishes' Presentations were made on: (1) significance of seasonal changes in prey consumption on energy budgets and ecosystem dynamics; (2) effects of changes in water temperature and other climatic variables on food requirements; (3) relationships between dietary shifts and population trends; (4) limits of plasticity in prey selection; and (5) how prey consumption of birds, mammals and predatory fishes is affected by the recent extreme climatic events. Overall, the collection of presented studies in this session contributed to the efforts of the S-MBM to estimate prey consumption of birds and mammals. They provided new methods to estimate prey consumption of marine mammals and gave insights into the existing databases of diets and population estimates that can be used to further this effort.

For 2018, the S-MBM will focus on 'diets, consumption and abundance of marine birds and mammals in the North Pacific'. Since the 2016 workshop, work on the agreed upon databases to estimate prey consumption has been initiated and will continue to be added to over the coming 12 months in anticipation of the 2018 workshop, when invited experts will review the compiled information. This process should result in near-complete databases of diets, abundances and energy requirements of marine birds and mammals in the North Pacific.

The 2018 annual meeting of the PICES will be held in Yokohama, Japan 25 October-4 November 2018. 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
No observer attended SPAW meetings in the intersessional period.

4.16 Pacific Region Environment Programme (SPREP)
No observer attended SPREP meetings in the intersessional period.

5. GENERAL ASSESSMENT ISSUES WITH A FOCUS ON THOSE RELATED TO THE REVISED MANAGEMENT PROCEDURE (RMP)
Several assessment topics apply not only to the Revised Management Procedure (RMP), but to the work of the Scientific Committee as whole. This item focuses on general assessment issues, such as: (1) the relationship between $MSYR_{mat}$ and $MSYR_{1+}$; (2) implications of RMP and AWMP simulation trials for consideration of 'status'; and (3) 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. In recent years, the Committee has been reviewing progress on an individual based energetics model (IBEM) to provide insights into the relationship between $MSYR_{1+}$ and $MSYR_{mat}$. Two papers on the IBEM were reviewed by the Committee in SC/67b.

SC/67b/EM07 outlined enhancements to the IBEM since the last meeting. This included the ability to explicitly model the effects of feeding while on migration, which can have effects on the yield curve as well as MSYR and MSYL. The Committee discussed (Annex D, Item 2.1) several ways in which this model can potentially enhance understanding of the relationship between biological processes and MSYR.

SC/67/RMP01 reported on trials using the IBEM within the standard RMP testing framework. The results were consistent with the behaviour of the RMP *CLA* observed in less complex population models and will also provide a point of comparison for the emulator model for the IBEM currently under development. The Committee has previously agreed that a fully-developed emulator model could form the basis for future *Implementation Simulation Trials*.

Attention: SC

The Committee ***agrees*** *that work continue to develop an emulator model; assess whether it is possible to represent the trajectories from the IBEM using an emulator model; compare the yield curves from the IBEM 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 ISTs for consideration of species' and populations' status
Last year, the Committee recommended that a set of *Implementation Simulation Trials* should be summarised using three statistics to provide information on status (IWC, 2018d). The Committee was advised that intersessional tasks toward that goal could not be completed prior to SC/67b due to computing workloads.

Attention: SC

The Committee ***agrees*** *that Allison should modify the control programs used for Implementation Simulation Trials to report the three measures of status agreed last year (IWC, 2018d). The RMP sub-committee, in conjunction with the Working Group on ASI, will review outcomes of the analyses* *at SC/68a. Punt and Donovan will develop draft updates to the Guidelines for Implementations and Implementation Reviews to reflect decisions on evaluation status of stocks for consideration at SC68a.*

5.3 General consideration of how to evaluate the effect of special permit catches on stocks and levels of information needed to show improved management performance

5.3.1 General issues

The Committee developed general guidelines on the levels of information needed to show improved management improvement, for proposals that identify this as an objective (Annex D; appendix 2). The guidelines are intended to assist proponents in proposal preparation and to facilitate the review process. It was stressed that these were guidelines not requirements. Proponents might request the establishment of an Advisory Group to provide comment on intersessional work, but this is not mandatory. An Advisory Group may most benefit nations which have not previously developed proposals or may be lacking analysts familiar with the modelling approaches commonly applied at the IWC.

Attention: SC

The Committee ***agrees*** *that the general guidelines on the levels of information needed to show improved management improvement, for proposals that identify this as an objective (Annex D; appendix 2), should be included as an Appendix to the Scientific Committee handbook.*

5.3.2 Specific issues

SC/67b/RMP03 provided draft specifications for RMP/IST type simulations to evaluate management procedures based on modified *CLA*s that use information on recruitment inferred from age data from Antarctic minke whales. This work originally arose from discussions of NEWREP-A and Recommendation 1 of the Panel Review of that proposal (and see Item 19). The Committee noted that SC/67b/RMP03 was a work-in-progress, and that several features of the operating models would need to be extended before final conclusions could be drawn. The author of SC/67b/RMP03 plans to continue this work and received several suggestions from the Committee to carry those efforts forward (Annex D, Item 2.3).

5.4 Work plan 2019-20

Details of work to be undertaken both before and during the 2019 Annual Meeting are given in Table 2.

6. RMP – *IMPLEMENTATION*-RELATED MATTERS (RMP)

This agenda item includes the details of ongoing *Implementation Reviews* and preparation for new *Implementation Reviews*. For discussions related to the stock structure and abundance of these stocks, see also Items 11 and 12.

6.1 Completion of the *Implementation Review* of western North Pacific Bryde's whales

6.1.1 Report of the intersessional Workshop

The second intersessional Workshop on western North Pacific Bryde's whales was held in Tokyo from 14-16 February 2018 (SC/67b/Rep02). The objective was to facilitate completion of the *Implementation Review*. Much of the Workshop focussed on completing the final trial specifications, especially confirming the mixing matrices, updating the abundance estimates for the new sub-areas and confirming future sighting survey plans and whaling options. The Workshop reviewed preliminary conditioning results and agreed that they were satisfactory. It developed a workplan to try to ensure completion of the *Review* at SC/67b .

The Committee noted that the intersessional workshop had led to considerable progress towards completing the *Implementation Review*. It thanked Donovan for chairing the meeting, the Government of Japan for providing excellent facilities and all the participants for their contributions to the development of trial specifications and work plan.

The code and specifications for *Implementation Simulation Trials* were updated following the intersessional Workshop.

Table 2

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

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Item 5.1: Conduct work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$	(a) Continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model (see Annex Y); (b) compare the yield curves from the IBEM with those from the emulator model (see Annex Y); and (c) 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 (see Annex Y).	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat.}$	Conduct follow-up analyses.	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat.}$
Item 5.2: Implications of *IST*s, for consideration of status	(a) Modify the control programs used for *Implementation Simulation Trials* to report the three measures of status (Allison); and (b) draft updates to the Guidelines for *Implementations* and *Implementation Reviews* to reflect decisions on evaluation status of stocks (Punt and Donovan).	Review the results of the projections. Review the draft guidelines.		
Item 5.3: levels of information needed to show improved management performance		Review progress implementing the suggested changes to the specifications of the model in SC/67b/RMP03 and any results.		

Attention: SC

The Committee ***agrees*** *to the updated trial specifications for the Implementation Review of western North Pacific Bryde's whales. These specifications are provided in Annex D, Appendix 3. It also* ***agrees*** *that conditioning has been achieved satisfactorily.*

6.1.2 Conclusions and recommendations

Once the trial specifications and conditioning had been agreed, the next step was to conduct projections under alternative RMP variants and survey plans. There was insufficient time during the meeting to complete all of the required projections and to check the associated calculations. Consequently, the remaining work will be completed intersessionally and reviewed and summarised by a Steering Group (Annex Y). This will occur well before SC/68a so that Japan has sufficient time to consider the results (e.g. with regard to its preferred survey options), prior to final conclusions being drawn. The Committee expects that this work can be completed before the end of 2018, but if complications arise conducting the projections, an extra day should be added to the 'First Intersessional Workshop for the western North Pacific minke whales' (see Item 6.2) to address outstanding issues.

Attention: SC

The Committee ***agrees*** *that the Implementation Review of western North Pacific Bryde's whales will be completed at SC/68a. Outstanding tasks will be completed intersessionally and the results reviewed and summarised by a Steering Group (Annex Y). This will occur well prior to SC/68a, and if complications arise then an extra day should be added to the First Intersessional Workshop for the western North Pacific minke whales (see Item 6.2) to address those issues.*

6.2 Start of the *Implementation Review* of western North Pacific common minke whales

6.2.1 Report of the intersessional Workshop

Donovan summarised the report of the preparatory Workshop for the Western North Pacific common minke whale *Implementation Review* (SC/67b/Rep05). Last year, the Committee recognised that the most difficult aspect of the last *Implementation Review* had been selecting, modelling and assigning plausibility to stock structure hypotheses. The objective of this Workshop was to begin to review work undertaken since the last *Implementation Review* and to develop, if necessary and possible, consensus advice on further analyses that will assist in the forthcoming *Implementation Review.* Stock structure discussions on common minke whales are detailed in Annex I, item 4.2.

This past lack of agreement with respect to the plausibility of existing stock structure hypotheses has, in part, revolved around how genetic analyses can be used to assign whales as part of the 'J' versus 'O' stocks. While some whales assign strongly to one of the two groups based on genetic data, the assignment of others is dependent on the assignment probability deemed sufficient to assign stock affinity. At the intersessional workshop (SC/67b/Rep05), the results of new stock structure-related analyses were reviewed by an advisory panel, and two recommendations were made with regard to additional genetic analyses needed to better understand stock structure. One of the recommended analyses involved evaluating the consistency of individual assignment probabilities when additional loci were genotyped. Progress with respect to that recommendation is discussed below.

The Workshop was also provided with an update to SC/67a/SCSP/13 that used information on the trend over time in the J:O stock ratio for common minke whale bycatches around Japan to draw various inferences, in particular about the value of the MSYR. The Workshop agreed that J:O stock ratios in bycatch will require attention when formulating stock distribution assumptions for the process of conditioning *IST*s in the coming *Implementation Review* and made some recommendations on how this could be achieved.

The Committee noted that the intersessional Workshop was held in an excellent spirit of co-operation among the participants and led to identification of additional data sets and analyses that should be taken forward. The Committee thanked Donovan for chairing the meeting, the Government of Japan for providing excellent facilities and all the participants for their contributions to progress the *Implementation Review*.

6.2.2 Progress since the intersessional Workshop

SC67b/SDDNA06 presented the results of the recommended analysis from the Workshop (see Item 6.2.1) and the Committee confirmed that the workshop's recommendation for this analysis had been properly completed.

Attention: SC

The Committee reviewed new results of genetic analyses that were recommended at the intersessional workshop (SC/67b/Rep05) to better evaluate the use of genetic data to assign stock affinity in North Pacific common minke whales. The Committee:

(1) ***agrees*** *that future analyses should incorporate a range of assignment thresholds to encompass uncertainty;*
(2) ***supports*** *the additional genetic analyses described in Annex I Appendix 5 relating to the second recommendation of the intersessional workshop and agrees that they should be performed prior to the next intersessional workshop; and*
(3) ***encourages*** *the inclusion of non-genetic biological data to inform stock structure where possible.*

SC/67b/RMP/02 aimed at suggesting a plausible range for $MSYR_{1+}$ for the western North Pacific common minke whales, and the relative plausibility of two stock structure hypotheses. The Committee thanked Kitakado for the updated analysis, which implemented some of the recommendations from the intersessional Workshop. Details of this paper and associated discussion can be found in Appendix D, Item 3.2.2. The Committee also discussed the analysis of genetic data conducted since the intersessional workshop (Annex I, Item 4.5).

Attention: SC, CG-A

The Committee ***agrees*** *that:*

(1) it is necessary to update the mixing matrices in the trial specifications to be more consistent with observed genetic and bycatch data, also taking into account sensitivity to alternative methods of genetic assignment to stock;
(2) whether it is possible to use the bycatch data to assign plausibility ranks to $MSYR_{1+}$ values and stock structure hypotheses depends on assumptions regarding trends in fishing effort spatially and temporally; and

Table 3

Work plan for RMP (*Implementation*-related matters).

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Item 6.1: Western North Pacific Bryde's whales	Finalise the projections and the application of the criteria for evaluating which RMP variants are acceptable, borderline, and un-acceptable.	Complete the *Implementation Review.*		
Item 6.2: Western North Pacific minke whales	(a) conduct the First Intersessional Workshop; and (b) code the resulting trials and condition the trials.	Conduct the work required for the First Annual Meeting.	Conduct the Second Intersessional Workshop.	Conduct the work required for the Second Annual Meeting.

(3) trials would need to consider different assumptions regarding the use of J:O bycatch ratios, including that these data do not provide information on $MSYR_{1+}$ and the plausibility of stock structure hypotheses because of possible differential distributional changes by stock.

The Committee therefore ***agrees*** *that scientists from Japan and Korea should provide data on the amount, location and timing (seasonal and annual) of fishing effort and bycatch to the First Intersessional Workshop (see Item 6.2.3).*

6.2.3 Preparation for the First Intersessional Workshop

The Committee began preparations for the First Intersessional Workshop on the *Implementation Review* of western North Pacific common minke whales. It re-established the Steering Group (Annex Y) to organise this Workshop.

In accordance with the Committee's *'Requirements and Guidelines for Implementations and Implementation Reviews'* (IWC, 2012b), the primary objectives of the First Intersessional Workshop will be to: (a) consider plausible hypotheses and eliminate any hypotheses that are inconsistent with the data); (b) examine more detailed information in expected whaling operations, including options or suggested modifications to the pattern of those operations; (c) review the small geographical areas ('sub-areas') that will be used in specifying the stock structure hypotheses and operational pattern; and (d) specify the data and methods for conditioning the trials that will be carried out before the next annual meeting. An initial annotated agenda for the Workshop, highlighting the associated data and analysis requirements can be found in Annex D, appendix 5.

6.3 Work plan 2019-20

Details of work to be undertaken both before and during the 2019 Annual Meeting are given in Table 3.

7. ABORIGINAL SUBSISTENCE WHALING MANAGEMENT PROCEDURE (AWMP)

This item continues to be discussed as a result of Resolution 1994-4 of the Commission (IWC, 1995), which has been 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) finalising the development of *SLA*s (*Strike Limit Algorithms*) for Greenlandic hunts, with a focus on fin and common minke whales; (2) finalising the work on the scientific components of the AWS (Aboriginal Subsistence Whaling Management Scheme); (4) completion of the *Implementation Review* for Bering-Chukchi-Beaufort Seas stock of bowhead whales; and (3) providing management advice for aboriginal hunts (see Item 8).

Considerable progress on items (1) and (2) was made because of intense intersessional work including two workshops in Copenhagen in October 2017 and March 2018, as well as a small technical meeting in December 2018 at OSPAR headquarters in London.

7.1. *SLA* development for the Greenland hunts

7.1.1 Fin whales

SC/67b/Rep06 incorporated the discussions of the two intersessional Workshops and the small working group meeting. Considerable progress was made in relation to (a) updated abundance estimates; (b) finalisation of the trial structure; (c) review and approval of conditioning; and (d) initial consideration of new *Strike Limit Algorithms* (*SLA*s) and results.

The Committee thanked Donovan, the Workshop chair and the participants for the excellent progress made.

The final trial specifications for the West Greenland fin whales are provided in Annex E (Appendix 2). Table 4 below summarises the main factors considered in the *Evaluation Trials.* The most influential involve different stock structure hypotheses, different productivity rates (MSYR) and different 'need' envelopes (need envelopes incorporate scenarios where need remains constant at the present level for 100 years (termed A), where it increases linearly to twice the present level over the 100-year simulation period (termed B) and where it increases linearly to three times the present level over the 100-year period (termed C).

7.1.1.1 CANDIDATE *SLA*S

The Committee received two papers with candidate *SLA*s, SC/67b/AWMP13 and SC/67b/AWMP15. The general properties of the three *SLA*s presented in SC/67b/AWMP13 involve taking an inverse variance weighted average of the last three estimates as an estimate of abundance and calculating the strike limit as a growth rate fraction of a lower percentile of the abundance (conditional on a trend modifier), a snap to need feature and a protection level. The three variants relate to how they are 'tuned' (the trade-off balance between conservation and need).

The three *SLA*s presented in SC/67b/AWMP15 are based on a weighted-average interim *SLA* which uses all abundance estimates, but where the earlier ones are down-weighted. An adjustment to the multiplier of the abundance estimate in the interim *SLA* is applied which depends on the trend of the abundance indices. The three variants relate to how they are 'tuned' (the trade-off balance between conservation and need).

7.1.1.2 REVIEW FINAL RESULTS AND PERFORMANCE

In total, seven potential *SLA*s (which include the 'Interim' *SLA* – a modified version of the *Interim SLA* used to provide advice previously by the Committee until the final *SLA*s had been developed) were considered. The full range of conservation and need statistics were reviewed for the *Evaluation Trials*[2], noting that the initial focus is on meeting the Commission's conservation objectives. Those candidate *SLA*s that meet these are then evaluated on their ability to meet need satisfaction. In summary, conservation performance is deemed satisfactory if either the population is not at MSYL but it is increasing towards it or the population is above MSYL (in which case it may be increasing or decreasing towards MSYL). These concepts are captured in the 'D1' and 'D10' statistics (defined fully in Annex E, table 2) and can be visualised in bivariate plots given in Annex E.

The Committee agreed that the proposed *SLA*s had performed satisfactorily on the joint conservation statistics for the A and B (but not for the C) need envelopes for all trials. The focus was then to evaluate the need satisfaction performance over 20 and 100 years and consider stability in catch levels. This performance was captured by examining three statistics: N9(20) the average need satisfaction over the first 20 years, N9(100) the average need satisfaction over the 100 years and N12 the mean down step statistic (these are also defined fully in Annex E, table 2). They can be visualised in 'Zeh' plots (e.g. see Annex E).

Given the present incorporation into the trial structure of two widely different stock structure hypotheses ('influx' and 'partial'- see Annex E, appendix 2) to explain the variability of the abundance estimates, the need satisfaction over 20 years was given more weight in the evaluation as it is likely that future *Implementation Reviews* may be able to remove one or other scenario.

After an examination of the full range of results, there was no obvious 'winner' between two of the *SLA*s (one from each developer). Depending on the trials considered, and which statistic was examined, they performed slightly differently but their performance overall was equivalent.

Following an approach originally adopted during the development of the *Bowhead SLA*, it was decided that an *SLA* which sets the strike limit to the average of the values obtained by the two *SLA*s[3] would be preferable, providing performance was as good or better than either individual *SLA*; no 'snap to need' for the averaged *SLA* has been applied. The results of the 'combined *SLA'* are summarised in Annex E, appendix 3[4].

7.1.1.3 CONCLUSIONS AND RECOMMENDATIONS

The management advice developed using this *SLA* is given under Item 8.6.

Attention: C-A, SC

The Committee draws attention to the extensive work undertaken over recent years to develop an SLA for the West Greenland hunt for fin whales. In concluding this work, the Committee:

*(1) **agrees** that the combined SLA (which sets the strike limit to the average of the values obtained by the two best SLAs considered) performed satisfactorily in terms of conservation performance and was to be preferred over the individual SLAs in terms of need satisfaction;*

*(2) **recommends** that this 'WG-Fin SLA' be used to provide management advice to the Commission on the subsistence hunt for West Greenland fin whales (provided the need request falls within need scenarios A and B);*

*(3) **expresses** its great thanks to the developers, Brandão and Witting for the vast amount of work put into the development process and to Allison and Punt for their extensive work developing the operating models and running the trials; and*

*(4) **agrees** that one focus of the next Implementation Review will be to examine further stock structure in relation to the two hypotheses being considered at present, and especially the 'influx' model which was developed in the context of low abundance estimates in some years, rather than being based upon genetic information.*

Table 4

Summary of the key factors considered in the fin whale trials.

Factor
Stock structure hypotheses
Mixing matrices
MSYR rate
Survey bias
Need envelope

7.1.2 Common minke whales (Greenland)

SC/67b/Rep06 incorporated the discussions of the two intersessional Workshops and a small working group meeting. Considerable progress was made in relation to (a) updated abundance estimates; (b) finalisation of the trial structure; (c) conditioning; and (d) initial consideration of new *Strike Limit Algorithms* (*SLA*s) and results.

The Committee thanked Donovan, the Workshop chair and the participants for the excellent progress made.

The final trial specifications for the West Greenland common minke whales are provided in Annex E (appendix 4).

Table 5 below summarises the main factors considered in the *Evaluation Trials* for common minke whales. The most influential involve different stock structure hypotheses, different productivity rates (MSYR) and different 'need' envelopes (see discussion under Item 7.1.1), where it increases linearly to twice the present level over the 100-year simulation period (termed B) and where it increases linearly to three times the present level over the 100-year period (termed C).

Considerable work was undertaken to finalise the list of trials, to ensure that the mixing matrices were correctly specified and to complete and agree conditioning. The final trial specifications are provided in Annex E, Appendix 4.

7.1.2.1 CANDIDATE *SLAS*

SC/67b/AWMP14 developed a candidate *SLA* for common minke whales off West Greenland similar to that used for fin whales in SC/67b/AWMP13. It operates on an inverse variance weighed average of the last three abundance estimates. The strike limit is calculated as a growth rate fraction of a lower percentile of the abundance measure, conditional on a 'snap to need' feature, and a protection level. It does not include a trend modifier.

[2]The Committee also examines the results of Robustness Trials to ensure that the SLA does not exhibit unusual behaviour in more extreme trials.
[3]Tuned to a D10 of 0.8 for the influx trial F34-1B.
[4]Final validation and archiving of results will be undertaken by Allison in Cambridge.

It was tuned to have a 5th percentile of D10 of 0.80 for need envelope A for the most difficult *Evaluation Trial* (trial M04-1A – see Annex E, appendix 4), where there are two sub-stocks in the western North Atlantic in which the mixing between the Central and the Western stock, and mixing between the putative western sub-stocks, is minimal, and where the MSYR is 1%).

Table 5

Summary of the key factors considered in the common minke whale trials.

Factor
Stock structure hypotheses
Mixing matrices
MSYR rate
Survey bias
Need envelope

7.1.2.2 CONSIDERATION OF RESULTS

Conditioning of the *Evaluation Trials* was completed satisfactorily and a summary of the results of the is provided in Annex E (appendix 5[5]). Annex E, fig. 3 provides the bivariate plot.

In determining satisfactory conservation and need performance when evaluating *SLA*s, the Committee considers the full range of results across all the *Evaluation Trials*, not simply the worst-case scenarios. Conservation performance was satisfactory for all but the most extreme trial (trial M04-1A) where it was slightly below for the lower 5th percentile. This trial had low MSYR and two W-stocks; it had been originally considered in the context of investigating potential problems for the hunt to simulate possible local depletion in the hunting area rather than for conservation reasons. Genetic stock structure in the entire North Atlantic is subtle such that even an hypothesis of almost complete panmixia is not rejected by most of the analyses and thus differentiation among 'C' and 'W' is very low. This is even more true for substructure within the W stock (if, indeed, there is any). Given that trials are conservative in so far as they overrate isolation among stocks, and the very subtle differentiation among stocks and sub-stocks in the North Atlantic, a single trial (which implements two fully separate W sub-stocks, for which there is little evidence) not meeting the D1/D10 criteria is not of conservation concern.

The SWG (Annex E, item 2.2.3) had noted that given the unforeseen situation with Secretariat computing, there had been insufficient time for it to consider the results of the *Robustness Trials* during its meeting. Such trials are not needed to determine an *SLA* but are examined to ensure that the selected *SLA* has no unforeseen properties in extreme trials. These were subsequently run prior to the plenary discussions and the results showed no unexpected properties.

7.1.2.3 CONCLUSIONS AND RECOMMENDATIONS

The management advice developed using the *WG-common minke SLA* is provided under Item 8.5.

Attention: C-A, SC

The Committee ***draws attention*** *to the extensive work undertaken over recent years to develop an SLA for the West Greenland hunt for common minke whales. In concluding this work, the Committee:*

(1) ***agrees*** *that the tested SLA which performed satisfactorily in terms of conservation performance;*
(2) ***agrees*** *that this 'WG-Common minke SLA' be used to provide management advice to the Commission on the subsistence hunt for West Greenland common minke whales provided the need request falls within need scenario A (i.e. does not exceed 164 annually);*
(3) ***expresses*** *its great thanks to the developers, Brandão and Witting for the vast amount of work put into the development process and to Allison and Punt for their extensive work developing the operating models and running the trials; and*
(4) ***agrees*** *that one focus of the next Implementation Review will be to examine further stock structure in relation to the two hypotheses being considered at present, should be consideration of the results of analyses of genetic data using additional samples from Canada (as well as the additional samples that will become available from West Greenland and Iceland); and*
(5) ***agrees*** *to establish an intersessional advisory group (Annex Y) to facilitate issues relating to samples.*

7.1.3 North Pacific gray whales (Makah whaling)

7.1.3.1 MANAGEMENT PLAN PROPOSED BY THE U.S. FOR MAKAH WHALING

The Makah Indian Tribe has requested that the U.S. National Marine Fisheries Service (NMFS) authorise a tribal hunt for Eastern North Pacific (ENP) gray whales in the coastal portion of its 'usual and accustomed fishing area' in Washington State. The Tribe intends to hunt gray whales from the ENP population, which currently numbers approximately 27,000 animals (Durban *et al.*, 2017). However, at certain times of the year there is a possibility that the hunt may take animals from the PCFG (Pacific Coast Feeding Group) and/or the WNFG (Western North Pacific Feeding Group). In an updated management plan – known as the Makah Management Plan (the Committee had approved an earlier plan for this hunt in 2012 (IWC, 2013), NMFS has taken measures to restrict the number of PCFG whales that are struck or landed in a given 10-year period and to avoid, to the extent possible, striking or killing a WNFG gray whale. The Government of the USA requested the Committee to test this plan to ensure that it meets IWC conservation objectives.

This task was begun at the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales (SC/67b/Rep07) from 28-31 March 2018. The major focus of the Workshop related to finalising the specifications for modelling, to enable results to be available for SC67b including incorporation of the Makah Management Plan (SC/67b/Rep07, Annex E, appendix 1) into the modelling framework. The factors taken into account in the trials are given in Table 6.

At the present meeting, the focus was on the conservation performance of the Makah Management Plan. Performance was evaluated in the same manner as described for the evaluation of the *SLA*s for West Greenland fin and common minke whales (see Items 6.1 and 6.2). The results can be found in Annex E (appendix 6). The only scenarios under which the plan might not perform adequately were considered to have low plausibility (e.g. a bycatch mortality of ~20 PCFG whales per year). Annex E, fig. 4 shows the bivariate plot.

7.1.3.2 CONCLUSIONS AND RECOMMENDATIONS

The management advice relating to the Makah Management Plan is provided under Item 8.2.

[5]Final validation and archiving of results will be undertaken by Allison in Cambridge.

Attention: C-A, SC

The Committee reviewed a US Management Plan for a Makah hunt of gray whales off Washington State (the Committee had evaluated a previous plan in 2011 - IWC, 2011; 2012), using the modelling framework developed for its rangewide review of gray whales (SC/67b/Rep07). In conclusion, the Committee:

*(1) **agrees** that the performance of the Management Plan was adequate to meet the Commission's conservation objectives for the Pacific Coast Feeding Group, Western Feeding Group and Northern Feeding Group gray whales;*
*(2) **notes** that the proposed management plan is dependent on photo-identification studies to estimate PCFG abundance and the mixing proportions of PCFG whales available to the hunt (and to bycatch in its range);*
*(3) **stresses** that its conclusions are dependent on the assumption that these studies will continue in the future; and*
*(4) **expresses** its great thanks to Punt, Brandon and Allison for their excellent work in developing and validating the testing framework and running the trials.*

7.1.4 Conclusions on AWMP work

The Chair of the SWG on the AWMP, Donovan, noted that this meeting represented the end of a long journey – with the adoption of the two new *SLA*s, the SWG and the Committee has completed the development tasks it had been assigned by the Commission, originally in Resolution 1994-1. It was an immense task but a great pleasure to work with such dedicated and talented people. He thanked all of the scientists who have made such a wonderful contribution to this work over the years and especially Geof Givens, Kjartan Magnússon (sadly no longer with us), Eva Dereksdóttir, Lars Witting, Anabela Brandão, Doug Butterworth, Cherry Allison and André Punt – the SWG has, in his view, achieved ground-breaking work over the last two decades in a spirit of great collaboration and co-operation, even when there were disagreements, as inevitably there were. He also thanked the hunters and their representatives who had made major contributions in terms of not only data provision but also advice on the AWS (see Item 7.2). The Committee concurred that this was an excellent example of what the Scientific Committee could achieve with international collaboration. Finally, they thanked Donovan for his dedicated, good humoured and impartial leading of such a major piece of complex work over such a long period - this work has been central to the Committee's role in providing the best scientific advice to the Commission on aboriginal subsistence whaling hunts, bringing together conservation needs and the needs of the hunters.

Table 6

Summary of the main factors considered in the Makah gray whale trials.

Factor	
Model fitting related: - Stock hypothesis - MSYR - Mixing rate - Immigration into the PCFG - Bycatches and ship strikes - Pulse migrations into the PCFG	Projection-related: - Additional catch off Sakhalin - Catastrophic events - Northern need in final year - Struck and lost rate - Future effort - Factors related to obtaining and matching photographs

7.2 Aboriginal Whaling Scheme (AWS)

7.2.1 Introduction

The Scientific Committee's Aboriginal Whaling Management Procedure (AWMP) applies stock-specific *Strike Limit Algorithms* (*SLA*s) to provide advice on aboriginal subsistence whaling (ASW) strike/catch limits.

ASW management (as part of an AWS, the aboriginal whaling scheme) incorporates several components, several of which have a scientific component:

(1) *Strike Limit Algorithms* (case-specific) used to provide advice on safe catch/strike limits;
(2) operational rules (generic to the extent possible) including carryover provisions, block quotas and interim relief allocations;
(3) Guidelines for *Implementation Reviews*; and
(4) Guidelines for data and analysis (e.g. guidelines for surveys, other data needs).

Considerable work on updating the AWS since the version presented (but not accepted by) to the Commission in 2002 (IWC, 2003) was undertaken by an intersessional correspondence group (SC/67b/AWMP 21) and at the intersessional workshops (SC/67b/Rep04).

7.2.2 Carryover request from the Governments of USA and Denmark/Greenland

The Governments of USA and Denmark/Greenland (SC/67b/Rep06, Annex F, appendix) had requested advice at the March intersessional Workshop on the conservation implications of carryover provisions allowed for a carryover provision that allowed use of unused strikes from the previous three blocks, provided that the number used in any year did not exceed 50% of the annual strike limit.

This request was tested on the two *SLA*s available for stocks hunted by the USA and Greenland at the time of the Workshop i.e. the *Bowhead SLA* (applicable to the Bering-Chukchi-Beaufort Seas stock) and the *WG-Humpback SLA* (applicable to West Greenland).

Three types of options were examined:

(1) baseline case - all strikes taken annually (i.e. no need for carryover);
(2) 'frontload' case - strikes taken as quickly as possible within block (+50% limit annually until the block limit is reached); and
(3) two alternative scenarios where carryover strikes are accrued for one or three blocks, followed by a period of carryover usage subject to the +50% limit.

The three-block scenario considered in (3) served as a direct test of the provision described in the request of USA and Denmark/Greenland.

Attention: CG-A

The Committee received a request from the USA and Denmark/Greenland (SC/67b/Rep06, Annex F, appendix) on the conservation implications of carryover provisions that '…allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit'.

The Committee reviewed the request using its simulation frameworks and the two SLAs available for stocks hunted by the USA and Greenland available at the time of the Workshop i.e. the Bowhead SLA (applicable to the Bering-

Chukchi-Beaufort Seas stock) and the WG-Humpback SLA (applicable to West Greenland):

(1) ***agrees*** *that a carryover provision for up to 3-blocks meets Commission's conservation objectives;*
(2) ***reiterates*** *its previous advice, applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable; and*
(3) ***agrees*** *to evaluate the above request for the other Greenland SLAs at the 2019 Committee meeting.*

7.2.3 Review proposed updates to the AWS

The proposed update to the previous AWS is provided in Annex E, appendix 8. It has sections on carryover, block quotas, interim relief allocation (and see Annex E, appendix 7), *Implementation Reviews* and guidelines for surveys and data.

7.2.4 Conclusions and recommendations

Attention: C-R

The Committee has been working for some years to update the scientific components of an Aboriginal Whaling Scheme. It has completed this work and recommends the AWS provided in Annex E, appendix 8 to the Commission. It has sections on carryover, block quotas, interim relief allocation (and see Annex E, appendix 7), Implementation Reviews and guidelines for surveys and data. It notes that the Commission's AWS may include additional, non-scientific provisions.

7.3 *Implementation Review* of BCB bowhead whales

According to the Committee's guidelines, 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 a *Strike Limit Algorithm* (*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).

The *Bowhead SLA* was adopted in 2002 (IWC, 2003, p.158) and there was an extensive *Implementation Review* completed in 2007 (IWC, 2008a, p.124) with a major focus on stock structure including three intersessional workshops. That included consideration of additional trials investigating management implications of assuming additional population structure even though these were considered of low plausibility. The Committee concluded that the *Bowhead SLA* remained the best tool to provide management advice. The next *Implementation Review* was completed in 2012 (IWC, 2013b, p.147); that concluded that there was no need to develop additional trials to those evaluated during the previous *Implementation Review* (IWC, 2008c).

The primary review was undertaken by the SWG on the AWMP (Annex E, Item 4) but the review benefitted from discussions within two other groups, SD-DNA (Annex I) and ASI (Annex Q).

7.3.1 Stock structure: review new information

A full discussion of the work on stock structure can be found in Annex E (item 4.1) and Annex I. New information considered included genetic analyses (SC/67b/SDDNA 01) and telemetry results (SC/67b/AWMP04). SC67b/SDDNA01provided information on genetic analyses using samples from the BCB, Canadian and Okhotsk Sea stocks of bowhead whales. Within the BCB stock, no significant differences were identified in temporal or spatial comparisons, and age-related structure was not detected in comparisons between groups of large (old) versus small (young) whales. While comparisons of the BCB stock with the Okhotsk Sea stock revealed significant differences, there were only small, and in most cases statistically insignificant, differences between BCB and Canadian stocks. While this pattern could be related to historical connectivity between the two stocks, it could also, or additionally, be driven by some degree of contemporary gene flow.

Attention: SC

With respect to stock structure, considering the multiple lines of evidence, the Committee:

(1) ***agrees*** *that BCB bowheads comprise a single population, with no signs of substructure;*
(2) ***agrees*** *that there was no need to consider any new SLA trials regarding stock structure, since the trials conducted in 2002 and 2007 already covered all plausible stock structure hypotheses;*
(3) ***welcomes*** *the telemetry information provided, thanks the hunters involved for their skill and assistance;*
(4) ***encourages*** *additional telemetry efforts; and*
(5) ***agrees*** *with the suggestions for future genetic studies in the Arctic provided under Item 11.*

7.3.2 Abundance estimates: review new information

A new abundance estimate (SC/67b/AWMP) has been accepted for the year 2011 from a long-term photo-id capture-recapture study (27,133, CV=0.217; 95% CI from 17,809 to 41,337) that it has been agreed is suitable for providing management advice and for use in the *SLA* (Annex Q). The previously accepted, completely independent, 2011 abundance estimate from the ice-based survey (Givens *et al.*, 2016) is also acceptable for use in the *SLA* and has already been used in that regard (16,820, CV=0.052; 95% CI 15,176 to 18,643).

There are thus two independent estimates for the same year considered suitable for use in the *SLA* and this is considered under Item 8.3.

The Committee also discussed plans for future surveys (SC/67b/AWMP 12 and AWMP 16) in Annex Q (item 3.1.1.1). These plans are in accord with the AWS Guidelines that 'plans for undertaking a survey/census should be submitted to the Scientific Committee in advance of their being carried out, although prior approval by the Committee is not required.

7.3.3 Biological parameters: review new information

New and extensive information on biological parameters was received as discussed Annex E (item 4.3). These covered such matters: length at sexual maturity and pregnancy rate from hunted animals (SC/67b/AWMP 07); the potential use of samples from baleen plates to examine hormone cycles and pregnancy; and information on calves from aerial surveys (SC/67b/AWMP03).

Attention: SC

With respect to biological parameter information, the Committee:

*(1) **welcomes** the extensive information presented;*
*(2) **encourages** the continued collection of such data from the hunt;*
*(3) **encourages** the work on the baleen plate analyses to examine hormone levels and pregnancy;*
*(4) **encourages** continued aerial surveys under the ASAMM surveys and any future collaboration involving life history data from the harvest; and*
*(5) **agrees** that the information presented does not suggest the need to consider any new SLA trials regarding stock structure.*

7.3.4 Removals: review new information

The Committee received updated information about the 2017 harvest (SC/67b/AWMP 05) and long-term removals (SC/67b/AWMP 06). In 2017, 57 bowhead whales were struck resulting in 50 animals landed. The total landed for the hunt in 2017 was higher than the average over the past 10 years (2007-2016 mean of landed =41.7; SD=6.7). Efficiency (number landed / number struck) in 2017 was 88%, which was also higher than the average for the past 10 years (mean of efficiency=75.2%; SD=6.5%).

The Committee also received SC/67b/AWMP06 that provided a summary of bowhead whale catches in Alaska between 1974 and 2016. The authors pointed to the excellent cooperation and contribution of the whale hunters from the 11 villages that are members of the Alaska Eskimo Whaling Commission (AEWC). This information is discussed in Annex E (item 4.4).

From 2013 to 2017, four bowhead whales (2 females and 2 males) were harvested near Chukotka, mainly in Anadyr Bay (SC/67b/AWMP20). The average length was 14.5m (minimum 13.0m, maximum 17.0m). Although the portion of the annual strike limit allocated to Russia under their bilateral agreement with the USA is 5 animals, the actual annual take is usually only 1-2 whales per year, and this has been the case since at least 2004.

The Committee thanked the authors of the provision of this information, noting that catch and strike data are used in the *SLA* calculations (see Item 8.3).

7.3.5 Other anthropogenic threats and health: review new information

The Committee received extensive information related to threats and health ranging from entanglement, predation and health (body condition, pathology and parasite loads). The discussion of this can be found in Annex E (item 4.5).

Attention: SC

With respect to threats and health to the BCB bowhead whales, the Committee:

*(1) **welcomes** the extensive information presented;*
*(2) **agrees** that whilst the present level of unintentional human induced mortality is too low to require new Implementation trials or incorporation into the SLA calculations, the situation should continue to be monitored and evaluated at the next Implementation Review;*
*(3) **agrees** that the health analyses give no cause for concern with respect to the continued application of the Bowhead SLA; and*
*(4) **encourages** that the excellent work on health-related issues continues.*

7.3.6 Conclusions and recommendations (and, if needed, work plan to complete Review)

Attention: SC

*With respect to the Implementation review of BCB bowhead whales, the Committee **concludes** that:*

(1) the Implementation Review has been satisfactorily completed; and
(2) the range of hypotheses and parameter space already tested in Bowhead SLA trials was sufficient and therefore the Bowhead SLA remains the best way to provide management advice for this stock.

In addition, it thanks the US scientists for the extremely hard work that they have put into providing comprehensive papers to facilitate this review.

8. STOCKS SUBJECT TO ABORIGINAL SUBSISTENCE WHALING (NEW INFORMATION AND MANAGEMENT ADVICE)

The Committee noted that the Commission will be setting new catch/strike limits for at its 2018 biennial meeting in Brazil. It had received written or verbal requests for limits to be considered for each hunt as discussed below.

Attention: C-A

A general request had been received from the USA and Denmark (SC/67b/Rep06, annex F, appendix) for advice on whether there would be a conservation issue if there was a one-time 7-year block followed by a return to 6-year blocks to address logistical issues related to the Commission.

*The Committee **agrees** there are no conservation issues associated with this suggestion (and see the block quota section of the ASW in Annex E, appendix 8).*

8.1 Eastern Canada/West Greenland bowhead whales

8.1.1 New abundance information

Last year, the Committee had recommended that Canadian scientists attend the Committee to present the results of their work on abundance. It was very pleased that Doniol-Valcroze from Department of Fisheries and Oceans Canada, and the primary author of the paper on the 2013 aerial survey abundance estimate, was present at the meeting.

The Committee accepted, for the provision of management advice and use in an *SLA* (see Annex Q for details), the fully corrected abundance estimate (Doniol-Valcroze *et al.*, 2015) from a 2013 aerial survey of 6,446 bowheads (CV=0.26, 95% CI 3,722-11,200). The survey covered the major summering area for the Eastern Canada/ West Greenland (EC/WG) stock.

The Committee recalled that the *WG-Bowhead SLA* had been developed on the conservative assumption that the abundance estimates for the West Greenland area alone (1,274 whales in 2012 (CV=0.12)) represented the abundance of the whole stock, as it believed that it was not possible to assume that a non-member country would continue with regular surveys. Doniol-Valcroze advised the Committee that the present management strategy of Canada does involves obtaining regular abundance estimates. The Committee noted it would be pleased to receive such estimates from Canada being presented to the Committee in the future.

Attention: SC

The Committee greatly appreciated the presence of a Canadian scientist at its meeting. The Committee:

*(1) **welcomes** the provision of the abundance estimate for the Eastern Canada/West Greenland stock and (see Item 8.1.2) the regular provision of information on catch data by Canada;*
*(2) **welcomes** the attendance of Canadian scientists at its meetings;*
*(3) **agrees** that consideration of how to incorporate abundance estimates from Canada should be one focus of the next Implementation Review for this stock;*
*(4) **notes** the regular collaboration of Canadian and Greenlandic scientists on other matters such as genetic sampling (inter alia for mark-recapture abundance estimation); and*
*(5) **encourages** further collaboration between Canada, Greenland and the USA for the study of bowhead whales across their range and the presentation of these results at future Committee meetings.*

8.1.2 New catch information

SC/67B/AWMP/10 provided an update of recent Canadian takes made in the Inuit subsistence harvest of the EC-WG bowhead whale stock. In the eastern Canadian Arctic, the maximum allowed take is 7 bowhead whales per year according to domestic policy, with no carry-over of unused takes between years. Since 2015, 5 strikes were taken and 4 bowhead whales were successfully landed (1 in 2015, 2 in 2016 and 1 in 2017). Witting reported that West Greenland hunters struck no bowheads in 2017. There was one 14.7m whale that died from entanglement in crab gear.

The Committee notes that the reported number of strikes was within the parameter space that was tested for the *WG-Bowhead SLA*, and encourages the continued collection of genetic samples from harvested whales.

8.1.3 Management advice

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67 and no changes were requested for bowhead whales. The Committee therefore:

*(1) **agrees** that the WG-Bowhead SLA remains the best available way to provide management advice for the Greenland hunt;*
*(2) **notes** that this SLA had been developed under the conservative assumption that the number of bowhead whales estimated off West Greenland represented the total abundance between West Greenland and Eastern Canada;*
*(3) based on the agreed 2012 estimate of abundance for West Greenland (1,274, CV=0.12), the catch of one whale in Canada in 2017, and using the agreed WG-Bowhead SLA, **agrees** that an annual strike limit of two whales will not harm the stock and meets the Commissions conservation objectives; and*
*(4) although the Committee has not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, annex F, appendix) for the WG-Bowhead SLA, **reiterates** its advice**,** applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next, is acceptable.*

8.2 North Pacific gray whales

8.2.1 New information (including catch data)

The Committee received considerable new information on the hunt off Chukotka as discussed in Annex E (item 5.2). In 2017, a total of 119 gray whales were struck in 2017 (37 males and 82 females). No whales were struck and lost, and no stinky (inedible) gray whales were taken. Similar whaling methods were employed as in recent years and the overall efficiency of the hunt was almost same as in 2016.

In advance of the gray whale *Implementation Review* that is scheduled to begin in 2019, the Committee reviewed new information regarding the stock structure of gray whales in the North Pacific (SC67b/SDDNA02 and SC67b/SDDNA03) – for details see Annex I. The results were based on whole genome sequence data from three individuals (one sampled off Barrow, Alaska and two sampled off Sakhalin Island, Russia) and SNP genotype data generated from larger sample sets representing whales sampled off Sakhalin and in the Mexican lagoons.

Attention: SC

*In reviewing the results of new genetic analyses of gray whales in the North Pacific, the Committee **agrees** that the genetic and photographic data for this species be combined to better assess stock structure-related questions. Given the potential for genomic data to aid in better evaluating the stock structure hypotheses currently under consideration for North Pacific gray whales, the Committee **encourages** the continuation of work to produce additional genomic data from sampled gray whales.*

8.2.2 Management advice

Attention: C-A

The Russian Federation (SC/67b/AWMP/17) had requested advice on the following provision:

'For the seven years 2019, 2020, 2021, 2022, 2023, 2024 and 2025, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 980 (i.e. 140 per annum on average) provided that the number of gray whales taken in any one of the years 2019, 2020, 2021, 2022, 2023, 2024 and 2025 shall not exceed 140.'

The Committee therefore:

*(1) **agrees** that the Gray Whale SLA remains the best available way to provide management advice for the gray whale hunts;*
*(2) **advises** that an average annual strike limit of 140 whales will not harm the stock and meets the Commission's conservation objectives;*
*(3) **notes** that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next remains acceptable;*
*(4) **advises** that the Makah Management Plan (see Item 2.3) also is in accord with the Commission's management objectives.*

8.3 Bering-Chukchi-Beaufort Seas bowhead whales

8.3.1 New information

New information (on abundance and catches) was considered as part of the *Implementation Review* discussed under Item 7.3.

The USA had indicated that it was proposing no changes to the present catch/strike limits although it may suggest changes to its carryover request in light of the advice received by the Committee as discussed at the intersessional workshop (SC/67b/Rep06).

The Committee noted that there are now two independent estimates of abundance for this stock in 2011 (see Item 7.3.1). Recognising the need to formally consider the general question of how best to combine estimates in such cases as part of the workplan in the next biennium, the Committee noted that if they are combined as a weighted average by the inverse of their variances, there is little difference (it is slightly higher) between the combined estimate and that from the ice-based census estimate; the ice-based approach has been the method used for the other estimates used in the *SLA*. Therefore, the ice-based census estimate for 2011 (16,820, CV=0.052; 95% CI 15,176 to 18,643) is considered the most recent estimate of abundance for use in the *Bowhead SLA* this year.

8.3.2 Management advice

Attention: C-A

The USA indicated that it requested advice on the existing catch/strike limits. The Committee therefore:

*(1) **agrees** that the Bowhead Whale SLA remains the best available way to provide management advice for this stock;*
*(2) **advises** that a continuation of the present average annual strike limit of 67 whales will not harm the stock and meets the Commission's conservation objectives; and*
*(3) **advises** that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit, has no conservation implications (see SC/67b/Rep04).*

8.4 Common minke whales off East Greenland

8.4.1 New information on catches

In the 2017 season, nine common minke whales (3 males and 6 females) were landed in East Greenland, and one was struck and lost. Genetic samples were obtained from 8 of the landed whales. One common minke whale died from entanglement in fishing gear.

8.4.2 New information on abundance

The Committee endorsed the 2015 aerial survey abundance estimate of 2,762 (CV=0.47; 95%CI 1,160-6,574). This is only a small part of the wider Western and Central stocks from which catches may occur.

8.4.3 Management advice

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on an annual take of 20 animals (it had previously been 12). It had also requested advice on any conservation implications of a 12-month hunting season for common minke whales.

The Committee therefore:

*(1) **notes** that in the past its advice for the East Greenland hunt had been based upon the fact that the catch was a small proportion of the number of animals in the Central Stock;*
*(2) **notes** the process to develop an SLA for common minke whales off West Greenland resulted in a simulation framework that produces a considerably more rigorous way to provide advice for this hunt than before, by taking into account stock structure issues;*
*(3) **notes** that the results of the simulation trials that incorporated a continuing catch of 20 whales from East Greenland gave rise to no conservation concerns;*
*(4) **notes** that the 2015 aerial survey abundance estimate of 2,762 (CV=0.47; 95%CI 1,160-6,574) is only a small part of the wider western and central stocks;*
*(5) **advises** that a continuation of the present average annual strike limit of 20 whales will not harm the stock and meets the Commission's conservation objectives;*
*(6) **advises** that changing the length of the season to 12 months had no conservation implications; and*
*(7) **agrees** that an SLA should be developed for this hunt in the future; and*
*(8) **encourages** the continued collection of samples from collaborative genetic analyses (and see Item 7.1.2.3).*

8.5 Common minke whales off West Greenland

8.5.1 New information on catches

In the 2017 season, 129 common minke whales were landed in West Greenland and four were struck and lost. Of the landed whales, there were 95 females, 33 males and one of unknown sex. Genetic samples were obtained from 104 whales, and the Committee was pleased to note that samples were already part of the data used in the genetic analyses of common minke whales in the North Atlantic. The Committee encourages the continued collection of samples and the collaborative approach of the genetic analysis.

8.5.2 New information on abundance

The Committee endorsed the 2015 aerial survey abundance estimate of 5,095 (CV0.46; 95%CI 2,171-11,961) as discussed in Annex Q.

8.5.3 Management advice

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on annual strikes of 164 animals (i.e. no change). It had also requested advice on any conservation implications of a 12-month hunting season for common minke whales.

The Committee therefore:

*(1) **agrees** that the WG-Common minke SLA is the best available way to provide management advice for this stock under need scenario A;*
*(2) **advises** that a continuation of the present average annual strike limit of 164 whales will not harm the stock and meets the Commission's conservation objectives;*
*(3) although the Committee has not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, annex F, appendix) for this SLA, **reiterates** its previous advice,*

applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable;

*(4) **advises** that changing the length of the season to 12 months had no conservation implications; and*

*(5) **encourages** the continued collection of samples for collaborative genetic analyses (and see Item 7.1.2.3).*

8.6 Fin whales off West Greenland

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on annual strikes of 19 animals (i.e. no change).

8.6.1 New information on the catch

A total of seven fin whales (5 females and 2 males) was landed, and one was struck and lost, off West Greenland during 2017. The Committee was pleased to note that genetic samples were obtained from five of these, and that the genetic samples are analysed together with the genetic samples from the hunt in Iceland.

8.6.2 New information on abundance

The Committee endorsed the 2015 aerial survey abundance estimate of 2,215 (CV=0.41; 95%CI 1,017-4,823) for use in providing management advice and in the *SLA* as discussed in Annex Q (Item Y).

8.6.3 Management advice

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on annual strikes of 19 animals (i.e. no change). It also requested advice on whether there were any conservation implications of removing length limits (while retaining the prohibitions relating to calves.

The Committee therefore:

*(1) **agrees** that the WG-Fin SLA is the best available way to provide management advice for this stock;*

*(2) **advises** that a continuation of the present average annual strike limit of 19 whales will not harm the stock and meets the Commission's conservation objectives;*

*(3) although the Committee has not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, annex F, appendix) for this SLA, **reiterates** its advice, applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable;*

*(4) **advises** that removing the length limits had no conservation implications; and*

*(5) **encourages** the continued collection of samples for collaborative genetic analyses (and see Item 7.1.1.3).*

8.7 Humpback whales off West Greenland

8.7.1 New information on catches

A total of two (both female) humpback whales were landed and none were struck and lost in West Greenland during 2017. Genetic samples were obtained from all the landed whales. The importance of collecting genetic samples and photographs of the flukes from these whales is emphasised. Five humpback whales were observed entangled in fishing gear in West Greenland in 2017. Of these, one died, two became free and one was successfully disentangled by a disentanglement team. The remaining animal was alive and still entangled when it was last sighted.

Inclusion of bycaught whales had been incorporated into the scenarios for the development of the *Humpback SLA*. If high levels continued, then this will need to be taken into account in any *Implementation Review*. The Committee noted the IWC efforts with respect to disentanglement and prevention and welcomed the news that the Greenland authorities requested IWC disentanglement training that took place in 2016 and that they successfully disentangled one humpback whale.

8.7.2 New information on abundance

The Committee endorsed the 2015 aerial survey abundance estimate of 993 (CV=0.46; 95%CI 434-2,272) as discussed in Annex Q (Item Y) for use in the provision of management advice and in the SLA.

8.7.3 Management advice

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on annual strikes of 10 animals (i.e. no change).

The Committee therefore:

*(1) **agrees** that the WG-Humpback SLA is the best available way to provide management advice for this stock;*

*(2) **advises** that a continuation of the present average annual strike limit of 10 whales will not harm the stock and meets the Commission's conservation objectives;*

*(3) **advises** that that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit' has no conservation implications (see SC/67b/Rep04); and*

*(4) **encourages** the continued collection of samples and photographs for collaborative analyses.*

8.8 Humpback whales off St. Vincent and The Grenadines

The alternate Commissioner for St Vincent and the Grenadines advised that no change to the present limits were envisaged.

8.8.1 New information on catch

It was reported that one humpback whale was struck and landed in 2017 by St. Vincent and The Grenadines.

8.8.2 New information on abundance

Last year, the Committee had requested that the USA provide a new abundance estimate for the western North Atlantic based upon the available NOAA data. A progress report on this work was provided with a focus on information on abundance estimates generated by the MONAH study, conducted in 2004 and 2005 on Silver Bank (a breeding ground in the West Indies) and in the Gulf of Maine feeding ground. The best estimate around 12,300, similar to the Committee endorsed best estimate from the YONAH project from 1992/93, which was 10,400 (8,000, 13,600). The lack of strong population growth was unexpected given information on rates of increase from some other areas of the North Atlantic, and may reflect either a true rate of increase, unidentified sampling bias, and/or the idea that Silver Bank as a habitat has reached maximum capacity. It is not clear whether the MONAH estimate is representative of the entire population, nor the extent to which the full estimate can be applied to the southeastern Caribbean in the context of the St Vincent hunt. However, four animals from the Gulf of Maine have been linked to animals seen in the southeastern Caribbean (including one that was caught in the hunt).

The Committee also noted several endorsed recent abundance estimates of humpback whales in parts of the North Atlantic including: 993 (95% CI: 434-2,272) in West Greenland in 2015; 4,223 (95% CI: 1,845-9,666) in East Greenland in 2015; and 12,879 (95% CI 5,074; 26,455) in the Iceland-Faroes region in 2007.

It has now been nearly two decades since the IWC has done an In-Depth Assessment on North Atlantic humpback whales. The Committee agrees that it would be a valuable exercise to perform a North Atlantic Rangewide review of humpback whales, similar in scope to the Rangewide Review for North Pacific gray whales and taking into account recent work on stock structure including that of Stevick *et al.* (2018).

8.8.3 Management advice

Attention: C-A

The alternate Commissioner for St Vincent and the Grenadines advised that no change to the present limits were envisaged. The Committee therefore:

*(1) **notes** that is does not have an approved abundance estimate for western North Atlantic since that in 1992;*
*(2) **notes** that in accord with the advice provided in the AWS (see Annex E, Appendix 8), it therefore **considered** the available evidence to see if was sufficient to provide safe management advice; and*
*(3) **advises** that, given the information above on recent abundance in the North Atlantic combined with the size of the requested catch/strikes (an average of four annually), continuation of the present limits will not harm the stock.*

The Committee also reiterates its previous advice that:

(1) the status and disposition of genetic samples collected from past harvested whales be determined and reported next year;
(2) photographs for photo-ID (where possible) and genetic samples are collected from all whales landed in future hunts; and that
(3) the USA (NOAA, NMFS) provides an abundance estimate from the MONAH data as soon as possible for the Committee.

8.9 Work plan 2019-20

Table 7 summarises the work plan for work related to aboriginal subsistence whaling. The Committee also established an Intersessional Correspondence Group to work on ASW related issues (Annex Y).

9. WHALE STOCKS NOT SUBJECT TO DIRECTED TAKES

9.1 In-depth Assessments

Donovan gave a presentation explaining a streamlined procedure hereby the Committee, via its sub-groups, can undertake Comprehensive Assessment (traditionally the first time an assessment is undertaken for a particular species/ocean basin) or an in-depth assessment (assessments subsequent to a comprehensive assessment). This can be found as SC/67B/GEN04 and is summarised in Fig. 1. The objective is to provide a consistent approach (including methods) that initially focusses on ensuring that sufficient data are available to undertake an assessment (the pre-assessment approach that will normally be undertaken at annual meetings) and then follows this with a concentrated effort (ideally two workshops and two annual meetings, with no new data) to complete the assessment. The objective is to provide Commission with robust information on present status. This involves identifying:

(1) if populations are recovering, recovered or if there is cause for concern;
(2) factors that may be or are affecting status so that conservation and management needs can be determined; and
(3) information gaps and ways to address these in order to reduce uncertainty at the next assessment.

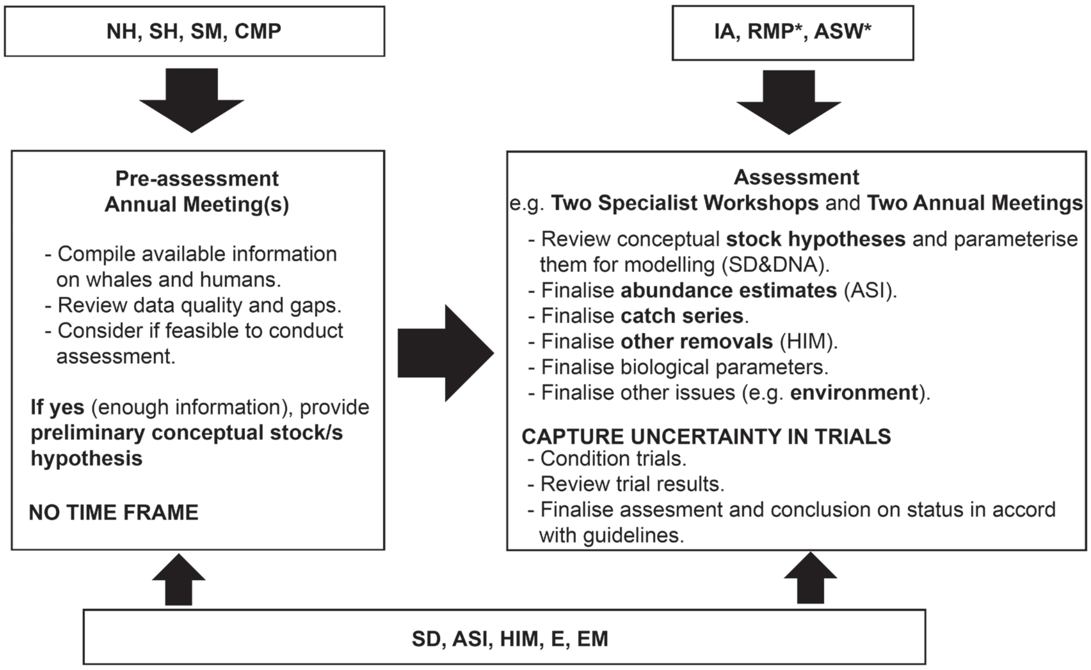
9.1.1 Comprehensive Assessment of North Pacific humpback whales

Work towards a Comprehensive Assessment of North Pacific humpback whales began in 2016, and included an intersessional workshop held in April 2017 (IWC, 2018b). After the 2017 Committee meeting, an intersessional steering group continued preparing the input data and assessment model (SC/67b/IA03). The assessment model

Table 7

Work plan for matters related to aboriginal subsistence whaling.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
(1) Annual review of catch/strike limits		Carry out		Carry out
(2) *Implementation Review*		Gray whales based upon rangewide review.		West Greenland humpback whales
(3) *SLA*s		Consider development of an *SLA* for the hunt of common minke whales off East Greenland based on operational models developed for the West Greenland hunt.		Adopt *SLA* if it is decided one is necessary.
(4) Interim relief allowance testing	Run trials for gray whale hunts.	Review results	Run trials for West Greenland common minke whales and fin whales.	Review results
(5) Carryover (US/Denmark request)	Run trials for remaining Greenland hunts (West Greenland common minke whales, bowhead whales and fin whales).	Review results		



is a simplified age-aggregated model of the breeding and feeding grounds. The development of the input data (stock structure, abundance, catches, and life history parameters) continued during the year but given the slower than initially expected progress, particularly with respect to narrowing down the number of stock structure hypotheses, the steering group had agreed that it was premature to hold the anticipated workshop prior to SC67b (see Figure above).

Work continued at this meeting and the detailed discussions can be found in Annex F (item 4). The subdivisions of the North Pacific humpback whale feeding and breeding grounds in Annex F (fig. 1) are broadly consistent with existing data; identified uncertainties will be addressed in the assessment by evaluating four scenarios with different numbers of feeding and breeding grounds. This work will be greatly assisted by undertaking comparisons of humpback whale photographs from the Pacific obtained after the conclusion of the photographic component of the SPLASH (Structure of Populations, Levels of Abundance and Status of Humpback Whales) programme in 2005 (e.g. see Calambokidis *et al.*, 2008).

The general underlying structure of the assessment model has been developed but before the model can be run the input data (e.g. catches and abundance estimates) need to be updated and allocated for each stock structure hypotheses and mixing matrices developed and parameterised.

Attention: SC, G

The Committee is undertaking a Comprehensive Assessment of North Pacific humpback whales. To complete this assessment the Committee ***agrees*** *that:*

(1) a large-scale matching effort of post-2005 photo-identifications should be undertaken (see Annex F, item 4 for methods); and

(2) this matching effort will (a) help clarify the connections among the feeding/breeding areas within the North Pacific; and (b) assist in developing updated abundance estimates where appropriate.

The Committee stresses that to obtain the most robust assessment and thus conservation advice, all available data should be included in the matching effort. Therefore, the Committee strongly encourages all catalogue holders to participate in this exercise, after the appropriate data sharing agreements are made.

The Committee also welcomes the provision of new abundance estimates (e.g. those from the IWC-POWER surveys and from local areas in Japan), noting that they will also need to be adjusted for the various stock structure hypotheses.

The Committee agrees that the next assessment workshop should take place at a time prior to SC68b when the intersessional Steering Group (Annex Y) decides sufficient progress has been made.

9.1.2 Comprehensive Assessment of North Pacific sei whales

The Committee began what was called an in-depth assessment of North Pacific sei whales in 2015 (IWC, 2016c) but, in keeping with the discussion under Item 9.1 will now be termed a Comprehensive Assessment for consistency. Work has focussed since then on finalising the stock structure hypotheses (two have been agreed for use in the assessment - a single-stock hypothesis and a five-stock hypothesis), developing an appropriate population model and finalising the model inputs in accordance with these hypotheses (including catches, mark-recovery locations, abundance estimates, estimates of mixing between sub-areas, and life history parameters).

Considerable progress was made with this work intersessionally and at this meeting as discussed in Annex H, item 3.

Attention SC, G

The Scientific Committee intends to complete the Comprehensive Assessment of North Pacific sei whales within the next biennial period. It notes the progress made at this meeting with respect to stock structure, abundance estimates, marking data, catch history, life history parameters and the assessment model. To complete this work, the Committee ***agrees*** *to:*

(a) the work undertaken to finalise input data for the assessment (Annex F, appendices 2-7);
(b) support the modelling work identified in Annex F; and
(c) re-establish the intersessional steering group to oversee the assessment.

In addition, the Committee ***encourages*** *telemetry work in waters outside the 'pelagic' sub-area to assist in quantifying the movement patterns of animals.*

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

An intersessional correspondence group under Murase completed its task to finalise a document synthesising the results of the 2001 - 2014 in-depth assessment of an eastern Indian stock (I-stock) and a western South Pacific stock (P-stock) of Antarctic minke whales distributed between 35°E and 145°W.

The Committee commends the authors for completing this paper and submitting it to the *Journal of Cetacean Research and Management.* As the paper has just entered the review process, the intersessional correspondence group (Annex X) has been re-established to see the paper through to publication.

9.1.4 Work plan 2019-20

The work plan for Comprehensive and in-depth assessments for the next biennium is provided in Table 8.

9.2 Evaluation for potential new Comprehensive or In-Depth Assessments

9.2.1 North Pacific blue whales

The Committee welcomed the report of an intersessional group that had been determining the data that are available on items required to carry out a Comprehensive Assessment of blue whales in the North Pacific. The status of the eastern North Pacific population is well known and a stock assessment was reviewed and accepted by the Committee in 2016 (Monnahan and Branch, 2015). However, information from the central and western North Pacific is sparser. Information presented at this meeting concerned stock structure, catch history, biological parameters, photo-identification, Discovery marks and sighting surveys. Details can be found in Annex G (item 6.1).

Several papers and datasets were discussed including: the use of blue whale sounds to identify stocks; morphological data; genetic data; sightings data (SC/67b/IA02; SC/67b/SCSP06; SC/67b/SCSP07; SC/67b/NH08).

Attention: SC

The Committee ***agrees*** *the following priorities to progress the pre-assessment:*

(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) compare photo-identification data from POWER, JARPN/JARPNII and other ENP catalogues;
(5) Review new acoustic locations and information and conduct fine-scale analysis of song features for central Pacific blue whale calls, with particular focus on calls around Japan;
(6) Obtain better life history parameters (especially age at sexual maturity and calving interval) from the Cascadia Research Collective, the Mingan Island Cetacean Study Research Station and the CICIMAR-IPN photo-ID dataset; and
(7) With respect to (3), the Committee ***requests*** *the collection of about 20 biopsy samples if possible during the NEWREP-NP surveys in the western North Pacific to improve the power to evaluate stock structure and* ***encourages*** *genetic analysis of the existing Japanese samples.*

With respect to (5), the Committee ***requests*** *a reanalysis of recordings from the Northern Mariana Islands (Saipan and Tinian) collected by the Pacific Islands Fisheries Science Center to look for the presence or absence of the new song type recorded from Japan. It also* ***encourages*** *passive acoustic data collection during surveys (e.g. IWC-POWER, university/training cruises) from the region of high blue whale density southeast of the Kamchatka Peninsula to determine the song type produced by animals in that region. The Committee* ***agrees*** *that the intersessional correspondence group continue to review data needed for an assessment of North Pacific blue whales be reappointed under Branch (Annex Y).*

9.2.2 Non-Antarctic Southern Hemisphere 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 (see Item 3.1, IWC, 2018a). This year, the web-based pygmy

Table 8

Work plan for in-depth assessments.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting (SC/68b)
In-depth Assessment of Indo-Pacific Antarctic minke whales	Complete review of paper submitted for publication.			
Comprehensive Assessment of North Pacific sei whales	Re-establish the ISG (see Annex Y) to further data preparation and development of the assessment model.	Review progress of intersessional work and continue the assessment.	Finalise preparation of assessment.	Review progress of intersessional work and finalise the assessment.
Comprehensive Assessment of North Pacific humpback whales	Re-establish the ISG (see Annex Y) to further data preparation, development of the assessment model and hold a Workshop.	Review progress of intersessional work and continue the assessment.	Finalise /continue preparation of assessment.	Review progress of intersessional work and continue/finalise the assessment.

blue whale song library funded by the IWC will be launched (SC/67b/SH12). This will enable researchers to compare their acoustic recordings with validated song archetypes and greatly assist the determination of Southern Hemisphere blue whale distribution patterns and stock structure. Photo-ID and genetic evidence support the idea that each distinct pygmy blue whale song represents a geographically and genetically distinct population of pygmy blue whales around the Southern Hemisphere. A full description of the discussion of the use of songs in this pre-assessment is given in Annex H (item 3.1), including comparison with genetic and photo-identification data. The Committee also received information from whale bones and notes that further analysis of blue whale bones from old whaling land stations will be helpful to establish the past distribution of these stocks.

Assessments require catches to be allocated to populations and in 2016 the Committee funded an examination of regional catches to assign them to each putative population (Item 5.1, IWC, 2017a). The results of this work are provided in SC/67b/SH23 and discussed in Annex H (item 3.1). Total pygmy blue whale catches were estimated at 12,184 with totals for each population of 1,228 (Northern Indian Ocean), 6,889 (South West Indian Ocean), 3,646 (South East Indian Ocean) and 421 (South West Pacific Ocean).

The Committee also discussed an intersessional effort to identify and standardise genetic markers used in Southern Hemisphere blue whale research (only four loci were common across all research laboratories) and received a progress report (SC/67b/PH04) on matching within the Southern Hemisphere Blue Whale Catalogue, which has been supported by funding from the Committee (Item 10.2.2, IWC, 2017a). This helps understanding of blue whale movements between regions, and allows estimation of regional abundance. The catalogue is currently being migrated to IWC servers (and see Item 23.2.3.2).

Attention: SC, G

In order to progress its work towards an assessment of pygmy blue whales, the Committee:

*(1) **agrees** that further work is needed to identify high and base case catch scenarios for pygmy blue whales;*
*(2) **encourages** deployment of more acoustic recorders in the southern Indian Ocean;*
*(3) **agrees** that further population modelling is needed to assess pygmy blue whale populations;*
*(4) **strongly encourages** blue whale research groups to publish the metadata associated with their sequences in order that levels of sample overlap can be established and datasets compared; and*
*(5) **agrees** that the Southern Hemisphere Blue Whale Catalogue should be continued to help understand blue whale movements, with a priority focus on matching photographs within regions to measure regional abundance of pygmy blue whales.*

9.2.2.2 INDONESIA/AUSTRALIA BLUE WHALES

The Australian blue whale photo-ID catalogue data have now nearly all been uploaded and matched within the Southern Hemisphere Blue Whale Catalogue, at which point quality control analysis can begin. This will allow the potential for using these data for mark recapture abundance estimation to be assessed. The Scientific Committee was informed that mark-resighting data from the Perth Canyon (Australia) will be analysed intersessionally, to provide a new estimate of Australian blue whale abundance which assist in a future assessment of this population.

Attention: SC, G

The Committee encourages analysis to provide an estimate of Australian blue whale abundance using mark-resighting data.

9.2.2.3 MADAGASCAR BLUE WHALES

The Committee was informed that passive acoustic monitoring of blue whales in the Mozambique Channel detected both South West Indian Ocean (SWIO) and Antarctic blue whale song types, as well as fin and Antarctic minke whales (SC/67b/SH14). In addition, SC/67b/SH24 reported an unidentified blue whale song off Oman. A full discussion of the results of these papers can be found in Annex I (item 3.3.2).

This new information means that the blue whale catch allocations for the Indian Ocean, currently only ascribed to a single 'NIO' population in the Northern Indian Ocean, will need revision to take this new acoustic pattern into account.

Attention: SC, G

The Committee notes that the distribution and population isolation of blue whales is poorly understood in the northern and western Indian Ocean. The Committee therefore:

*(1) **strongly encourages** further acoustic work in the western Indian Ocean and Arabian sea to better understand the distribution, seasonality and overlap of blue whale calls;*
*(2) **strongly encourages** the collection and analysis of available tissue samples for analysis of genetic population structure in this region to assist with characterising these populations; and*
*(3) **agrees** that catch allocations of blue whales be revised to include the new blue whale song in the northwest Indian Ocean as a potential distinct 'stock'.*

9.2.2.4 NEW ZEALAND BLUE WHALES

Three papers were presented on blue whales off New Zealand (see Annex H, item 3.3.4 for a full discussion).

SC/67b/SH09 reported a recent study of blue whale movement and habitat use in the Taranaki region of New Zealand in which two animals were tagged. However, due to the small sample size and La Niña conditions, it is uncertain how representative these movements are for blue whales in New Zealand waters.

SC/67b/SH05 summarised a multi-disciplinary study included acoustics, genetics and photo-identification in the same area, and provided a conservative estimate of blue whale population abundance (see Annex Q, item 3.1.1.9), to consider if this estimate can be used in the upcoming regional assessments of pygmy blue whales. SC/67b/SH04 reported projects underway to assist regional conservation management, including a description of fine-scale habitat use during summer months in the South Taranaki Bight, and response to local acoustic disturbance.

Attention: SC, G

With respect to information on blue whales off New Zealand, the Committee:

*(1) **welcomes** the work being undertaken to understand abundance and connectivity, which will contribute towards the pygmy blue whale population assessments; and*
*(2) **agrees** that New Zealand photo-identifications should be combined with others within the Southern Hemisphere Blue Whale Catalogue to provide the fullest possible assessment of regional abundance and connectivity.*

9.2.2.5 SOUTHEAST PACIFIC BLUE WHALES

The Committee received two papers relevant to blue whales off Chile and the full discussion can be found in Annex H (item 3.3.1). SC/67b/SH03 presented a morphometric analysis of Chilean blue whales which reinforces the argument that Chilean blue whales should be considered a separate sub-species from the Antarctic and pygmy forms. (Bedrinana-Romano *et al.*, 2018) reported distribution modelling of blue whales using Chilean Northern Patagonia waters. Preliminary delimitations of possible blue whale conservation areas in this region overlap with highly used vessel navigation routes and areas allocated for aquaculture. The Committee was also informed that predictions of southeast Pacific blue whale habitat following Redfern *et al.,* (2017) will be completed intersessionally.

Attention: SC, G

In view of the recent identification of movements of Chilean blue whales into the South Atlantic and ongoing questions about the distribution of this population, the Committee:

(1) ***encourages*** *further satellite tracking and surveys (including collection of photo-ID and genetic data) to assess the population limits, habitat use and abundance and sub-species identity of blue whales in Chile;*

(2) ***encourages*** *compilation of morphometric data available for northeast Pacific blue whales and comparison with Chilean data, to assess morphological differentiation of these whales in the eastern Pacific and evaluate sub-species identity; and*

(3) ***welcomes*** *plans for further photo-ID catalogue matching within this region to assist with regional abundance estimation.*

9.2.2.6 WORK PLAN

The work plan for all Southern Hemisphere blue whales is given in Table 9.

9.2.3 Antarctic blue whales (Areas III and IV)

Undertaking a regional population assessment of Antarctic blue whales is challenging due to the scarcity of whales and logistical challenges. The Committee received new information this year on sightings, abundance and genetic studies.

SC/67b/SH08 presents a preliminary estimate of abundance (the first using photo-ID data) and this is discussed in Annex Q (see item 3.1.19) where suggestions were made to refine the analyses. Reports from two 2017/18 NEWREP-A summer cruises included sightings of blue whales and information on biopsy sampling (SC/67b/SP08 and SC/67b/ASI07). An IWC-SORP Southern Ocean blue whale-focussed cruise is planned for January to March 2019 (140°E-175°W), which intends to describe krill swarms in relation to blue whale density and distribution (SC/67b/SH07).

With respect to genetic work, IWC-SORP funded work on blue whale bones to compare past and current genetic diversity levels is reported in SC/67b/SH02 and discussed in Annex I (item 4.4.2). The Committee was also updated about ongoing work to analyse a collection of 1,626 baleen plates (roughly 50:50 blue and fin whales) from the Japanese whaling in the 1940s and held at the Smithsonian Natural History Museum, USA. A pilot study has established that mitochondrial DNA can be sequenced from these plates. Further analyses including of stable isotope and hormone levels are planned for these samples.

Attention: SC, G

The Committee welcomes the progress being made towards being able to undertake am in-depth assessment of Antarctic blue whales. The Committee:

(1) ***encourages*** *further work to update the abundance estimate for Antarctic blue whales following Committee recommendations;*

(2) ***strongly encourages*** *continued opportunistic photo-ID data collection in the Antarctic to assist with developing estimates of population abundance for this subspecies; and*

Table 9

Workplan for Southern Hemisphere Antarctic and pygmy blue whales.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Antarctic blue whales				
Catalogue matching	Catalogue matching of photo-IDs (see Annex Y)	Report	Catalogue matching (opportunistically collected photos)	Report
Abundance estimation	Mark recapture modelling work to update SC/67b/SH08 (see Annex Y)	Report		
Photo-ID outreach material	Create photo-ID information booklets for distribution via IAATO operators	Report		
Southern Hemisphere non-Antarctic blue whales				
Population assessment	Improve catch separation model, explore alternative catch allocation models (see Annex Y)	Report	Population assessment. Analyse minimum and extrapolated recovery status of all populations for which abundance is available	Report
Catalogue matching	Catalogue matching of photo-IDs within southeast and central east Pacific (see Annex Y)	Report	Catalogue matching (opportunistic photos from citizen scientists and collaborators) if funds are available	Report
Blue whale song library	Finish implementation of blue whale song library (see Annex Y)	Report		
Australian abundance estimate	Analyse Perth Canyon abundance using mark recapture data (see Annex Y)	Report		

(3) ***encourages*** *continued collection and analysis of bone and baleen from historical Antarctic commercial whaling samples and sites to evaluate loss of genetic diversity and shifts in population structure.*

9.2.3.1 WORK PLAN

The work plan for all Southern Hemisphere blue whales is given in Table 9.

9.2.4 Southern Hemisphere fin whales

9.2.4.1 POPULATION STRUCTURE

As part of its pre-assessment work, the Committee is gathering information on Southern Hemisphere fin whales in order to: (1) clarify the subspecies status of these whales (currently two Southern Hemisphere subspecies are recognized, Committee on Taxonomy, 2017); and (2) measure population differentiation around the Southern Hemisphere to establish whether any distinct populations exist.

A summary of available data on Southern Hemisphere fin whale structure was presented in SC/67b/SH15 and is discussed in detail in Annex H (item 4.1). The only evidence for any structure comes from acoustics. A genetic study from the southeast Pacific (SC/67b/SH13) found high local diversity in Chile, with no significant differentiation from the other Southern Hemisphere datasets. The Committee noted however that genetic differentiation can be difficult to detect when diversity levels are high and genetic differentiation is low (see Annex H, item 4.1).

Attention: SC, G, S

Knowledge of population structure is essential to future efforts to assess Southern Hemisphere fin whales. To determine the differentiation and potential sub-species structure among fin whales the Committee:

(1) ***agrees*** *that analysis of concurrently collected acoustic recordings of fin whales, to assess song variation around the Southern Hemisphere, is a priority;*
(2) ***agrees*** *that a review of all Discovery mark data published on fin whales to assess population connectivity patterns should be carried out; and*
(3) ***requests*** *that the Secretariat provide a letter of support for a study examining the evidence for B. physalus patachonica, which requires access to the holotype for this species from the Bernardino Rivadavia Natural Sciences Museum in Buenos Aires.*

The Committee also ***encourages****:*

(1) *analysis of fin whale distribution and geographic aggregations using all available catches;*
(2) *strategic biopsy sampling and analysis to measure the genetic differentiation of fin whales around the Southern Hemisphere;*
(3) *further biopsy sampling and sequencing of multiple nuclear loci to establish Chilean fin whale differentiation patterns, with co-collection of photo-IDs and body length measurements to establish population identity;*
(4) *satellite telemetry to discern seasonal movements; and*
(5) *photo-identification to understand site fidelity and residency patterns and linkages between high- and low-latitude grounds.*

9.2.4.2 DISTRIBUTION AND ABUNDANCE

The Committee welcomed a review of the available metadata on Southern Hemisphere fin whales (SC/67b/SH19), compiling data from dedicated and opportunistic surveys, moored acoustic recorders, sonobuoy surveys, photo-identifications, satellite tagging and biopsy sampling. The Committee also welcomed a summary of recent work by the Brazilian Antarctic Program to conduct dedicated fin whale research using sighting surveys, photo-ID, biopsy sampling and telemetry.

Reports from two 2017/18 NEWREP-A summer cruises included sightings of fin whales and information on biopsy sampling (SC/67b/SP08 and SC/67b/ASI07). A new abundance estimate for fin whales using sightings data from the third IDCR-SOWER circumpolar survey is expected to be available for review at next year's meeting.

SC/67b/14 provided information on the presence of fin whales in the Mozambique Channel and a new lower-latitude song. Details of the discussions can be found in Annex H (item 4.2).

The Committee was also informed that an analysis has suggested that Antarctic fin whales are sufficiently well marked to enable to use in photo-ID projects (SC/67b/PH01) and this is discussed in Annex S (item 4.1).

Attention: SC, G, CG-A

With respect to obtaining information on the distribution, movements and abundance of Southern Hemisphere fin whales for use in a future assessment, the Committee:

(1) ***encourages*** *a meta-analysis of the Antarctic Peninsula and Scotia Sea sightings data, to measure recent fin whale distribution, density and habitat use;*
(2) ***strongly encourages*** *continued work by the Brazilian Antarctic Program towards the understanding of fin whale population structure, movements and habitat use;*
(3) ***agrees*** *that a new abundance estimate for fin whales from the IWC IDCR/SOWER programme should be presented for review at next year's meeting; and*
(4) ***welcomes*** *news that fin whales can be used in photo-ID studies, and encourages further photo-ID data collection at high latitudes.*

Table 10

Work plan for Southern Hemisphere fin whales.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Fin whale acoustic structure	Review fin whale call patterns across Southern Hemisphere, investigate call variation (see Annex Y)	Report	Complete review of fin whale call patterns (see Annex Y)	Report
Discovery marks	Review available Discovery mark data on fin whales (Pastene and Jackson)	Report		
Catch maps	Update fin whale catch model to include Soviet catch data (De la Mare)	Report		

9.2.4.3 WORK PLAN

The work plan for Southern Hemisphere fin whales is given in Table 10.

9.2.5 North Atlantic sei whales

The Committee welcomed information on two separate habitat-based density modelling efforts, using visual survey data to produce seasonal abundance estimates for sei whales from the purported 'Nova Scotia' stock, ranging from Nova Scotia to the southeastern USA (SC/67b/NH07). There was also some consideration of passive acoustic and strandings data from the US eastern seaboard. No new data are available from around Iceland or Norway, partially due to difference in timing between surveys and species' arrival in regional waters. This information was discussed in Annex G (item 6.2). An intersessional correspondence group (Annex Y) will compile additional information this species in the North Atlantic and the Committee looks forward to a further update on reanalysis of historical data, particularly related to stock structure and strandings, next year.

9.2.6 North Atlantic right whales

Since 2016, the Committee has recommended a comprehensive update on North Atlantic right whales. SC/67b/NH05 summarised the information on the status of the North Atlantic right whale. This population has been slowly declining since 2010 and the abundance at the end of 2015 was estimated to be around 460 individuals (Pace *et al.,* 2017[6]). Of particular concern is the lower annual survival rate of females than males and poor recent calving (five in 2016/17 and none so far in the 2017/18 calving season). The observed number of dead whales in 2017 was 17 whales, several showing signs of death from fishing gear or blunt force trauma. These clearly represent minimum numbers and there was some discussion as to whether it was possible to scale minimum observed mortalities to an overall estimate but several confounding factors preventing this were identified (see Annex F, item 6.3 and Annex J, item 2.1.2).

Due to the increased 2017 Canadian interactions in the Gulf of St. Lawrence, on 19 April 2018 the Government of Canada implemented mitigation measures to reduce future interactions (DFO, 2018), including: closing a large part of the Gulf of St. Lawrence snow crab fishery on 30 June; creating a dynamic 15-day fishing closure; introducing a 10 knot speed restriction when any single right whale sighting in any area is detected; putting in place mandatory gear marking and reporting of any lost gear; minimising the allowable amount of floating line at surface; and using vessel monitoring systems that reports the boats position every 5 minutes.

A substantial increase in collaboration and data sharing between the US and Canada has occurred as a result of these mortalities.

Attention: C-A, CC

*The Committee **reiterates** its serious concern over the status of the western North Atlantic stock of right whales as it is probably the only viable population of this species, for which entanglements and ship strikes have long been identified as key threats.*

This year, the Committee:

*(1) **recognises** that entanglements have now replaced ship strikes as the primary cause of deaths (Kraus et al. 2016);*
*(2) **reiterates** its recommendation for the USA to submit a comprehensive update on the status of North Atlantic right whales (IWC, 2017:40) including an update of the Pace et al. abundance estimate, prior to the 2019 meeting;*
*(3) **stresses** that this update will allow time for explanations or additional analyses to be undertaken before the proposed 2019 Workshop on the Comparative Biology, Health, Status and Future of North Atlantic Right Whales: Insights from Comparative with other Balaenid Populations (including bowheads);*
*(4) **encourages** updates from the US Large Whale Take Reduction Team (ALWTRT) on progress of the Whale Safe Rope and Gear Marking Feasibility Subgroups; and*
*(5) **requests** that the Commission asks the IWC Executive Secretary to write to the U.S. National Marine Fisheries Service (NMFS) and the Canadian Department of Fisheries and Oceans, informing them of the Committee's serious concerns over the declining population trend of this species, and stressing that, as a matter of absolute urgency, every effort be made to reduce human induced mortality in the population to zero.*

9.2.7 North Pacific right whales

The Committee received a report of a dead right whale caught in a set net off Izu, Japan in 2018 (SC/67b/NH06) – the first in a set net since one in Korea in 2015 (Kim *et al.*, 2015).

The Committee welcomed information on a single sighting off Hokkaido (and a biopsy sample) from a Japanese national cruise (SC/67b/ASI10). It also welcomed information on North Pacific right whales from the visual, acoustic and biopsy sampling components of the 2017 IWC-POWER cruise in the eastern part of the Bering Sea. A total of 9 schools and 18 individuals (including 2 duplicate schools of 3 individuals) of right whales were sighted with photo-identification of 12 individuals and biopsy samples from 3 individuals. Discussion of these sightings can be found in Annex G (item 6.4).

In response to a recommendation made last year (IWC, 2018c), US and Japanese scientists presented the results of new genetic analyses of right whales in the North Pacific. Comparison of whales sampled in the eastern and western North Pacific revealed statistically significant differentiation based on mtDNA data, supporting presumed separation of the two stocks based on gaps in the spatial distribution of sightings (and also see discussion in Annex I, item 4.3).

Attention: SC

The results of new genetic analyses support the recognition of separate stocks of right whales in the eastern and western North Pacific. Given the importance of this work and the precarious situation of this species, especially in the eastern North Pacific, the Committee encourages the publication of this information as soon as possible.

9.2.8 Work plan 2019-20

The Committee agreed to the two-year work plan in Table 11.

[6]Any revised estimate from the Pace *et al.* 2017 paper will be reviewed by the ASI sub-committee during SC68a.

Table 11

Workplan for other Northern Hemisphere stocks.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
North Pacific blue whales	Data collection and review with focus on catches and stock structure	Review especially stock structure	Develop proposal for stock structure	Agree stock structure hypotheses
North Atlantic sei whales	Review distribution, strandings, sightings and stock structure	Review new information for assessment	Develop proposal for stock structure	Agree stock structure hypotheses
North Atlantic right whales		Review status and mortality data		Review status and mortality data
North Pacific right whales		Review new information for assessment		Review new information for assessment
North Atlantic humpback whales		Consider information for new assessment		Develop plans for new assessment
Gulf of Mexico Bryde's whale		Review new information on mortality		Review new information on mortality
All other stocks		Review new information		

9.3 New information and workplan for other northern stocks *(NH)*

9.3.1 North Pacific fin whales

The Committee received new information on studies of North Pacific fin whales. New sightings of fin whales were reported in the papers (SC/67b/ASI12, SC/67b/ASI10, SC/67b/SCSP06) during the POWER cruise in the Bering Sea and the two surveys in the western North Pacific (Areas 7, 8 and 9). Over 260 schools found, many individuals were photo-identified and biopsy samples were obtained from 28 whales.

9.3.2 Omura's whale

The Committee welcomed the new information on this species (SC/67b/NH09) from the west coast of Madagascar, supporting the current understanding that the population is resident and non-migratory with strong site fidelity. Likely threats to the Madagascar population include entanglement in local fisheries, impacts from oil and gas exploration, and most imminent the risk of coastal water contamination from a recently initiated mining operation for Rare Earth Elements. Future work should include a long-term latitudinal study that incorporates multiple methodologies to investigate all aspects of the species biology and conservation threats to the population.

Kim and colleagues reported on the first confirmed documentation of Omura's whale in the waters of South Korea. Two of six large baleen whales bycaught were confirmed by genetic analysis to be Omura's whale. This bycatch reinforces the concept that this coastal species is vulnerable to anthropogenic impacts, especially entanglement in fishing gear.

Attention: SC, G

The Committee notes that little information is available to assess the status of Omura's whale. The Committee:

(1) ***recognises*** *the significant contribution the research efforts off Madagascar have made to the understanding of this species and encourages this work to be continued and expanded into the future; and*

(2) ***encourages*** *identification of study sites that are suitable for long-term comparative study on Omura's whales in other parts of its range (e.g. New Caledonia, Komodo Islands, Indonesia, and the Bohol Sea, Philippines).*

9.3.3 North Atlantic Bryde's whales

SC/67b/ASI01 presented sightings collected during recent coastal surveys off Guinea, Sierra Leone and Liberia in March 2018. During this survey, two groups of five individual Bryde's whales were observed.

The Committee welcomed this information and encourages future surveys in this region.

9.3.4 North Atlantic blue whales

The Committee welcomed new information from the USA on blue whales in the North Atlantic including recent sightings, serious injuries or mortalities, seasonal occurrence based on acoustics. Lesage *et al.* (2018) provides an extensive summary of recent data collected in Canadian waters. This is discussed in Annex G (item 7.6) where it was noted that multiple new datasets (including from passive acoustic monitoring) have been recently collected and may provide more information on blue whale distribution in North Atlantic waters.

Attention: SC, G

The Committee notes that there has been a recent increase in information available on North Atlantic blue whales. The Committee:

(1) draws attention to the lack of data on interchange between blue whales in the eastern and western North Atlantic and ***recommends*** *that U.S., Canadian and Icelandic colleagues conduct a new comparison of blue whale photo-identification catalogues and present this information at SC/68a; and*

(2) ***encourages*** *Canadian colleagues to generate a new population abundance estimate as soon as feasible, and looks forward to updates on new passive acoustic and visual sightings data SC/68a.*

9.3.5 North Atlantic humpback whales

The Committee received new information (NOAA, 2018b) on humpback mortalities along the US coast (vessel strikes and entanglements were noted as the primary causes of anthropogenic mortality). An 'Unusual Mortality Event' was declared by the USA for humpback whales in April 2017. This is discussed further in Annex G (item 7.7. New abundance estimates for parts of the North Atlantic are discussed in Annex Q (item 3.1.1.3) and presented in Item 12.1. Consideration of the need for a new in-depth assessment of North Pacific humpback whales is given in Annex E (item 5.8.2) and Item 8.7.3.

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

No new information was available to the Committee.

9.3.8 North Pacific sperm whales

Three papers (SC/67b/ASI10,12 and SC/67b/SCSP06) provided new information of sperm whale occurrence and distribution was collected during 2017 in the western North Pacific, eastern Bering Sea. An intersessional correspondence group to examine possible ways to assess sperm whales has been reappointed (Annex Y)

9.3.9 Gulf of Mexico Bryde's whales

9.3.9.1 NEW INFORMATION

The Committee received an update on activities related to monitoring and new research plans for the critically endangered Gulf of Mexico sub-species of Bryde's whale. The Southeast Fisheries Science Center undertook a shipboard survey in the northern Gulf of Mexico in 2017, including known habitat of the Gulf of Mexico Bryde's whale. Passive acoustic data were collected in historic habitat of the central and western Gulf from June 2016 to June 2017. The In the USA, there is legislation that provides funds to restore and protect ecosystems of the Gulf of Mexico following the Deepwater Horizon oil spill (2010); this work will include research on the Gulf of Mexico Bryde's whale.

Attention: SC, G

The Committee agrees that the NOAA scientists working with this sub-species should present results from shipboard and acoustic data analyses to the IWC at the 2019 Scientific Committee meeting and looks forward to receiving a report from the Workshop held in conjunction with the initiation of research associated with funds to restore and protect ecosystems of the Gulf of Mexico following the Deepwater Horizon oil spill.

The Committee also encourages U.S. and Mexican scientists to collaborate in efforts to determine whether any of these whales occur in Mexican waters (e.g. Bay of Campeche) where a major oil spill of three million barrels occurred in 1979. This should include consideration of the use 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 passive acoustic data or specimen records from the northern coast of Cuba would be useful to determine potential occurrence of this subspecies in that region.

9.3.9.2 CONSERVATION ADVICE

Attention: CG-R, S

*The small population size, known human related mortality, restricted range and low genetic diversity place the Gulf of Mexico sub-species of Bryde's whale (added to the Critically Endangered category of the IUCN Red List in 2017) at significant risk of extinction. The Committee **reiterates** its previous **recommendations** that US authorities:*

(1) 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;

*(2) **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;*

(3) 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);

(4) 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;

(5) 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;

(6) design and conduct research programmes (sighting surveys, acoustic monitoring, genetic mark-recapture, photoidentification 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; and

(7) ensure that information about core known habitat and movements in the Gulf of Mexico is transmitted to the U.S. Coast Guard, shipping industry trade organizations, and Gulf of Mexico port authorities (e.g. in Tampa, Florida) for their consideration to mitigate ship-strike risk.

*In addition, the Committee **reiterates** its recommendation that the IWC Secretariat (i) 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 recognized 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.*

9.3.10 Other stocks - Northern Indian Ocean sperm whales

No new information was available to the Committee.

9.3.11 Work plan 2019-20

The Committee agreed to the two-year work plan in Table 11.

9.4 New information and work plan for other Southern stocks

9.4.1 Southern Hemisphere humpback whales

9.4.1.1 BREEDING STOCK D

The assessment of the Breeding Stocks D (West Australia), E1 (East Australia) and Oceania was completed in 2014 (IWC, 2015a), but there were substantial associated problems in obtaining a reliable estimate of absolute abundance for Breeding Stock D. See Annex H (IWC, 2017a; 2018a) for a detailed discussion of these issues. Last year (IWC, 2018c), the Committee had agreed that efforts should focus on designing and implementing a new 'survey' (perhaps using new approaches such as drones), and recommended that 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 conducted.

Attention: SC, G, CG-R

The Committee ***agrees*** *that 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* ***reiterates*** *its recommendation that 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.*

9.4.1.2 WORK PLAN

The work plan for Southern Hemisphere humpback whales is given in Table 12.

9.4.2 Southern Hemisphere right whales not the subject of CMPs

The Committee would like to progress regional population assessments for southern right whales (Item 10.8.1.5, IWC, 2017b) This requires a good understanding of population structure, abundance, trend and past exploitation levels. It was agreed that Australia should be the highest priority region for the next assessment (Item 9, IWC, 2018a).

9.4.2.1 SOUTH AFRICA

SC/67a/SH01 provided the results of the 2017 survey of southern right whales flown along the coast of South Africa, part of a long-term monitoring programme since 1979. Since 2015 there has been a marked decline in the presence of unaccompanied adults and cow-calf pairs for unknown reasons (see discussion in Annex S, item 5.1.3). Photo-ID analyses indicated an increasing occurrence of apparent 4- and 5-year calving intervals since 2014. SC/67b/SH22 applied a life history model to photo-ID data collected from 1979 to 2017. They showed that a model variant which allows the probability of a resting female remaining in the resting phase (rather than having a calf) to vary through time provided a better fit to the data than a time-invariant model. They calculate an annual population growth rate of 6.5% and measure first year survival at 0.852, with subsequent annual survival of 0.988.

Attention: SC, G, C-A, CG-A

The Committee is concerned that the future of the exemplary long-term monitoring programme of right whales in South African waters remains uncertain. The Committee therefore ***reiterates*** *that it:*

(1) strongly ***recommends*** *continuation of the survey;*
(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.*

9.4.2.2 AUSTRALIA

The Committee was informed about the latest of a series of aerial surveys conducted in South and West Australia in 2017. The 2017 counts were the highest yet in the series and an exponential increase of ~6% per year remains a good description of the data. Funding has been obtained for the next three years of surveys. The Committee was also informed about: (a) a 26-year cliff-top study conducted at the Head of the Great Australian Bight (south Australia) on right whale population trends and identifications (Charlton *et al.*, In prep); and (b) an aerial survey in southeast Australia where small numbers of whales have been sighted (Watson *et al.*, 2015). Right whales in southeast Australia are genetically and geographically distinct from the large population in south/southwest Australia (e.g., Carroll *et al.*, In press).

The Committee was advised that the Australian Government has recently allocated funds towards a two-year project that will provide an abundance estimate for Australia's two southern right whale populations. It will investigate life history characteristics as well as connectivity between breeding areas on the eastern, southern and western coasts of Australia.

Attention: SC, G, CC, CG-A

The Committee ***recognises*** *the value of the Australian long-term right whale monitoring programmes to understand right whale population trends and dynamics, and recommends that this monitoring continues.*

In regard to right whales in southeast Australia, the Committee ***reiterates*** *concerns expressed in 2017 that abundance remains low despite this area having been a significant historic calving ground. The Committee therefore:*

(1) ***recommends*** *an assessment of the likely effects of fish farms and other developments in hindering population recovery in this region; and*
(2) ***encourages*** *further work to estimate the abundance of the southeast Australia population.*

9.4.2.3 NEW ZEALAND

The Committee welcomed information that surveys will be conducted in the Auckland Islands in 2020/21 to estimate abundance (updating the last estimate from 2009), to assess trend and population age structure, as well as changes in genetic diversity of right whales using this calving ground.

9.4.2.4 FEEDING GROUNDS

The Committee welcomed the results of a visual and acoustic survey of southern right whales off South Georgia/ Islas (SC/67b/SH20). SC/67b/SH06 used genotypic markers to assess re-sight rates and sex ratios from biopsy samples (n=157) collected during 14 summer surveys in Antarctic Area IV. A preliminary abundance estimate was calculated using these data and further mark recapture analyses will be conducted intersessionally to provide an abundance estimate for review at next year's meeting. To further investigate linkages it was suggested that these high latitude data be compared the western Australia stock to investigate what population component is using this high latitude area.

Table 12

Work plan for Southern Hemisphere humpback whales.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Survey feasibility	Reanalyse pilot study to assess feasibility of future West Australia surveys (Kelly)	Receive report		

Attention: SC

The Committee ***encourages*** *further mark recapture analysis of the genotype data of the 14-year dataset collected in the high latitudes of Area IV, to estimate the abundance of southern right whales in this feeding area and agrees that this will be considered at next year's meeting.*

9.4.2.5 PROGRESS TOWARDS POPULATION ASSESSMENT

This year, the Committee reviewed newly available information on population structuring of southern right whales around the Southern Hemisphere (Carroll *et al.*, In press) which further confirms the genetic differentiation of regional calving grounds off Argentina, South Africa, New Zealand and Australia, showing limited migratory movements between these areas (see Annex H, item 5.1).

The Committee was provided with updates on trends and distribution for calving grounds off South Africa and off south and southwest Australia. Recent published data on population size and trend for calving grounds across the Southern Hemisphere were summarised in Annex H (table 2); this will be reviewed at next year's meeting. Given the trends in abundance and calving rates reported this year (Items 9.4.2.1 and 9.4.2.2), integration of these analyses in a common modelling framework was suggested as a useful way to evaluate common patterns and changes in demography and investigate the relative importance of environmental drivers in determining these patterns.

Another important aspect of population assessment is to update the pre-modern catch series for southern right whales, to better reflect patterns of regional exploitation. The Committee was informed that substantial new data are available on offshore whaling patterns and extent, particularly from American and British voyage logbooks (see Annex H, item 5.2), which are likely to increase regional catch estimates and provide revised estimates of the numbers of whales struck but lost at sea by the different fisheries.

Attention: SC, G

To better understand patterns of right whale population dynamics around the Southern Hemisphere, and further the work on updated assessments, the Committee:

(1) ***agrees*** *that analysis of three southern right whale calving grounds (Head of the Bight and southwest Australia, southwest Atlantic and south Africa) should be undertaken using the same life-history model, to estimate regional demographic parameters and investigate commonalities in the population dynamics of these populations; and*
(2) ***supports*** *the compilation of new data on pre-modern right whale catches, and the organisation of a workshop to investigate regional right whale catches and rates of whales struck but lost by fisheries, in order to proceed toward regional population assessments.*

9.4.2.6 WORK PLAN AND BUDGET REQUESTS FOR 2019-2020

The work plan for southern right whales not the subject of a CMP is given in Table 13.

10. STOCKS THAT ARE OR HAVE BEEN SUGGESTED TO BE THE SUBJECT OF CONSERVATION

MANAGEMENT PLANS (CMPS)

10.1 Stocks with existing CMPs

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.

10.1.1 SE Pacific southern right whales

10.1.1.1 NEW INFORMATION

The Committee received information on advances with respect to sightings (SC/67b/CMP20) and acoustic monitoring (SC/67b/CMP08; SC/67b/CMP18) of the critically endangered population of SE Pacific southern right whales. This information is discussed in detail in Annex O (item 2.1.1). Four confirmed observations were made off Chile in 2017 (three opportunistic sightings and one entangled carcass) and there was another, as yet unconfirmed sighting involving adults and calves. Analysis to date of acoustic data collected off the southwestern tip of Isla de Chiloe in 2012 has provided valuable new information about call parameters and patterns.

10.1.1.2 PROGRESS WITH THE CMP

The Committee received information on progress in implementing priority actions of the CMP (SC/67b/CMP20) as discussed in Annex O (item 2.1.1.2).
This progress includes:

(1) deployment of Passive Acoustic Monitoring (PAM) devices along the coast of Chile and Peru (SC/67b/CMP18) in two locations that will also be used as the focus of educational and capacity-building activities in communities near the monitoring sites;
(2) additional capacity-building and awareness efforts (including posters, press releases and social media) including advice on how fishermen and the public can provide information to the national sighting network; and
(3) additional training towards increasing the capacity of range states to respond to entanglements.

Attention: SC, CC

The Committee ***reiterates*** *the importance of the CMP for the conservation of this critically endangered population of southern right whales in the southeastern Pacific,* ***welcomes*** *the progress being made in its implementation by Chile and Peru. It therefore:*

(1) ***commends*** *the scientific work and international co-operation being undertaken for the PAM project and looks forward to receiving the results of the acoustic studies such that future sighting surveys will be more informed and baseline information on the location of breeding grounds will be available; and*

(2) ***advises*** *that satellite imagery be explored as an additional means to inform the design of sighting surveys because it is likely that line-transect surveys would not successfully identify whales in some areas even if they were present.*

Table 13

Workplan for southern right whales that are not the subject of a CMP.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Southern right whales	Examine southern right whale demographic parameters across multiple calving grounds using a common modelling framework	Review progress		Complete comparison
Southern right whales	Plan right whale catch series Workshop	Progress update	Organise catch series Workshop	Workshop report

10.1.2 Southwestern Atlantic southern right whales

10.1.2.1 NEW INFORMATION

The Committee was pleased to receive a considerable amount of new information on the southwest Atlantic population of southern right whales; this is fully discussed in Annex O (item 2.1.2.1).

With respect to abundance, SC/67b/CMP/05 suggested that although the population has continued to increase, the rate may have been slowing, perhaps as a consequence of changes in distribution due to density-dependence processes (SC/67b/CMP02).

The Committee has for some time been focussing on the die off at Peninsula Valdes (e.g. IWC, 2011; 2015) and the excellent work of the Southern Right Whale Health Monitoring Program. New and updated information was presented this year on strandings and investigations related to health including examination of levels of stress hormones in baleen and kelp gull attacks (SC/67b/CMP04) and nutritional condition (SC/67b/CMP03). This work is ongoing.

Information was received on telemetry studies (one animal in 2016 and 8 in 2017) as part of an ongoing long-term study to understand the migratory routes and destinations of southern right whales wintering off the coast of Argentina (SC/67b/CMP17. Tracks reveal that these animals are found across a vast extent of the South Atlantic and each season visit multiple potential feeding areas.

The Committee also received the report of a land-based survey of whales near Miramar on the southwest coast of the Buenos Aires Province, Argentina, where there has been a recent expansion of right whales into the region where they have been seen from May to October with peaks in August and September (SC/67b/CMP21).

Attention: SC, G

The Committee ***reiterates*** *the importance of continued monitoring of the southwestern Atlantic population of southern right whales and research into threats that it may face. The Committee therefore:*

(1) ***commends*** *the work being undertaken on understanding the mortality events and* ***encourages*** *its continuation;*
(2) ***encourages*** *the researchers working on stress hormones in baleen to increase their sample size, consider suggestions for additional studies provided in Annex O (item 2.1.2.1) and present a full report to the Committee when it becomes available; and*
(3) ***commends*** *the telemetry work, encourages its expansion and draws attention to additional analyses that could be addressed using the telemetry data suggested in Annex O (item 2.1.2.1).*

10.1.2.2 PROGRESS WITH THE CMP

The overall objective of the southern right whale CMP is to protect their habitat and minimise anthropogenic threats to maximise the likelihood that the population will recover to healthy levels and recolonise its historical range. The Committee was pleased to receive information on progress with the actions of the CMP from Argentina (SC/67b/CMP14), including the work described under Item 10.1.2.2, and Brazil (Annex O, appendix 2). Work in Brazil includes long-term monitoring via sightings and strandings networks, mitigation of entanglements and the development of a management plan for whalewatching (see Annex O, item 2.1.2.2).

Attention: SC, CC

The Committee ***reiterates*** *the importance of the CMP for the conservation of the southwestern Atlantic population of southern right whales. The Committee therefore:*

(1) ***welcomes*** *the progress being made in the implementation of the CMP reported by Argentina and Brazil and supports its continuation;*
(2) ***encourages*** *the continued co-operation and collaboration amongst range states towards implementing the CMP and addressing mortality evens in this population;*
(3) recognising the report of a ship-struck southwestern Atlantic southern right whale in the range of the southeastern Pacific (Estrecho de Magallanes), ***encourages*** *co-operation with those involved in the southeastern Pacific CMP to facilitate a regional assessment; and*
(4) ***encourages*** *the research work identified under Item 10.1.2.1.*

10.1.3 North Pacific gray whales

10.1.3.1 RANGEWIDE ASSESSMENT

Donovan summarised the report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales (SC/67b/Rep07) held at the Granite Canyon Laboratory, California of the Southwest Fisheries Science Center from 28-31 March 2018. The primary tasks of the workshop were to (a) review the results of the modelling work identified at the fourth rangewide workshop (IWC, 2018a) and the 2017 Scientific Committee meeting (IWC, 2018b), (b) examine the new proposed Makah Management Plan (submitted by the USA – given as Annex E, Appendix 1) for gray whaling off Washington state and (c) to update as possible, and develop a work plan for, updating the scientific components of the Conservation Management Plan (CMP) for western gray whales.

A full discussion of the workshop can be found in Annex O (item 2.1.3.1). The Workshop finalised its work on (a) prioritising stock structure hypotheses, (b) finalising inputs for the modelling work especially related to bycatch; and (c) incorporating the Makah Management Plan (SC/67b/Rep07, Annex E, Appendix 1) into the modelling framework.

Two stock structure hypotheses (3a and 5a) were given priority whilst others were used in sensitivity tests. In summary, Hypothesis 3a assumes that whilst two breeding stocks (Western and Eastern) may once have existed, the Western breeding stock is extirpated. Whales show matrilineal fidelity to feeding grounds, and the Eastern breeding stock includes three feeding aggregations: Pacific Coast Feeding Group (PCFG), Northern Feeding Group (NFG), and the Western Feeding Group. Hypothesis 5a assumes that both breeding stocks are extant and that the Western breeding stock feeds off both coasts of Japan and Korea and in the northern Okhotsk Sea west of the Kamchatka Peninsula. Whales feeding off Sakhalin include both whales that are part of the extant Western breeding stock and remain in the western North Pacific year-round, and whales that are part of the Eastern breeding stock and migrate between Sakhalin and the eastern North Pacific.

In discussion of the report and intersessional progress, the Committee thanked Donovan, Punt and the participants for the progress made, approved the conditioning results developed after the workshop, noted the preliminary results from the modelling and agreed a strategy for obtaining conservation advice (see recommendation below under Item 10.3). The management implications of the results for the Makah Management Plan are found under Item 7.1.3.

10.1.3.2 REGIONAL STUDIES

The Committee was pleased to receive recent information from long-term studies in the breeding lagoons of Mexico (SC/67b/CMP09) as discussed in Annex O (item 2.1.3.1.1). The Committee received several updates on work undertaken in the Russian Federation (see Annex O, item 2.1.3.2). It welcomed the annual update of activities from the IUCN Western Gray Whale Advisory Panel (see Annex O, appendix 3) which highlighted work to develop a monitoring and mitigation plan for a 2018 seismic survey being undertaken near the feeding grounds off Sakhalin Island, Russia and issues related to fishing gear. SC/67b/CMP07 updated findings from the long-term monitoring programme carried out by the Russian Gray Whale Project off Sakhalin Island, Russia. The research programme run in the same area by two oil companies was presented in SC/67b/ASI04 and discussed in Annex S (item 4.2).

The recent status of conservation and research on gray whales in Japan was reported in SC/67b/CMP12. During May 2017-April 2018, no anthropogenic mortalities were reported from the adjacent waters off Japan, while two opportunistic sightings of gray whales were made near Aogashima Island in May 2017 and February 2018.

Finally, SC/67b/CMP11 reported on the possible occurrence of a gray whale off the east coast of Korea; work is continuing to try to confirm the species identification; if confirmed it will be the first record in these waters in over 40 years.

Attention: CG-R, SC, G

The Committee ***reiterates*** *the importance of long-term monitoring of gray whales, recommends that range states support such work and* ***welcomes*** *the information provided this year. In particular, the Committee:*

(1) ***commends*** *the work in the breeding lagoons and urges its continuation;*
(2) ***encourages*** *an additional calf-count survey for Punta Banda to address apparent differences in numbers of calves observed in the lagoons with counts from California;*
(3) ***reiterates*** *its concern at the risk of whales becoming entangled in gear placed by the salmon trap-net fishery off Sakhalin Island, recognises that disentanglement training has occurred but recommends that measures to be taken to reduce risk;*
(4) ***encourages*** *continued genetic analyses to assist in stock structure discussions especially related to a western breeding stock;*
(5) ***welcomes*** *the continued provision of information from Japan and encourages researchers to continue to collect as much information on sightings as possible, including, if feasible, attempting to obtain biopsy samples; and*
(6) ***welcomes*** *the information from Korea and the willingness of researchers to investigate sightings from social media as a form of 'citizen science', which can be especially valuable for areas where occurrence is very rare animals in areas with little to no information on critically endangered species.*

10.1.3.3 PROGRESS WITH THE CMP

As noted above, one of the objectives of the fifth rangewide workshop was to progress work with updating the scientific components of the original IWC/IUCN CMP in the light of the results of the rangewide review. Although some work was undertaken, there was insufficient time at the workshop to complete this although a work plan to achieve it was suggested (see SC/67b/Rep07). The Committee concurred with this view and this is incorporated into the work plan below.

Another important component of the CMP effort is the need for a stakeholder workshop (tentatively forecast to occur in 2019) to finalise the CMP and develops a strategy for its implementation. The plan is for a workshop, co-sponsored by IWC, IUCN and the signatories to the Memorandum of Cooperation, to: (1) review and updating of the CMP; (2) establishing a stakeholder Steering Group to monitor CMP implementation; (3) arrange for a coordinator of the CMP; and (4) establish a work plan and consider funding mechanisms to implement the actions of the plan.

Attention: C-A, CG-R, CC, SC

The Committee ***reiterates*** *the importance of the CMP for the conservation of western gray whales. The Committee therefore:*

(1) ***recognises*** *the tremendous work undertaken in the rangewide assessment and the value of the modelling framework developed;*
(2) ***agrees*** *that the next part of the process is to develop conservation-related questions and to use the framework to address these with a view to examining results at SC68a;*
(3) ***agrees*** *that a small group meeting (see Item 27) attended by at least the national co-ordinators of the Memorandum of Co-operation on gray whales, Reeves, Punt and Donovan be held to: (a) draft an update to the CMP; and (b) identify conservation-related questions to be addressed by the modelling framework and to present results at SC68a;*
(4) ***requests*** *those signatories to the Memorandum of Co-operation on western gray whales who have not yet named a national co-ordinator to do so promptly; and*
(5) ***supports*** *the holding of a stakeholder workshop in 2019 co-sponsored by the IWC, IUCN and the states that have signed the Memorandum of Co-operation and welcomes the valuable assistance of IUCN in organising the workshop.*

10.1.4 Franciscana

10.1.4.1 NEW INFORMATION

The Committee received valuable new information on franciscana at this meeting related to fisheries and bycatch from five localities in North Espírito Santo State, Brazil (SC/67b/SM30) – bycatches of Guiana dolphins was also reported. Additional information was presented assessing fisheries that operate in Fisheries Management Area (FMA) Ib for their compliance with Brazilian ordinance (IN) 12 (e.g. with respect to gill-net regulations and no-take zones) and risk of bycatch (SC/67b/SM05) – compliance was limited and enforcement poor. Both projects were funded by the IWC Small Cetacean Fund and the Government of Italy. This information is discussed in Annex O (item 2.1.4.1) and a related recommendation is given under Item 10.4.2.2.

10.1.4.2 PROGRESS WITH THE CMP

The overall objective of the CMP, submitted by Argentina, Brazil and Uruguay (IWC/66/CC11) and adopted in 2016, is to protect franciscana habitat and minimise anthropogenic threats, especially bycatch. It includes seven high priority actions, ranging from public awareness and capacity building through research to mitigation. Coordination with Uruguay to implement the CMP in this area will be initiated during a workshop that will take place in May 2018 with the main stakeholders (SC/67b/CMP16). The CMP is funded by the IWC CMP Voluntary Funds and the World Wildlife Fund.

Attention: *CG-R*

The Committee ***emphasises*** *the importance of the CMP for the conservation of franciscana in the waters of Argentina, Uruguay and Brazil. The Committee therefore:*

(1) ***stresses*** *the value of the actions included in the CMP towards future assessments of the status of franciscana, which is imperative for determining the effectiveness of conservation efforts;*
(2) ***recommends*** *that research be undertaken to estimate the abundance of franciscana dolphin off Buenos Aires province, Argentina; and*
(3) ***recommends*** *that additional research be undertaken to determine the effectiveness of management measures, such as that described in SC/67b/SM05 for other ports (e.g. Macaé, Tamoios (Cabo Frio) and Armação dos Búzios – the fishery in Tamoios coincides with a high diversity of marine megafauna).*

The Committee established an intersessional correspondence group that will help co-ordinate the presentation of CMP projects for this species across sub-committees at SC/68a (Annex Y).

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 received several papers that improved knowledge of Arabian Sea humpback whales and a full discussion can be found in Annex O (item 2.2.1). It welcomed the information on the progress of work being undertaken by the Arabian Sea Whale Network (ASWN) formed in 2015 (SC/67b/CMP10). The ASWN is an informal collaboration of researchers, consultants and conservation and governmental organisations interested in the conservation of whales in the Northern Indian Ocean. A primary goal of the ASWN is to promote and foster research and collaboration in previously unsurveyed parts of the Arabian Sea humpback whales' suspected range, as well as in Oman where surveys have been conducted since 2000. Work has focused on collecting data on whale distribution and status (including through increased awareness and an observer programme – described in SC/67b/CMP15)), the introduction and implementation of a regional online data platform (SC/67b/PH03) and providing updates on research activities in Oman, India, Pakistan and Sri Lanka (SC/67b/INFO07). Two marine protected areas have been established in Pakistan (Astola Island and Indus Canyon).

Madhusudhana *et al.* (2018) reported on and compared humpback whale songs recorded off India, Oman, Reunion Island and Comoros Islands in the southwest Indian Ocean. The results highlighted (a) the distinct nature of the Arabian Sea population and (b) that SW Indian Ocean whales may move into the Arabian Sea more commonly than previously thought.

SC/67b/CMP13 reported on a humpback whale tagged off Oman that moved to the southern tip of India and back again - the first recorded movement of a whale across the Arabian Sea. Four additional satellite tags were deployed where the whales remained over the continental shelf of central and southern Oman.

Attention: G, SC

The Committee ***welcomes*** *the new information from the region on this critically endangered population and* ***commends*** *the researchers for their initiatives and collaborative efforts. In light of the information presented, the Committee:*

(1) ***encourages*** *the collection of genetic information which would be helpful for identifying stock structures within the area;*
(2) ***recommends*** *future use of unoccupied aerial systems to (i) measure whale health, (ii) develop long-term health metrics, (iii) compare body condition to stock C in the Southern Hemisphere, which is the presumed 'source' population for whales in the Arabian Sea and (iv) assess for evidence of anthropogenic threats;*
(3) ***commends*** *the use of fishing crew as observers and* ***advises*** *that the crew-based observer programme continue, recognising that it is not clear if the timing of the sightings reflects the seasonal distribution of whales or the seasonal nature of fishing effort and* ***encourages*** *future research to tease apart timing of the distributions using targeted surveys;*
(4) ***advises*** *that capacity building for local scientists be continued such that surveys can be deployed in suspected areas of humpback whale distribution and data can be gathered for future assessments;*
(5) ***advises*** *the continuation of monitoring songs of Arabian Sea humpback whales and that additional data sets be acquired comparison purposes, particularly from the southwest Indian Ocean, if they exist, to further (i) detect the movement of southwestern Indian Ocean animals in Boreal winter, (ii) document potential diffusion of southwestern Indian Ocean song, (iii) provide a long-term data set for the comparison of songs across Oman, Pakistan and India to assess continuity of whales in the Arabian Sea and (iv) evaluate the unprecedented temporal stasis of song in the Arabian Sea; and*
(6) ***agrees*** *that an intersessional correspondence group (Annex Y) be formed to review the methods used for the preliminary estimates of abundance, in order to increase their robustness by taking into account the non-random survey approach that violates some key assumptions of mark-recapture models.*

Table 14

Summary of the work plan on Conservation Management Plans.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Southeast Pacific right whales		Review progress with scientific aspects of the CMP		Review progress with scientific aspects of the CMP
Southwestern Atlantic right whales		Review progress with scientific aspects of the CMP		Review progress with scientific aspects of the CMP
Gray whales	Hold workshop on scientific aspects of CMP and use of modelling framework	Review results and provide advice on scientific aspects of CMP	Stakeholder workshop	Review scientific aspects of results of stakeholder workshop
Franciscana		Pre-assessment for in-depth review		Continue pre-assessment and develop plan for in-depth assessment
Humpback whales in Northern Indian Ocean	Intersessional email group (see Annex Y) on abundance estimates	Review new information and progress towards CMP		Review new information and progress towards CMP
Mediterranean fin whales	Develop outline draft	Review draft and progress towards CMP		Review progress towards CMP
South American river dolphins		Review new information and progress towards CMP		Review new information and progress towards CMP

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

A Concerted Action for Arabian Sea humpback whales under the Convention on Migratory Species (CMS; SC/67b/INFO06) was drafted and passed with wide support from Arabian Sea range states at the CMS COP in October 2017. It is hoped that this Concerted Action can be implemented in conjunction with a CMP as a means to translate current research and conservation efforts and plans into concrete, government-supported conservation measures in Arabian Sea humpback whale range states.

Attention: *C-A, S*

*The Committee **reiterates** its serious concern about the status of the endangered Arabian Sea humpback whale population and the anthropogenic threats it faces. It therefore:*

*(1) **commends** efforts to develop the Concerted Action under the CMS, noting that it covers many of the elements required for a CMP;*
*(2) **stresses** the value of regional initiatives and **encourages** range states to explore future sources of collaboration; and*
*(3) **encourages** continued efforts between range states and Secretariats to work toward a joint CMS-IWC CMP.*

10.2.2 Mediterranean fin whales

The ACCOBAMS Meeting of Parties has endorsed the development of a CMP, ideally jointly with the IWC, for fin whales in the Mediterranean Sea. A small group will meet in the summer of 2018 to draft an outline for a CMP that can be presented at SC/68a. ACCOBAMS is also considering the development of CMPs for other species in the region.

10.2.3 South American River Dolphins

Advice was sought regarding the development of a CMP for South American river dolphins, which currently have several actions plans endorsed by various range states.

Attention: CG-A

*The Committee **advises** that the applicable range states work towards developing a draft CMP for presentation at SC/68a.*

10.3 Work plan 2019-20

The work plan on matters related to stocks that are or might be the subject of CMPs is given as Table 14.

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. During SC67b, the Stock Definition and DNA Testing Working Group assessed genetic methods used for species, stock and individual identification, including matters associated with the maintenance of DNA registers (see 11.1); continued to develop and update guidelines for preparation and analysis of genetic data within the IWC context (see 11.2); and provided the Committee with feedback and recommendations concerning stock structure related methods and analyses (see 11.4), including those relevant to other sub-committees (see 11.3). The Report of the Working Group is given as Annex I.

11.1 DNA testing

This item has been considered since 2000 in response to a Commission Resolution (IWC, 2000).

11.1.1 Genetic methods for species, stocks and individual identification

The Committee received two papers relating to the use of genetic methods for species, stock and individual identification. The first paper (Carroll *et al.*, 2018) provided a review of how technological advances, particularly those associated with the development of high throughput sequencing (HTS) technology, can aid in genetic monitoring. Of particular interest to the Committee was discussion of targeted capture approaches that allow for microsatellite genotyping via HTS (e.g. De Barba *et al.*, 2017). Much of the past genetic work has relied on generating microsatellite datasets, including the work to maintain DNA registries of bycaught or direct catches (see Items 11.1.2 and 11.1.3). These 'legacy' datasets may include microsatellite genotypes for thousands of individuals. While technical challenges exist, microsatellite genotyping via HTS could 'bridge the gap' by maintaining the utility of these legacy datasets while also taking advantage of the newer HTS approaches.

The second paper (Baker *et al.*, In press) presented the results of a study confirming the potential to detect environmental DNA (eDNA) in seawater collected from the wake of killer whales. This is a new approach for detecting and identifying cetacean species, including those that may be elusive to study using other methods. Although eDNA has been more broadly used to detect the occurrence of species in an area (i.e. DNA barcoding), it could provide sequence data useful for stock-level identifications of cetaceans under certain circumstances (e.g., when a single animal is present). It was noted, however, that its utility in addressing questions requiring individual identification via multi-locus genotyping is, at least currently, limited for scenarios in which the water sample could contain DNA from multiple individuals.

Attention: SC

The Committee welcomes the opportunity to review papers that take advantage of technological advances to improve the ability to detect and identify species, stocks, and individual cetaceans. It encourages the submission of similar papers in the future and recognises the relevance of these techniques to the Committee's work.

11.1.2 'Amendments' of sequences deposited in GenBank

While *GenBank*[7] is an important scientific resource, it is an uncurated database of DNA sequences and thus contains sequences that are misidentified or have other annotation problems. 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. The Committee has agreed (IWC, 2018c, p. 228) that its revised DNA quality guidelines will contain a section discussing the precautions that should be taken when including GenBank sequences in a study. This text has been drafted and will be incorporated into the revised guidelines (see Item 11.2).

11.1.3 Collection and archiving of tissue samples from catches and bycatches and 11.1.4 Reference databases and standards for diagnostic DNA registries

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 Annex I (appendices 2-4) for each country, covering the period up to and including 2017. 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.

During last year's discussion of the Norwegian minke whale DNA register (IWC, 2018c, p.228-229), 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 had expressed concern regarding the comparability of the DNA registers in the future. This year, the Committee noted that Norway had discontinued mtDNA typing of samples and substituted it with SNP genotyping.

Attention: CG-A

*The Committee **expresses** appreciation to Japan, Norway and Iceland for providing updates to their DNA registries using the standard format agreed in 2011 and providing the detailed information contained in their DNA registries.*

11.2 Guidelines and methods for genetic studies and DNA data quality

Two sets of guidelines have been developed for reference in the Committee's discussions of stock structure. The most recent version of the guidelines for genetic data analyses are in press with the Commission's *Journal of Cetacean Research and Management*. The DNA data quality guidelines address DNA validation and systematic quality control in genetic studies, and are currently available as a 'living document' on the IWC website[8]. In recent years, it has become common for the Committee to review papers using data derived from Next Generation Sequencing (NGS) approaches, including SNPs, to address stock structure questions (see Item 11.3).

Attention: SC

*The Committee **emphasises** the importance of keeping its guidelines related to genetic data quality and analyses up to date. It therefore:*

*(1) **reiterates** the need to update these guidelines to incorporate the discussion of data quality measures used for Next Generation Sequencing data; and*

*(2) **agrees** to continue the intersessional correspondence group (Annex Y) to review revised sections of the DNA data quality guidelines that apply to data generated from next generation sequencing platforms, including SNPs and whole genome sequencing, with the goal of posting an updated version of the guidelines on the website next year.*

11.3 Provide advice on stock structure to other sub-groups

The Working Group on Stock Definition and DNA also has the task of discussing high-priority stock related papers from other sub-committees and working groups to provide them with stock structure related feedback and recommendations. These discussions often refer to the genetic analysis guidelines and genetic data quality documents.

The discussions (see Annex I for details) are summarised under the relevant stock agenda items in this report. Two, more general issues arose from discussions of Southern Hemisphere stocks and North Atlantic common minke whales. These are considered below.

11.3.1. Southern Hemisphere whale stocks and use of samples

The Committee reviewed the results of genetic analyses of Southern Hemisphere whale stocks, including Southern Hemisphere blue, fin, right and sei whales. These results highlighted the value of existing collections of tissue samples to address stock structure questions.

Attention: SC

*In reviewing the results of stock structure analyses of Southern Hemisphere whale stocks, the Committee **expresses** concern regarding the depletion of tissue samples in existing collections (including those collected during the IWC SOWER surveys, although the Steering Group does take this into account when reviewing requests). Given recent advances in high throughput sequencing technology, the Committee **agrees** that an intersessional correspondence group (Annex Y) should be formed to provide recommendations on genomic approaches to maximise the utility of these samples for future studies.*

11.3.2. North Atlantic common minke whales

The Committee reviewed the results of genetic analyses pertaining to the stock structure of North Atlantic minke whales (SC/67b/Rep06). The analyses presented involved the use of a new approach to evaluate stock mixing proportions by (1) identifying a 'reference' year in which mixing of

[7]*https://www.ncbi.nlm.nih.gov/genbank/*

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

stocks was considered low based on a lack of heterogeneity in genetic characteristics estimated for each area, and (2) using principal component analysis of the genetic data to assign stock affinities in the non-reference years based on proximity to mean values in the reference year.

Attention: SC, C-A

The Committee reviewed the use of a new approach that used ordination analyses of genetic data to assign stock mixing proportions. Recognising that this new approach requires making certain assumptions about the data, the Committee:

*(1) **agrees** that the inference of mixing rates was informative for AWMP/RMP simulation trials in the absence of empirical data; and*
*(2) **encourages** the attempt to use genetic data to estimate mixing rates in the context of other IWC-related tasks.*

11.4 New statistical and genetic issues relating to stock definition

11.4.1. Simulation tools for spatial structuring

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 used within the IWC Scientific Committee for this purpose.

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, 2014, and see IWC, 2017c p.44), and in 2016 the Committee agreed to expand this item (formerly specific to TOSSM) to include a broader range of tools (IWC, 2016c p.44).

Attention: SC

*The Committee **noted** that while simulation-based approaches have been particularly valuable in informing the interpretation of results of stock structure-related analyses, they have not been broadly utilized within the Committee for this purpose. The Committee **agrees**:*

(1) to continue an intersessional review via an email correspondence group (Annex Y) of the available simulation tools and their potential utility to the Committee; and
(2) to consider bringing in invited expertise to present an overview of the applicability of such approaches in order to expedite progress on this agenda item.

11.4.2. 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, 2014 p.287-8). At SC67b, the status of the existing draft glossary on key terms related to stock definition was revisited.

Attention: SC

*The Committee **agrees** to establish an intersessional correspondence group (Annex Y) to revisit terminology with specific reference to the implications of inferred stock structure in other sub-committees, particularly those that deal with large whale assessments, and suggest revisions where appropriate for consideration at SC68a.*

11.4.3. Close-kin mark-recapture

An overview of the close-kin mark-recapture (CKMR) approach (Bravington *et al.*, 2016) was presented to the Committee last year (IWC, 2018c p.40). 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 stock structure. No papers applying the CKMR approach were reviewed by Committee this year, although the value of integrating data from epigenetic aging (see 11.4.4) into CKMR was noted.

Attention: SC, G

*Given that close-kin mark-recapture has multiple applications that fall within the Committee’s scope of work, the Committee **encourages** the submission of papers using this approach in the future.*

11.4.4. Epigenetic ageing

Information on estimated age of individuals can be used in many aspects of the Committee’s work, including (1) discriminating between the parent and offspring among genetically identified parent-offspring pairs, which can inform both assessment of stock structure as well as genetic mark-recapture estimates of abundance (e.g. CKMR); and (2) integrating age information into the population modelling exercises integral to assessment work (e.g. on RMP implementation). Recently, epigenetic (DNA-methylation) ageing has been successfully used to estimate age in humpback whales (Polanowski *et al.*, 2014). This year, the Committee invited Jarman, the lead scientist on the humpback whale work, to give an overview presentation to the Committee. This session was organised as a special evening session in order to enable participation across sub-committees and Working Groups. He covered issues specific to age estimation in cetaceans, including how DNA methylation-based age estimation are likely to perform in cetaceans and what current and near-future prospects there are for this class of methods (see Annex I, item 5.5).

The Committee also reviewed the results of a study to evaluate the feasibility of using the DNA-methylation technique to estimate age in Antarctic minke whales (SC/67b/SDDNA04). This study was initiated in response to a recommendation made during the Expert Panel review of the NEWREP-A proposal (SC66A/REP06, p17). DNA-methylation rates were examined for seven methylation sites (CpG sites) within three genes, and regressions of each CpG methylation site against age determined by earplug were conducted. When all sites were incorporated, the assay predicted age from skin samples with a standard deviation of about 8.9 years. While some sites showed age-related effects, others did not show such correlation. Thus, using only those loci that appear to have an age-related effect might reveal a stronger relationship between methylation rates and age.

During the discussion (Annex I, item 5.5) it was noted that the humpback whale age assay, which used the same sites, reports a precision of 2.99 years, measured as the average of the absolute values of the differences between known and estimated ages (Polanowski *et al.*, 2014). During the presentation, the precision as measured by the standard deviation for absolute age prediction was reported as 4.8 years. That was a preliminary study demonstrating the fundamental feasibility of this approach, and is not as accurate or precise as tests developed for humans and mice based on analysis of many more CpG sites. While precision is expected to improve with the inclusion of more CpG sites, the maximum precision possible for any DNA methylation-based age estimator is likely limited by the imperfect relationship between chronological age and biological age. To date, that precision has ranged from 3.9% in humpback whales (Polanowski *et al.*, 2014 assuming a 95-year lifespan), to 3.2% of lifespan in humans (e.g. Horvath, 2013) and 1.7% of lifespan in mice (Stubbs *et al.*, 2017). These observations indicate that the SD and 95% CI for age estimation described in Polanowski *et al.* (2014) and in SC67b/SDDNA04 could be substantially improved before an inherent limit is reached. These precision estimates adhere to age determination in individual specimens. Hence, averaged age estimates over cohort will improve over larger sample sizes and may be more precise.

The Committee noted that the implications of this upper limit on precision in estimating age for individuals would need to be evaluated in the context of the specific application for which the age data were being used. For example, although additional precision is helpful, CKMR studies may be informed by relatively crude estimates of age allowing the parent to be discriminated from the offspring (i.e. ordinal age).

Attention: SC

The Committee ***welcomed*** *the results of the study to evaluate the feasibility of using epigenetic techniques to estimate age in Antarctic minke whales and agrees:*

(1) that the current set of loci did not provide sufficient precision for use in the population dynamics modelling exercise ***recommended*** *for NEWREP-A;*
(2) that identification of additional sites with an age-related DNA-methylation pattern is ***encouraged****, as it would likely allow more precise estimates of age to be made in the future; and*
(3) given that there is an upper limit to the degree of precision that can be achieved using this technique, the utility of epigenetic age estimation to the Committee should be further evaluated by the sub-committees concerned with regard to the degree of precision needed for the specific application of interest.

11.5 Work plan 2019-20

The details of the work plan are given in Table 15.

12. CETACEAN ABUNDANCE ESTIMATES, STOCK STATUS

The Committee received new information from the Standing Working Group on Abundance Estimates, Status and International Cruises (ASI) that had been established (IWC, 2017c, p. 94) 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. It also assists the Committee and the Secretariat in developing a biennial document reporting to the Commission on the abundance and status of whale stocks.

12.1 Summary of abundance estimates and update of IWC consolidated table

Appendix 3 of Annex Q provides detailed information about abundance estimates agreed by the Committee, including estimates received prior to and during 2017, as well as ones evaluated this year. The Secretariat maintains a consolidated table.

Broadly, cetacean abundance estimates are usually obtained in one of three ways. Line transect surveys require observers on ships or aircraft to detect animals while the observers are traveling on paths traversing the survey area. Statistical methods are used to estimate how many animals were not seen, usually by evaluating how detection deteriorates as sighting distance increases and by extrapolating to survey areas beyond visual detection distance. Mark-recapture studies require multiple attempts to 'capture' individuals that are mixing between attempts. For cetaceans, individual animals are usually identified - and hence 'captured'- on the basis of matching photographs of whale markings, or by genetic analysis of biopsy samples of live animals. Statistical methods are used to estimate how many animals were never captured, based on information about the probability of capture, which is inferred from instances when the animal was sometimes captured and sometimes not. Population model based abundance estimates use information from a variety of sources to build a mathematical model of how a population changes over time. Important data and parameters in such models include survival rates, productivity rates, and previous abundance estimates. By fitting (and possibly projecting) this model, an estimate of current abundance is achieved.

Many sophisticated abundance estimation methods are hybrids or extensions of these basic approaches.

This year, the Committee endorses the following:

(1) a photo-ID mark-recapture estimate of 2011 abundance for Bering-Chukchi-Beaufort Seas bowhead whales;
(2) an aerial line transect estimate of 2013 abundance of East Canada / West Greenland bowhead whales;
(3) aerial line transect estimates of 2015 abundance of East Greenland and West Greenland North Atlantic humpback whales;
(4) ship-based line transect abundance estimates of North Atlantic humpback whales in Iceland/Faroe Islands in 2007 and 2015;
(5) aerial line transect abundance estimates of East Greenland (2015) and West Greenland (2007 and 2015) North Atlantic minke whales;
(6) ship-based line transect abundance estimates of North Pacific Bryde's whales for several areas and time periods;
(7) aerial line transect abundance estimates of East Greenland (2015) and West Greenland (2005, 2007 and 2015) North Atlantic fin whales;
(8) genetic mark-recapture abundance estimates for Maui's dolphins in New Zealand for several years and
(9) photo-identification mark-recapture estimates of western gray whales in 1995 and 2015.

Table 16 summarises key information about the agreed abundance estimates. Full details are given in Annex Q (item 3 and appendix 3).

Attention: SC, S, C-A

Abundance estimates are a key parameter in determining status. The Committee:

(1) ***endorses*** *the new abundance estimates presented in Annex Q, Appendix 3 for inclusion in the IWC Table of Accepted Abundance Estimates;*

Table 15

Work plan on topics related to genetics.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
3.1 DNA quality guidelines	Intersessional group (see Annex Y) to review recent revisions to the DNA quality guidelines that pertain to data produced using NGS approaches.	Report and finalise updated guidelines		
4.4.2 Recommendations to avoid sample depletion	Intersessional email group to provide recommendations on genomic approaches to maximise the utility of tissue samples that are in danger of becoming depleted in the future.	Report and provide advice		
4.5 North Pacific minke whale stock structure	Perform genetic analyses detailed in Appendix 5; report results at intersessional workshop on the North Pacific minke whale IR.	Review results and provide advice		
5.1 Simulations	Intersessional email group to review software packages and evaluate utility to the Committee.	Report	Continue as needed	Report (if needed)
5.3 Terminology	Intersessional email group to continue discussions of the use of stock structure-related terms within the Committee.	Report	Continue as needed	Report (if needed)

*(2) **agrees** that they should be incorporated into that table and uploaded to the IWC website; and*
*(3) **agrees** that the table should continue to be updated intersessionally by the Steering Group (Annex Y).*

12.2 Process to review abundance estimates

Abundance estimates are needed to assess the status of cetacean populations and are used extensively by the Committee, including for providing management advice. These estimates are often computed by standard, but technically advanced methods. In addition, because of the high scientific standards found within the Committee's work, it is not uncommon for the Committee to receive estimates of abundance computed using novel methods and non-standard software/code. The review of these estimates can be complex and time consuming. At last year's meeting, the Committee noted that adequate time is needed to review abundance estimates and agreed that a process to facilitate the review of these estimates be developed (IWC, 2018c). In addition, the Committee noted that reviews would benefit if minimum requirements for the presentation of abundance estimates are established.

This year, the Committee developed a process to improve the review of abundance estimates, including a prioritisation of the estimates according to the timeline they need to be used by the Committee. This process is described in detail in Annex Q, item 2.1. In addition, minimum requirements to present abundance estimates for review by the Committee were established. Details are given in item 2.2 of Annex Q.

The Committee noted that validation may be needed before estimates computed using novel methods and non-standard software are used to provide management advice (Annex Q, item 2.3). The Committee also noted the need to consider how estimates of abundance from population models are reviewed before they are included in the Table of Accepted Abundance Estimates (Annex Q, item 2.4).

Attention: SC, S

*The Committee **reiterates** the importance of using high quality, fully reviewed abundance estimates for its work. To achieve this the Committee **agrees**:*

(1) to adopt the process to improve the review of abundance estimates given in Annex Q (item 2.1);
(2) the minimum requirements for the presentation of estimates for review by the Committee given in Annex Q (item 2.2);
(3) to host a pre-meeting before next year's meeting (SC68a) to develop (a) a process to validate abundance estimates computed with non-standard methods, noting the value of simulated datasets in this process; (b) a process to review estimates of abundance computed with population models is needed.

12.3 Methodological issues

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

The Committee noted that there was a need for RMP guidelines to be modified in order to incorporate spatial modelling approaches to estimate abundance.

Attention: SC

*The Committee **noted** that whilst much progress has been made with respect to considering model-based estimates (IWC, 2016c), the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' need to be modified. The Committee **agrees** that an intersessional steering group (Annex Y) will develop instructions and select a candidate to modify the Guidelines.*

12.3.2 Review new survey techniques/equipment

The Committee received information on the use of unmanned aircraft vehicles (UAVs) to improve estimation of abundance of river dolphins in the Amazon. Details are provided in Annex Q, item 5.

Attention: SC, G

The Committee looks forward to receiving information on new survey technologies used to improve estimates of abundance of cetaceans.

12.4 Consideration of the status of stocks

The Committee noted that further consideration on how to report status of cetacean stocks is needed.

Table 16

Abundance estimates, CVs and 95% confidence intervals for estimates agreed at the 2018 meeting.

Whale and Region	Year	Estimate	CV	95% confidence interval
North Pacific Bryde's whales				
Area 1W	1995	12,149	0.41	5,579-26,454
	2000	6,894	0.47	2,872-16,549
	2011	25,158	0.38	12,202-51,872
Area 1E	1995	15,695	0.42	7,079-34,801
	2000	19,200	0.56	6,929-53,204
	2011	9,315	0.33	4,957-17-505
Area 2	1995	4,340	0.45	1,876-10,039
	2000	6,083	0.61	2,030-18,229
	2014	6,491	0.36	3,254-12,950
North Atlantic common minke whales				
East Greenland	2015	2,762	0.47	1,160-6,574
West Greenland	2007	9,066	0.39	4,333-18,973
	2015	5,095	0.46	2,171-11,961
North Atlantic fin whales				
East Greenland	2015	6,440	0.26	3,901-10,632
West Greenland	2005	9,800	0.62	3,228-29,751
	2007	15,957	0.72	4,531-56,202
	2015	2,215	0.41	1,017-4,823
North Atlantic humpback whales				
East Greenland	2015	4,223	0.44	1,845-9,666
West Greenland	2015	993	0.44	434-2272
Iceland/Faroe Islands	2007	18,105	0.43	7,226-45,360
	2015	10,031	0.36	4,962-20,278
Bowhead whales				
Bering-Chukchi-Beaufort Seas	2011	27,133	0.22	17,809-41,377
East Canada/West Greenland	2013	6,446	0.26	3,722-11,200
Gray whales				
Western North Pacific	1995	74	0.05	66-81
	2015	200	0.03	187-211
Maui's dolphin				
North Island, New Zealand	2016	57	n/a	44-75

Attention: SC

*The Committee **recognises** the need to further consider how to report status of stocks to the Commission in a consistent manner and **agrees** to address this topic at a pre-meeting to be held prior to next year's SC meeting (SC68A).*

12.5 Work plan 2019-20

The Committee agrees to the work plan given in Table 167

13. BYCATCH AND ENTANGLEMENTS

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

The Committee received three papers relating to the bycatch of large whales. SC/67b/HIM03 provided information on stranded humpback whales stranded along the southeastern coast of Brazil in 2016 and 2017 including records of entanglements over the São Paulo coast. SC/67b/HIM09 focussed on ten baleen whale populations for which bycatch appears to be a component of substantial conservation problems and the authors categorised priorities for action. SC/67b/AWMP08 provided information on Bering-Chukchi-Beaufort Seas stock of bowhead whales. Discussion can be found in Annex J (item 2.1).

13.2 Reporting of entanglements and bycatch in National Progress Reports

Reports of large whale bycatch are summarised in Annex J (item 2.4) and the issue of partial reporting discussed. Issues related to reporting and progress reports is given under Item 3.2.

13.3 Mitigation measures for preventing large whale entanglement

Mattila, the IWC's technical advisor for reducing unintended human impacts, reported on relevant activities under the entanglement initiative. Details can be found in Annex J (item 2.5). Since last year's meeting, IWC entanglement trainings have been conducted in Sakhalin (Russia), Arica (Chile), Sortland (Norway) and Bahía Solan (Colombia). This brings the total number of trainees in this initiative to 1,130 from 27 countries. In addition, two apprentices were hosted this year, one from Chile and one from Oman. Mattila also presented the IWC's work with entanglement in two workshops at the Society for Marine Mammalogy Biennial conference (2017). The Committee thanked Mattila for his exemplary work in coordinating the Global Whale Entanglement Response Network.

13.4 Review proposal for global entanglement database

The Committee considered progress with the development of a dedicated entanglement database. This will be considered further at the June 2018 meeting of the Global Whale Entanglement Response Network (see Annex J, item 2.3).

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

13.5.1 Small cetacean bycatches in Peru

The Committee received a report (SC/67b/HIM01) summarising monitoring efforts of beach-cast cetaceans in 11 locations along the Peruvian coast from 2000-2017. Full discussion can be found in Annex J (item 2.1.2) that showed clear evidence of continued high bycatch rates and some intentional takes. Burmeister's porpoises accounted for 66% of the specimens and the low proportion (25%) of dusky dolphins contrasted with 1985-1990 statistics, when dusky dolphins accounted for three quarters of all cetacean captures. This reiterated prior concerns (Van Waerebeek, 1994) about a persistent long-term trend of a significant decline in prevalence of Peruvian dusky dolphin in catch and stranding records.

The observed high mortality levels in Burmeister's porpoise are a serious concern, and action is needed to avoid the same critical situation as with the closely related vaquita. Burmeister's porpoise is already included in a preliminary list for potential Conservation Management Plan development (Genov *et al.*, 2015), and dusky dolphin could potentially also be included. The Committee reiterated recommendations from 2008 regarding bycatch monitoring programmes and mitigation efforts in these fisheries (IWC, 2009, p. 323).

Attention: C-A, CC

*The Committee **draws the attention** of the Commission to its **serious concern** over the high mortality levels from bycatches in Peru and especially those of the Burmeister's porpoise and dusky dolphin. It **stresses** that action is needed to avoid the same critical situation for Burmeister's porpoise as with the closely related vaquita. In this regard the Committee:*

*(1) **reiterates** its advice (IWC, 2009, p. 323) on bycatch monitoring and mitigation in these fisheries;*
*(2) **reiterates** that the Burmeister's porpoise is a potential candidate for a Conservation Management plan;*
*(3) **highlights** opportunities to focus on the bycatch of small cetaceans in Peru through the new IWC Bycatch*

Table 17

Workplan on abundance estimates and status.

Topic	Intersessional 2018-19	SC/68a	Intersessional 2019-20	SC/68b
Review of abundance estimates	Review estimates identified at SC/67b (New Zealand Blue Whales, Arabian Sea humpback whales) – see Annex Y	Review intersessional progress and estimates available at SC/68a	Review estimates identified at SC/68a	Review intersessional progress and estimates available at SC/68a
Upload the estimates accepted at the annual meeting to the IWC website and continue to update the IWC Abundance Table	Update the table with estimates accepted at SC/67b (see Annex Y)		Update the table with estimates accepted at SC/67b	
Review and provide advice on plans for future surveys		Receive, review and provide feedback to research plans to conduct abundance estimates		Receive, review and provide feedback to research plans to conduct abundance estimates
Pre-meeting to consider: (a) validation of non-standard software and methods; (b) estimates of abundance computed from population models; and (c) status of populations	Meeting preparation	Review of progress		
Amend the RMP Guidelines to consider abundance estimates computed with model-based methods.	Identify a candidate to update the RMP Guidelines (see Annex Y)	Review an updated document of the Guidelines		
Develop simulation software to evaluate methods for abundance estimates		Review progress		

Mitigation Initiative and ***recommends*** *that they are considered as a potential pilot project;*

(4) ***offers its assistance*** *to the Government of Peru; and*

(5) ***requests*** *that the Commission, through the Secretariat, transmits the Committee's concern and offer of assistance to the Government of Peru.*

13.5.2 Franciscana bycatch in Brazil

Considerable information was provided on the Santos Basin Beach Monitoring Project required by the Brazilian authorities for licensing oil and gas production and transport (see Annex J, item 2.1.2). This provided information *inter alia* on stranded franciscana. From October 2015 to September 2017, 1,123 carcasses were recorded stranded in the area and interactions with fishing gear was reported for over 85% of necropsied individuals with signs of human activities.

Attention: CG-A

The Committee ***draws attention*** *to the fact that the franciscana remains under strong pressure from human activities, especially bycatch, in Brazilian waters despite fishing net regulations established by the government. The Committee:*

(1) ***advises*** *that the existing regulation on gillnets, implemented in 2012, is either not being effectively enforced or is not effective in reducing bycatch; and therefore*

(2) ***recommends*** *the need for this to be investigated further by the Brazilian authorities.*

13.5.3 Estimating bycatch from strandings data

Estimates of common dolphin mortality in the Bay of Biscay based on strandings data (Peltier *et al.*, 2016) had been discussed at SC67a. SC/67B/HIM/05 and SC/67B/HIM/08 provided further analyses related to using stranding data to make inferences about small cetacean mortality. An intersessional group was established at SC67a to provide advice on consistent ways to estimate bycatch across both large and small cetaceans, and specifically, to review the methods applied in Peltier *et al.* (2016) focused on small cetaceans. Discussion of the report of the intersessional group and some additional related papers (SC/67b/ HIM05 and SC/67b/HIM08) can be found in Annex J (item 2.1.2).

In discussion of other ways to estimate bycatch, the Committee noted that Bartholomew *et al.* (2018) had concluded that Remote Electronic Monitoring can provide a time- and cost-effective method to monitor target catch in small-scale fisheries and can be used to overcome some of the challenges of observer coverage. This requires consideration by the Committee.

Attention: CG-A, SC, G

With respect to methods for obtaining bycatch estimates the Committee:

(1) ***agrees*** *with the recommendations of its intersessional group regarding (a) uncertainties in bycatch estimates derived from strandings; (b) the use of bycatch estimates derived from strandings; and (c) assessing whether strandings can identify gaps in observer coverage;*

(2) ***notes*** *the importance of observer programmes, including electronic monitoring, and the limitations of stranding information for determining the type of fishing gear implicated in a bycatch event, or in determining reliable bycatch estimates;*

(3) ***recognises*** *that in small scale fisheries (a) observer programmes are particularly complicated, given the small size of vessels and (b) electronic monitoring may not capture the animals falling from the net during hauling;*

(4) ***advises*** *that a robust evaluation of the effectiveness of bycatch mitigation measures requires a combination of monitoring measures, including well-designed and effectively implemented observer programmes, electronic monitoring and stranding programmes;*

(5) ***advises*** *that the above advice is relevant to the situation of the franciscana in Brazil; and*

(6) ***agrees*** *that given the increased use of Remote Electronic Monitoring techniques and the rapid development of camera and associated electronic technology, these techniques should be a focus topic at SC68a.*

13.6 Scientific aspects of mitigation measures

13.6.1 The IWC Bycatch Mitigation Initiative

The Committee considered the outcomes of an assessment on the potential work areas for the new IWC Bycatch Mitigation Initiative (SC/67b/HIM12). This resulted in several recommendations for the Committee in relation to potential work areas, including:

(1) identification of priority fisheries/sites/species/populations to be considered for pilot projects based on conservation need and the establishment of bycatch baselines for relevant cetacean populations where mitigation is to be trialled;
(2) leading in communicating the need for increased research on mitigation measures/management approaches for cetaceans to the broader scientific community;
(3) annually reviewing mitigation measure tables;
(4) providing technical assistance to the coordinator and the expert panel in the development of scientific trials/monitoring programmes to evaluate mitigation measures; and
(5) collaborating with researchers identifying fishing effort using vessel monitoring and tracking systems and assessing bycatch risk, with a focus on small scale fisheries.

With respect to the identification of priorities, five criteria for the selection of pilot projects were identified:

(1) urgency of conservation situation driven by bycatch or concern over situations with little or no data on bycatch, but suspected overlap between high risk fishing gears and vulnerable cetacean species;
(2) enabling conditions necessary for success;
(3) scope for IWC to contribute (e.g. enhanced international cooperation);
(4) ability to monitor effectiveness of mitigation actions; and
(5) potential for the project to contribute to mitigation of bycatch in other areas.

A list of information sources (including SOCER) was created at the meeting to assist Tarzia, the new BMI coordinator, to identify potential projects, after which she will consult with the expert panel to apply the above criteria, including contact with any of the governments involved, to select the projects for review by the initiative's Standing Working Group which can be presented to the Commission. The Committee suggested that identified fisheries in the Republic of Congo, Peru, Ecuador, Pakistan and India appear to fulfil many of the criteria and are locations where past or present IWC work is being carried out which is relevant to bycatch.

Attention: C-R, SC, CC

The Committee discussed the strategic assessment of the Bycatch Mitigation Initiative (BMI) and the role of the Committee. The Committee:

*(1) **welcomes** the progress made thus far under the BMI, including the Strategic Assessment;*
*(2) **thanks** Tarzia for the excellent work she has carried out since her appointment as co-ordinator;*
*(3) **agrees** to incorporate in its work plan the five work areas listed in its report under Item 13.6.1 and also consideration of 'rapid bycatch and risk assessment' tools;*
*(4) **agrees** to the criteria listed in its report under Item 13.6.1 when identifying priority fisheries/sites/species/populations; and*
*(5) **recommends** to the Commission that the BMI continues and is supported, including the provision of ongoing support for the BMI coordinator.*

13.6.2 Collaboration with FAO

FAO held an Expert Workshop on Means and Methods for Reducing Marine Mammal Mortality in Fishing and Aquaculture Operations in March 2018 which had been attended by several members of the Committee. The workshop report contained a review of mitigation measures and a decision tree providing guidance on choosing a bycatch mitigation pathway. The IWC Executive Secretary and BMI Coordinator will attend the FAO Committee on Fisheries (COFI) meeting in July 2018 where the report will be reviewed.

Attention: C-R, S

*The Committee **welcomes** the efforts of the FAO to consider cetacean bycatch and **recommends** that the IWC Secretariat continues to collaborate with the FAO on this issue.*

13.7 New information on cetacean bycatch in the Western, Central and Northern Indian Ocean

Last year (IWC, 2018c, p. 46), the Committee had recommended that in light of the scope and scale of cetacean bycatch in the Western, Central and Northern Indian Ocean and the considerable data gaps associated with intensive and extensive gillnet fisheries, the topic be included in the work plan for this meeting and the Secretariat establish communications on the issue with the Indian Ocean Tuna Commission (IOTC). SC/67B/HIM/07 provided updated information on this topic, as discussed in Annex J (item 2.7). The IWC's Executive Secretary provided an update on engagement with the IOTC, including a recent teleconference with the IOTC Executive Secretary.

Attention: C-A, CC, SC

With respect to bycatches of cetaceans in the Indian Ocean, the Committee:

*(1) **reiterates** its willingness to collaborate with the IOTC on this issue; and*
*(2) **encourages** the Secretariat to continue to work with the IOTC Secretariat.*

13.8 Work plan 2019-20

The Committee's work plan on bycatch and entanglement is given in Table 18.

14. SHIP STRIKES

14.1 Review esitames of rates of ship strikes, risk of ship srikes and mortality

The Committee received information on a pilot study to better characterise ship strikes in Southeastern Alaska (see Annex J, item 3.1) and looks forward to further updates on this work.

14.1.1 Review progress on ship strike database

The IWC continues to develop a global database of ship strike incidents as discussed in Annex J (item 3.1.1). The primary task is ongoing review of previously reported records by two data coordinators in conjunction with a data review group (SC/67b/HIM11). It is expected that the review process for all historical records will be completed in the next biennium.

Attention: C-R, S

The Committee ***reiterates*** *the importance of the global ship strikes database to its work. It therefore:*

(1) ***welcomes*** *the work undertaken thus far; and*
(2) ***recommends*** *the continuation of this work including (a) that of the co-ordinators and Data Review Group on the review of historical records and (b) the Secretariat on upload tools.*

14.2 Mitigation of ship strikes in high risk areas

The Pelagos Sanctuary in the Mediterranean is a recognised high risk area for ship strikes to fin and sperm whales. In France, the REPCET reporting system became mandatory on 1 July 2017 for French passenger, cargo vessels (SC/67b/HIM04). As discussed in Annex J (item 3.2.1), 'alerting' systems such as REPCET require a trained observer and a subsequent avoidance action of some sort by the vessel in order to be a considered as a mitigation tool.

The Committee had previously agreed that the available data supported a proposal to IMO to move the shipping lanes off the southern coast of Sri Lanka to reduce the risks of ship strikes to Northern Indian Ocean blue whales. In 2017, major shipping organisations represented at IMO also wrote to the Sri Lankan government requesting the routing change to reduce ship strike risks and improve maritime safety. So far, there has been no response from Sri Lanka.

The Hellenic Trench west of Greece is also an identified high risk area for sperm whales and in 2015 (IWC, 2016d), the Committee recommended that interested parties (including Greece, ACCOBAMS and the shipping industry) move forward with Greece in order to develop a proposal for routing measures.

The IUCN Marine Mammal Protected Areas Task Force process for identifying Important Marine Mammal Areas (IMMAs) may assist in identifying high risk areas for ship strikes. The Committee and the IWC's Ship Strike Standing Working Group have previously encouraged cooperation on this between the IUCN Task Force and the IWC.

Attention: C-A, CC, SC, G

The Committee has continued its work on identifying high risk areas for ship strikes and potential mitigation measures. In this regard the Committee:

(1) ***recommends*** *continued work to develop and evaluate mitigation measures, such as speed restrictions, that might be associated with the designation of a Particularly Sensitive Sea Area (PSSA) in the Pelagos Sanctuary area;*
(2) ***reiterates*** *its previous recommendations on the importance of evaluating the efficacy of the REPCET system for reducing the risk of ship strikes;*
(3) ***requests*** *the Commission, via the Secretariat, to remind the authorities in Sri Lanka of its previous offer of assistance from the IWC on this issue;*
(4) ***requests*** *the Commission via the Secretariat, to follow up on previous correspondence on the ship strike risks to sperm whales off Greece;*
(5) ***agrees*** *to support a workshop to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes; and*
(6) ***agrees*** *to continue ongoing IWC engagement with the process to identify IMMAs, including consideration of their utility to address other threats.*

14.3 Co-operation with IMO Secretariat and relevant IMO committees

The Committee has long recognised the importance of co-operation with IMO on matters related to shipping including ship strikes.

Attention: C-R, S

The Scientific Committee ***reiterates*** *the importance of cooperation with IMO and:*

(1) ***welcomes*** *the ongoing co-operation the Secretariat has maintained with IMO and its Secretariat on ship strike issues, including meetings during IMO MEPC 72; and*
(2) ***recommends*** *that this dialogue continue.*

Table 18

Workplan on bycatch and entanglement related issues.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Bycatch Mitigation Initiative		Review aspects relevant to Committee and respond to requests for advice		Review aspects relevant to Committee and respond to requests for advice
Rates and risks		Review new estimates of entanglement rates, risks and mortality		Review new estimates of entanglement rates, risks and mortality
Mitigation		Review new information on mitigation		
Inferences from strandings	Consider new information and issues that need to be addressed at SC/68a	Review new information		
Rapid risk assessment		Consideration of 'rapid risk assessment' tools and outputs		
Electronic monitoring		Consideration of remote electronic monitoring and vessel tracking		
Mitigation measures tables		Develop table of mitigation measures for small cetaceans and update table for large whales from 2017 if needed.		
Global disentanglement database	Discussion at GWERN Workshop	Review Progress	Advance database development if considered feasible	Review Progress
Collaboration with FAO	Secretariat attend COFI meeting	Review FAO outputs on bycatch	Continue collaboration	Continue to review
Encouraging innovative research on mitigation	BMI through existing networks, at conferences, workshops and with students – all members of Committee with relevant expertise	Review progress		

14.4 Work plan
The Committee's work plan on matters related to ship strikes is given as Table 19.

15. ENVIRONMENTALCONCERNS
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; 2010). As a result, the Committee formalised its work by establishing a Standing Working Group that has met every year subsequently. This year, it has been established as a sub-committee and its report can be found in Annex K.

15.1 Pollution 2020
15.1.1 Review on intersessional progress on the Pollution 2020 initiative
The individual based model to investigate the effects of pollutants on cetacean populations (SPOC) has been finalised. A peer-reviewed paper detailing the model and applying it to a number of case studies has been published in *Environmental Pollution* (Hall *et al.*, 2018) and the model's R code is available through the repository associated with the paper. The web-based, user-friendly version is now available through the Sea Mammal Research Unit, University of St Andrews server (*http://www.smru.st-andrews.ac.uk/reports/*) and a link will be added to the IWC webpages on the Chemical Pollution page. There are new data on the combined effects of persistent organic pollutants (POPs) on the immune system of killer whales (Desforges *et al.*, 2017) and this will be integrated into the model in the next year.

As noted in Annex K (item 2.1), the contaminant mapping tool will be completed next year, with the inclusion of the data on the concentrations of mercury in cetacean tissues by time and region. This online resource that will be made available through the IWC website and will be updated with new information identified in the SOCER annual reviews. Research to estimate how long it is likely to take for POPs in the blubber of cetaceans to observably decline, following a reduction in environmental levels, will be completed next year.

Attention: SC

The Committee ***agrees*** *that the Pollution 2020 initiative should be completed and presented at SC/68a. It also* ***encourages*** *a paper to be presented at SC/68a summarising the potential mitigation measures for reducing exposure of cetaceans to polychlorinated biphenyls (PCBs) in particular and persistent organic pollutants (POPs) in general.*

15.1.2 Report on mercury in cetaceans
The impact of mercury exposure is still an issue of concern for cetaceans. SC/67b/E08, reviewed mercury in cetaceans, in response to Commission Resolution 2016-4, 'Resolution on Minamata Convention'. The paper (see discussion in Annex K, item 2.2) highlights continued global exposure and potential effect of mercury on cetaceans. Although cetaceans have a unique detoxifying mechanism which may protect them from the health effects of organic mercury, the resulting mercuric-selenide complexes may cause adverse effects in individuals experiencing other physiological and metabolic challenges. Research into identifying the toxic thresholds for mercury in cetaceans is still required.

The Committee also received several papers presenting information on mercury in cetaceans including river dolphins (SC/67b/E06), humpback whales (SC/67b/E09) and gray whales off Chukotka (SC/67b/E03). The Committee highlighted the need for standardisation in reporting units. It also discussed preferred tissues for mercury analyses. Discussion of these papers can be found in Annex K (item 2.2)

Attention: SC, CG-R

The Committee continued to work on mercury in cetaceans in response to Resolution 2016-4. It therefore:

(1) ***encourages*** *the continued provision of information on mercury and cetaceans;*

Table 19

Workplan on matters related to ship strikes.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Rates and risks		Review estimates of rates of ship strikes, risk of ship strikes and mortality		Review estimates of rates of ship strikes, risk of ship strikes and mortality
Mitigation		Review new information on mitigation		
Advice on routing measures related to ship strike risk	Provide advice as required (see Annex Y)	Review advice	Provide advice as required (see Annex Y)	Review advice
Follow up on previous contacts offering IWC assistance regarding high risk areas	Secretariat to contact Sri Lankan and Greek authorities	Review progress on identified high risk areas in IWC Ship Strike Strategic Plan		
Continued co-operation with IMO	Secretariat to maintain dialogue with IMO Secretariat. Attend relevant IMO meetings.	Review cooperation		
Ship strike database	Continue ongoing data entry into Ship Strike Database and validation of records	Review progress against specific deliverables and time line	Continue ongoing data entry into Ship Strike Database and validation of records	Review progress against specific deliverables and time line
Provision of AIS data	Secretariat to develop MOU with Marine Traffic for provision of data	Consider best way to handle requests for data through the MOU		
Use of IMMAs to identify high risk areas for ship strikes	Hold workshop to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes.	Review workshop report		

(2) ***encourages*** *researchers presenting such information to report concentrations on both wet and dry weight bases; and*
(3) ***recommends*** *that Contracting Governments support the continued monitoring of mercury in cetaceans, as this is required in order to assess the medium- and long-term impact of the Minamata Convention.*

15.1.3 Impact of heavy fuel oils on cetaceans
There is a paucity of information on the impacts of heavy fuel oils on cetacean health (Annex K, item 2.3). However, some new information comparing the occurrence of cancer and elevated PAH levels in St Lawrence Estuary white whales with similar cancers in the local human population, was highlighted. In addition, behavioural changes in white whales in the White Sea following exposure to oil have been observed.

Attention: CG-A, SC, G

The Committee:

(1) ***reiterates*** *the need to estimate the risk and impact of oil spills, particularly to cetaceans in the Arctic;*
(2) ***notes*** *that heavy fuel oil could pose an environmental threat in many regions due to its high viscosity and chemical composition;*
(3) ***notes*** *that heavy fuel oil poses a special threat in the Arctic due to difficulties in recovery and potential impacts of some recovery measures (e.g. dispersant use and in situ burning); and*
(4) ***encourages*** *the collection of baseline data for cetaceans, including standardisation of measures.*

15.1.4 Other pollution issues
Understanding the effects of oil dispersants and dispersed oil on cetaceans is a gap in our current knowledge. To address this need, the Coastal Response Research Center (CRRC) in the USA has co-ordinated a discussion among scientists with dispersant research expertise, as well as those with Arctic expertise, to determine the state-of-science regarding dispersants or dispersed oil, as it applies to Arctic waters. The Committee looks forward to the publication of the final report.

Attention: CG-A, SC, G

The Committee ***draws attention*** *to the lack of data the effects of oil dispersants and dispersed oil on cetaceans. It therefore:*

(1) ***encourages*** *Contracting Governments to support research on the effects of dispersants or dispersed oil to the Arctic and other ecosystems; and*
(2) ***requests*** *that the results of such research be brought forward to future meetings of the Scientific Committee.*

15.2 Cumulative effects
The Committee welcomed the summary of the Cumulative Effects Workshop (see Annex K, item 3) and looked forward to receiving the report. Overall, the Workshop found that there is considerable uncertainty in addressing this topic and thus in developing assessments and management advice.

The Scientific Committee also received a report on a workshop entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea', which was held jointly by the IUCN Joint Species Survival Commission/ World Commission on Protected Areas (SSC/WCPA) Marine Mammal Protected Areas Task Force (the 'Task Force') and by the Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS). The workshop provided the opportunity to support the ongoing effort to map specific threats to cetaceans in the ACCOBAMS area by overlaying the Mediterranean IMMAs with the available area-explicit information on shipping and seismic surveys, thereby giving preliminary indications of new Cetacean Critical Habitats in the ACCOBAMS area and facilitating the implementation of conservation actions at the regional level.

Attention: SC, G

The Committee ***recognises*** *the importance of understanding cumulative effects of threats on populations of cetaceans, as well as its complexity. It therefore:*

(1) ***concurs*** *with the Cumulative Effects Workshop recommendations (see Annex K, item 3) to improve our knowledge and enable quantitative assessments;*
(2) ***highlights*** *the recommendation that consideration needs to be given to 'developing a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern';*
(3) ***agrees*** *to establish cumulative effects as a standing item on its agenda;*
(4) ***notes*** *the work on Important Marine Mammal Areas (IMMAs) and* ***encourages*** *additional efforts to identify the relevant threats in these, in order assist with the management of cumulative effects;*
(5) ***endorses*** *the results of the recent IUCN/ACCOBAMS workshop entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea';*
(6) ***encourages*** *that such an effort – aimed at overlaying different sources of threat and pressure on existing Important Marine Mammal Areas (IMMAs) – be continued and carried out in more detail in the other marine regions where IMMAs have already been identified; and*
(7) ***offers*** *its assistance in such assessments.*

15.3 Strandings and mortality events
15.3.1 Update on the IWC Strandings Initiative
The IWC strandings initiative was agreed by the Commission at its 2016 meeting (IWC, 2017d) and details can be found in Annex K (item 4.1). It noted that the rescue and welfare aspects of live strandings will be addressed by the Strandings Initiative but that this aspect is not within the purview of the Committee.

Attention: C-R, S, SC

The Committee ***reiterates*** *the importance of the IWC Strandings Initiative. It therefore:*

(1) ***welcomes*** *the excellent progress that has been made in the Strandings Initiative and the appointment of Sandro Mazzariol (Italy) as the Chair of the Strandings Expert Panel and Karen Stockin (New Zealand) as the Stranding Coordinator;*
(2) ***recommends*** *that the Commission (a)* ***endorses*** *the Strandings Initiative governance structure in Annex K (appendix 2) and (b)* ***endorses*** *the continuation of the Strandings Coordinator position for another two years (until IWC68) subject to available funding and requests the Secretariat make the necessary arrangements;*

*(3) **recommends** that the Strandings Initiative Steering Committee and Expert Panel, with the support of the Secretariat, should explore the best ways to gather information on strandings events and what basic data about these events should be recorded, focussing on what is useful for the Committee and the Commission;*
*(4) **agrees** that a phased approach to this, starting with an initial pilot project, will assist in this endeavour; and*
*(5) **agrees** that criteria for allocating funds for emergency responses should be developed by the Steering Committee and the Expert Panel and should be presented to the Committee at SC/68a.*

15.3.2 New information on unusual mortality events
Cetacean morbillivirus continues to be a major disease issue for cetaceans and a cause of unusual mortality events in dolphins in and around the Atlantic. Focus this year was on an outbreak of cetacean morbillivirus in the South Atlantic Ocean (SC/67b/E14) that is discussed in Annex K (item 4.2).

Attention: CG-R, SC

*The Committee **commends** the impressive rapid and comprehensive response to the cetacean morbillivirus outbreak in Brazilian Guiana dolphins. It therefore:*
*(1) **encourages** further work on the longer-term impact of the outbreak and the investigation of the occurrence and impact of this disease in cetaceans across different geographical areas;*
*(2) **draws attention to** the large number of animals that died during the outbreak (particularly mature females) and the historical high levels of human impacts affecting Guiana dolphins in Rio de Janeiro state, such as bycatch, chemical and noise pollution;*
*(3) **recommends** that immediate actions should be taken to protect affected populations in order to increase the chances of population recoveries;*
*(4) **draws attention to** the increase in Guiana dolphin deaths reported in Sao Paulo and Espirito Santo states in the weeks following the onset of the cetacean morbillivirus outbreak in Rio de Janeiro; and*
*(5) **encourages** the monitoring of the virus presence in neighbouring coastal dolphin populations, particularly species and populations in which immunosuppressive conditions or cumulative threats are identified.*

15.4 Noise
The Committee welcomed an update on international efforts addressing anthropogenic noise and their impacts on cetaceans, particularly regarding the appropriate assessment and protection of acoustic habitat quality as discussed in Annex K (item 5), and commended IWC engagement with organisations such as IMO and the UN.

Guidelines developed by the Convention on Migratory Species (CMS) Secretariat, also on behalf of the ASCOBANS and ACCOBAMS Secretariats, for Environmental Impact Assessments for noise-generating offshore industries were presented to the Scientific Committee. These guidelines had been endorsed through CMS Resolution 12.14 on Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species, and provide a pathway to implementing the Best Available Techniques (BAT) and Best Environmental Practice (BEP).

The Committee also considered the results of a study utilising modelling approaches to evaluate relative levels of communication masking for four baleen whale species in the Stellwagen Bank National Marine Sanctuary, in Massachusetts Bay, USA Cholewiak *et al.* (In press).

Attention: SC, G, CG-A

Recalling its previous recommendations on noise and the importance of addressing its impacts on cetaceans, the Committee:
*(1) **welcomes** and **draws attention** to the Convention on Migratory Species Family Guidelines on Environmental Impact Assessments for Marine Noise-Generating Activities (https://www.cms.int/en/guidelines/cms-family-guidelines-EIAs-marine-noise), noting that these guidelines will help improve global standards for environmental impact assessments;*
*(2) **recommends** that levels of anthropogenic noise and its effects on marine species be explicitly considered in the management of marine protected areas;*
*(3) **welcomes** the information received on using marine soundscape planning strategies to reduce interference between hydroacoustic instrumentation (e.g. echosounders and airgun arrays) and marine mammals, and **encourages** work to further develop this approach;*
*(4) **recognises** the commonalities identified among the concurrent efforts of multiple international bodies to develop national guidance on noise strategies, and **encourages** continuing efforts to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise;*
*(5) **welcomes** the work on modelling cetacean communication space, and **encourages** scientists engaged in the development of modelling techniques that address multiple anthropogenic impacts, such as noise and entanglement in fishing gear to bring these forward to the Scientific Committee; and*
*(6) **agrees** that a pre-meeting on noise be organised for SC/68b and that an intersessional steering group be convened (Annex Y) to develop the agenda for that pre-meeting.*

15.5 State of the Cetacean Environment Report – SOCER
The Scientific Committee thanks the editors of the State of the Cetacean Environment Report (SOCER) for their work and commended them on compiling this information on the Mediterranean and Black Seas. Next year's region will be the Atlantic Ocean. The Scientific Committee would welcome input from the members for information on this region. A 5-year global compendium is being produced in cooperation with the Secretariat that will receive a dedicated webpage on the IWC website in time for presentation to the 2018 Commission meeting.

15.6 Update on other standing topics
15.6.1 Marine debris[litter]
The Committee received and discussed a number of papers relating to several aspects of marine debris as discussed under Annex K (item 7.1). Exposure to marine debris and microplastics in cetaceans is now widespread and common. However the impacts on cetacean health and populations is not fully understood.

Attention: C-A, SC

*The Committee **draws attention** to the fact that marine debris remains a threat, and that in particular, exposure to plastics (including microplastics) is a rapidly emerging area of concern. It therefore:*

*(1) **agrees** that an intersessional workshop on Marine Debris should take place, preferably to coincide with the World Conference on the Biology of Marine Mammals in Barcelona in December 2019.*

15.6.2 Climate change
Climate change was highlighted at SC/67a as being an overarching issue that is important to various topics, and that where relevant its impact should be discussed in conjunction with that topic (see discussion in Annex K, item 7.2). Notwithstanding that, the Committee may want to initiate a specific activity related to climate change in future (see intersessional correspondence group in Annex Y).

Attention: C-A, CG-A, SC

*The Committee **draws attention** to the fact that climate change remains a threat that interacts with other threats and stressors impacting cetacean populations.*

15.6.3 Cetacean diseases of concern
Monitoring health and disease agents in large whales in the Arctic is continuing to provide important information on changing patterns in prevalence, environmental status, and potential impacts. In addition, morbillivirus and Brucella continue to be important pathogens causing disease and increased mortality in cetaceans in the Atlantic.

Remote methods for assessing health and condition using visual and aerial photography (e.g. SC/67b/CMP13), is a major rapidly developing field, due to the widespread availability and reduced cost of unmanned aerial vehicles (UAVs). Standardisation efforts (e.g. see Annex S) for measuring body condition using UAVs for photogrammetry, and for collecting blow samples, should progress to ensure this useful tool can provide comparable data across studies, taking into account the differences between the various platforms available. Cross-validation with current methods for assessing body condition from visual health assessments is essential.

Attention: SC

*The Committee **agrees** to hold a focussed session next year (SC/68a) on our current understanding of the pathology and epidemiology of morbillivirus and Brucella and the potential for identifying and understanding the cumulative effects of exposure to other immunosuppressive stressors in cetaceans.*

15.7 Progress on previous recommendations
15.7.1 Pollution
The SC/67a recommendations were to (a) make the effect of contaminants on cetacean populations (SPOC) model available to the public; (b) review mercury in cetaceans; and (c) include new data into the contaminant mapping tool. These have all been completed.

15.7.2 Cumulative effects
As recommended last year, a workshop on understanding the cumulative effects of multiple stressors was held as a pre-meeting to SC/67b.

15.7.3 Diseases of concern
The Committee noted that the content on the Cetacean Diseases of Concern (CDoC) website will now be utilised and merged with the Strandings Initiative for the development of their training and outreach materials.

Whilst the recommended quarterly CDoC updates remain of interest to the Committee, a means of progressing this on a voluntary basis has not yet been identified although efforts to find such assistance are ongoing.

15.7.4 Strandings
The Strandings Initiative has progressed as recommended at SC/67a and a full progress report can be found in Annex K, Appendix 2.

15.7.5 Noise
In response to a previous recommendation, that Committee has received the recently developed seismic survey guidelines by the New Zealand government, a link to the technical working group reports created during the NZ seismic guidelines review is now available (*http://www.doc.govt.nz/our-work/seismic-surveys-code-of-conduct/work-of-the-technical-working-groups/*). However, these guidelines have not yet been discussed by the Committee.

As recommended and noted earlier under Item 15.5, the intersessional group assisted in the development of a summary of the IWC recommendations relevant to shipping noise for presentation to the International Maritime Organization's Marine Environment Protection Committee in 2018.

15.7.6 Thanks
The Committee would like to thank Teri Rowles for her exceptional support and hard work as Chair of the sub-committee on environmental concerns over recent years. Her extensive knowledge, expertise and guidance has been most appreciated and will be missed.

15.8 Work plan 2019-20
The Committee's work plan on environmental concerns is given as Table 20.

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, 2008b). 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, that 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
The Committee has been considering plans for joint workshops with CCAMLR on ecosystem modelling for some time (e.g. see IWC, 2017c, p.56), although this has not yet happened, the Committee remains interested.

Attention: SC

*The Committee **reiterates** its interest in holding joint workshops with CCAMLR. It **agrees**:*

(1) that a two-year delay in the occurrence of the workshop will provide the opportunity to pursue and complete the relevant work with input from CCAMLR as needed; and
(2) that collaboration between SC-IWC/SC CCAMLR should be on going, and that the revised plan for the workshops (IWC, 2018e) be implemented.

Table 20

Work plan for matters related to environmental concerns (for more details see Annex K, Appendix 4).

Item	SC/68a	SC/68b
Pollution 2020 (including oil spills)	If new information	Primary topic (including oil spills and mercury), summary report to Commission
Cetacean diseases of concern (including HAB toxins)	Primary topic	Primary topic
Strandings	If new information	Primary topic
Noise	-	Noise focus session
Marine litter	Pre-meeting on litter and plastics focus session	If new information
Cumulative impacts	If new information	If new information
Emerging issues	If new information	If new information
SOCER	Receive report	Receive report
Climate change	Over-arching topic	Over-arching topic

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

The Committee had agreed in 2015 to review the application of species distribution modelling (SDM) and associated techniques as they pertain to the goals of the Committee and to develop good practice guidelines and recommendations. While the review has occurred (IWC, 2016b), there has been no significant progress in the intersessional correspondence group set up to develop the guidelines.

Attention: SC

The Committee ***reiterates*** *the importance of developing good practice guidelines and recommendations for species distribution modelling and* ***agrees*** *that this should be pursued by an intersessional correspondence group (Annex Y) with a view to reviewing and adopting guidelines within the next biennium.*

16.3 Modelling of competition among whales

16.3.1 Individual-based energetic models

Enhancements to an individual-based energetics model (IBEM) were presented to the Committee (SC/67b/EM07). These included the explicit modelling of feeding on migration, individual dives and searching for prey schools. Results showed that carrying capacity and productivity were sensitive to the level of food available during migration, making it important that ecosystem models to cover the entire migratory range of the species. This is an important contribution to the determination of species' function response, which can play a pivotal role in ecosystem modelling. This approach is also discussed under Item 5.1.

16.3.2 Modelling of relationships between whales and prey

The Committee reviewed three papers relevant to modelling of the relationships between whales and prey, SC/67b/EM04, SC/67b/EM06 and de la Mare *et al.* (*in press*). The discussion of these can be found in Annex L (item 3.2).

16.3.3 Modelling of competition among baleen whales

The Committee noted that multi-species individual based energetic models (IBEM) such as those described under Items 16.3.1 and 16.3.2 could be used to model direct and indirect competition of different whale species in the same environment, and that relevant modelling work was nearing completion.

16.3.4 Stable isotope analyses

The Committee received preliminary results of the analysis of stable carbon (δ13C) and nitrogen isotope ratios (δ15N)) on samples from the edge of baleen plates in Antarctic minke whales (SC/67b/SP09). The details can be found in Annex L (item 3.5).

16.4 Standing topics

16.4.1 Effects of long-term environmental variability on whale populations

How long-term environmental variability might affect stock assessments is of particular interest to the Committee. Given the need for a literature review on the subject to facilitate discussions, an intersessional correspondence group (Annex Y) has been established.

16.4.2 Update on body condition analyses for the Antarctic minke whales

For several years, the Committee has been discussing whether there has been a statistically significant (5% level) decline in the blubber thickness and fat weight of Antarctic minke whales over the course of the JARPA surveys. In 2014, the Committee had agreed that there had been such a decline (IWC, 2015b). Since then, scientists from Australia, Japan and Norway have presented a series of models both supporting and challenging this conclusion. There has been collaboration over this period and significant development in the types of models used. In addition, there have been in-depth discussions regarding the proper handling of data, the explanatory variables to be included in the analysis and the appropriateness of various statistical methods.

New analyses were presented this year and detailed discussions can be found in Annex L, item 2. This year the debate focused on three points; (1) the use of a new variable of primary interest (the 'accumulated blubber thickness in each feeding season); (2) the use of FIC and (3) the appropriate handling of the data.

Attention: SC, G

The Committee has been discussing whether there has been a statistically significant (5% level) decline in the blubber thickness and fat weight of Antarctic minke whales over the course of the JARPA surveys for several years. In conclusion, the Committee ***agrees****:*

(1) that, for the data set considered as a whole, all approaches result in point estimates reflecting a decline when fit to a linear trend in time;
(2) however, the extent of the decline estimated differs amongst the methods, and is not statistically significant at the 5% level for all approaches;
(3) for some approaches, when the data are disaggregated by gender and/or area, some point estimates of trend are not negative; and
(4) there are some indications of temporal variation that is more complex than linear.

In addition, the Committee:

(1) ***encourages*** *the authors to publish the results of their study in peer-reviewed journals; and*

(2) ***agrees*** *that this matter will not be considered during the forthcoming biennium.*

In discussion of the above, Norwegian scientists stated that since an error in parts of the Australian scientists' calculations has recently been acknowledged by them, and parts of the Australian scientists' conclusion and appendix had recently been withdrawn, the overall position regarding the blubber thickness and fat weight analyses now became as follows. There are no new analyses from the Australian scientists on the five response variables which have been considered and discussed in the Committee from 2011 to 2017. The results presented this year by the Norwegian scientists (SC/67b/EM02), which took into account some of the queries from the Australian scientists from last year, confirmed results presented by the Norwegian scientists earlier. Thus, the conclusions by the Committee in 2014 and 2017 on these variables remain valid. For this meeting the Australian scientists had presented analyses related to a new difficult dependent variable 'increase in blubber thickness during summer feeding in Antarctic waters' estimated from the blubber thickness at position BT11. The conclusion above about variables with a non-significant decline now pertains to the new variables only (points (2) and (3) above). The Norwegian scientists' position is that the conclusion drawn above was heavily influenced by the results of the calculations subsequently withdrawn, so that parts of those conclusion are no longer valid.

In response, the Australian scientists stated that results of some calculations carried out earlier were withdrawn because of a previously unidentified problem with a standard statistical package failing to converge on a solution without giving an error message. Subsequent collaborative checking with the Norwegian scientists led to the discovery of this problem. Withdrawing this calculation (which the Australian scientists had carried out to illustrate a property of the Norwegian scientists' methods) had no effect on the main results which the Australian scientists had presented in SC/67b/EM03. Nor did this retraction affect the results of analyses the Australian scientists had presented in 2017 showing non-significant trends in fat weight and blubber thickness (De La Mare *et al.*, 2017a; 2017b). The Australian scientists held the view that the assertion by the Norwegian scientists that "There are no new analyses from the Australian scientists on the five response variables which have been considered and discussed in the SC from 2011 to 2017" was not correct; the Australian scientists had provided full results of fitting models to BT11 in SC/67b/EM03. The main results in SC/67b/EM03 were based on differences between early- and late-season predictions from models with BT11 as the dependent variable. This difference was a simple measure of feeding in Antarctica. The earlier conclusion should not be materially affected by withdrawing the Australian scientists' compromised demonstration in relation to the Norwegian scientists' methods.

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

The Committee received the results of the krill and oceanographic surveys during the third NEWREP-A survey in Area V-E and VI-W (SC/67b/EM05). Discussion of this information can be found in Annex L (item 6.1).

16.4.4 Ecosystem functioning

Resolution 2016-3 tasked the Committee with investigating the contribution of cetaceans to ecosystem functions. Last year, the Committee noted that its focus would be on scientific aspects of the issue and it established an intersessional correspondence group to progress this work. Progress made by that group, including development of a final terms of reference, can be found in Annex L, item 6.2. The Committee notes that the Conservation Committee will focus on the conservation and social science aspects of this issue.

It was noted that there is broad interest in understanding the role of cetaceans in ecosystem functions, and that the Committee's expertise relates to the scientific aspects of the issue. Given the broad international interest, it is suggested that the Committee work in collaboration with interested parties (e.g. CMS, CCAMLR, SCAR and SCOR) to share information and avoid the duplication of work.

C-A, CC, SC

Commission Resolution 2016-3 tasked the Committee with investigating the contribution of cetaceans to ecosystem functions. The Committee ***notes*** *that the Conservation Committee will focus on the conservation and social science aspects of this issue. In responding to the Resolution 2016-3, the Committee* ***advises*** *the Commission that with respect to the scientific aspects on the contribution of cetaceans to ecosystem functioning:*

(1) *it is unlikely that the ultimate goal of reliably determining the contribution of cetaceans to ecosystem functioning could be achieved in under a decade, given the complexity of the issue and the data gaps; and*
(2) *a more immediate and achievable goal is the carrying out of a gap analysis to identify knowledge gaps and to develop a plan to address them.*

To further this work, the Committee ***agrees****:*

(3) *to hold a workshop to (a) define short- and medium-term objectives to be addressed and (b) to identify what further research is required in order to begin initial modelling of the contribution of cetaceans to ecosystem function; and*
(4) *that the Secretariat in conjunction with the Steering Group (Annex Y) should contact CMS to determine their interest in participating in such a workshop.*

16.5 Work plan 2019-20

The Committee's work plan on ecosystem modelling is provided in Table 21.

Japan referred to its statement on the adoption of the Agenda (Annex Z) and considered that several of the items for the proposed workshop (Item 16.4.4 and Item (7) in Table 1) are outside the competence of IWC. Therefore, it cannot support the proposed workshop or associated funding from the Committee's budget.

17. SMALL CETACEANS

The report of the Committee on Small Cetaceans is given as Annex M.

17.1 Overview of taxonomy, distribution and abundance for *Inia* and *Sotalia*

In this assessment, two species and two sub species of dolphins were considered, some of which have several common names. In addition, a new species has been proposed but has not yet been recognised (Table 22).

The river and estuarine dolphins of South America are subject to various threats from habitat degradation, competition with fisheries, bycatch and direct exploitation. A major threat to river dolphins in South America is population fragmentation, altered habitat productivity and regulation of natural river flow as a result of dam construction. The cumulative impacts from this type of infrastructure at the macrobasin scale exacerbate the threats to river dolphins and their habitat in the Amazon and Orinoco basins. It was estimated that more than 50% of the range of Araguaian *Inia* is affected by damming.

Two genera were discussed in depth, *Inia* and *Sotalia,* from the vast and convoluted systems within the Amazon, Orinoco, Tocantins and Araguaia River basins. In the case of *Sotalia*, two species are recognised: *Sotalia guianensis* (marine) and *Sotalia fluviatilis,* (freshwater) in the Amazon basin. *S. guianensis* in the Orinoco basin likely represents an independent population unit as it is isolated from other coastal populations. Two intersessional workshops have been proposed that aim to elucidate the status of *S. guianensis* and it is that divisions within this genus will be clearer on the completion of this work in 2020. The taxonomoy of *Inia* has a complex history and at this time, one species and two sub species are recognised: *Inia geoffrensis,* the Amazon river dolphin, *I. g. boliviensis,* the Bolivian bufeo, and *I. g. geoffrensis*, the common boto. There is a third putative subspecies, *I. g. humboldtiana*, in the Orinoco basin of Venezuela and Colombia. The information currently available suggests that *I. g. boliviensis* should be elevated to species level and that *I. g. humboldtiana* should be recognised. Another new species, *I. araguaiensis*, has been proposed for the dolphins that inhabit the Tocantins and Araguaia basins of central Brazil as this area is geologically and hydrologically separate from the Amazon basin.

Attention: SC, G

Given the incomplete resolution of Inia *taxonomy, the importance of clarifying and solidifying recognition (or elevation to species) of the* Inia *subspecies found in different river basins, the possibility that in such complex habitats localised specialisation is likely, and the need to focus attention on the conservation of demographically independent populations, the Committee* ***encourages*** *support for efforts to resolve* Inia *spp. taxonomy in light of the significant and diverse threats affecting the populations inhabiting the Amazon-Orinoco-Tocantins/Araguaia drainages.*

17.1.1 Inia

For *Inia*, there are estimates of abundance for some rivers, however, there is little information on population trends. It was suggested that new technologies, such as Unmanned Aerial Vehicles (UAV), may help to better refine population survey techniques. From telemetry studies and two long term studies some information on population parameters is available. In particular, the Committee commends an ongoing telemetry study as it begins to address some of the most important scientific questions concerning *Inia* ecology, habitat use, behaviour and, particularly movements.

In addition, and central to IUCN assessments, a generation time for *Inia* has been calculated as 24.8 years from a long-term mark and recapture study. Given the estimated rate of population decline, this equates to a loss of 82% per generation and in excess of 99% over three generations. Such values are well above the threshold for a Red List assessment of a species as Critically Endangered. Concern was also expressed at the high rate of mortality of <1 year calves in one study site, where examined carcasses show evidence of both deliberate killing and net entanglement.

The information presented on population parameters were based on direct observations in a very small geographic area of the Amazon and therefore, a very small proportion of the total range of *I. geoffrensis.* As such, extrapolation to the whole region would be unwarranted, nonetheless these results and their implications for population decline are alarming.

Attention: CG-A, G

The Committee ***draws attention*** *to declines in Inia numbers documented in two study areas and the lack of abundance surveys in most parts of its range. The Committee therefore* ***encourages*** *the collection of data, calculation of abundance estimates and undertaking of analyses to estimate population trends for Inia throughout its range, for use in assessments of the status of the species, subspecies, and regionally isolated populations.*

Table 21

Summary of the two-year work plan on matters related to ecosystem modelling.

Item	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
(1) Ecosystem modelling in the Antarctic Ocean	Continue further analyses.	Review results of further analyses	Continue further analyses.	Review results of further analyses
(2) Application of species distribution models (SDMs)	Intersessional group activity (see Annex Y)	Review progress		
(3) Effect of long-term environmental variability on whale populations	Continue further analyses. Intersessional group activity (see Annex Y)	Review results of further analyses. Review progress	Continue further analyses	Review results of further analyses
(4) Further investigation of individual-based energetic models	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(5) Modelling of competition among whales	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(6) Update of any exercises on krill distribution and abundance	Conduct NEWREP-A krill survey and an international cooperative krill survey. Conduct simulation analyses to resolve issues on survey design.	Review results of survey and analyses.	Conduct NEWREP-A krill survey. Conduct analysis of data taken by the international survey.	Review results of survey and analyses.
(7) Cetaceans and Ecosystem Functioning: a gap analysis workshop or pre-meeting	Review relevant scientific studies before the workshop in addition to preparation of workshop (see Annex Y).	Review outcomes of workshop and develop clear work plans with priorities.	Continue analyses	Review results of analyses.

Table 22

Summary of names used in the description of *Inia* and *Sotalia*.

Scientific name	Common name
Inia geoffrensis	Boto, Amazon river dolphin
I. g. boliviensis	Bolivian bufeo
I. g. geoffrensis	Common boto
I. araguaiensis	Araguaian boto
(proposed species)	(from the Tocantins and Araguaia basins)
Sotalia fluviatilis	Tucuxi, delphín gris, bufeo negro
Sotalia guianensis	Guiana dolphin

17.1.2 Sotalia

Sotalia fluviatilis, known as tucuxi (Brazil) delphín gris (Colombia) or bufeo negro (Peru and Ecuador) is restricted to the Amazon basin in Ecuador, Peru, Colombia and Brazil and has a more limited distribution than *Inia*. *Sotalia guianensis*, the Guiana dolphin, occurs mainly in nearshore and estuarine waters of the Atlantic from southern Brazil, along the coast of Central America, to Nicaragua and possibly Honduras. Small populations in Lake Maracaibo and in the lower reaches of the Orinoco River, Venezuela, were highlighted as being heavily impacted.

In the Mamirauá Reserve, Brazil, the population of *S. fluviatis*, has shown a precipitous decline in abundance over a 22-year study period. Using the average observed decline of 7.4% per year, and, from literature, a generation time estimate of 15.6 years, the Mamirauá population trend equates to a 97% reduction over 3 generations, qualifying this population as Critically Endangered under IUCN Red List criteria. Unlike *Inia*, which is heavily exploited for use as bait in the piractaninga fishery, the primary driver of the decline in Sotalia in this region is gillnet entanglement.

17.1.3 Threats shared by dolphins in the Amazon and Orinoco River systems and Lake Maracaibo

Throughout the range of both genera, illegal hunting was highlighted as a transnational problem, making it difficult to create and enforce effective conservation measures. This issue is severe for *Inia* throughout its range and, for *Sotalia* in the Orinoco River and particularly in Lake Maracaibo, Venezuela.

Attention: C-A, G, CC

The Committee ***draws attention*** *to the serious situation reported for Lake Maracaibo in Venezuela, where both directed takes and oil pollution are thought to be having serious impacts on populations of S. guianensis. The Committee therefore* ***recommends*** *that NGOs and researchers focus on documenting the threats to Sotalia and work with local communities to mitigate the impacts on these dolphin populations.*

In addition to direct exploitation, there are numerous other threats to both species throughout their habitat in South America: the recent increase in deforestation effects their prey species, as there is no deposition of seeds and fruits into the rivers to support productivity and sustain fish stocks; hydropower developments and channel dredging affects flows regimes, the connectivity of rivers, the migrations of fish and can fragment dolphin populations, as has already occurred in the Tocantins River basin; heavy metals, such as mercury, have been measured in high concentrations in dolphin tissues; negative interactions with fisheries, in addition to directed takes for use as bait and food, also include bycatch, deliberate poisoning and 'control' killing.

Attention: CG-A, G, CC

The Committee ***draws attention*** *to the multiple threats associated with development, habitat degradation and fragmentation, and pollutants facing river dolphins in the Amazon, Orinoco and Tocantins basins. It therefore:*

(1) ***advises*** *the Brazilian, Bolivian and Peruvian Governments, as they carry out their reviews of proposed construction of new dams for hydroelectric energy production, to explicitly consider the potential impacts on river dolphins (e.g. isolation, loss of genetic diversity, habitat degradation;*

(2) ***discourages*** *water pumping in the Araguaia-Tocantins river basin for agricultural use as such a practice causes dramatic decreases in water levels in rivers, thereby increasing the probability that dolphin populations will be extirpated;*

(3) ***encourages*** *range states of the Amazon basin and its tributaries to support and carry out baseline research into the impacts of the development of commercial waterways in the Amazon (hydrovias) and their potential impacts on dolphin populations and habitats, including but not limited to the ecological impacts of dredging, noise pollution, channelisation by embankments, altered sediment suspension and transfer, and changes in turbidity, light, oxygen availability and primary productivity, and (b) work to minimize or at least mitigate these impacts;*

(4) ***encourages*** *(a) a review of the status of dolphins trapped within dammed stretches of the Tocantins and Madeira rivers and (b) evaluation of possible relocation (translocation) of animals when environmental conditions create a high likelihood that they cannot continue to survive in this severely compromised habitat; and*

(5) ***encourages*** *the review of the effects and the scale of contaminant and heavy metal (e.g. mercury) pollution on river dolphins in key areas of the Amazon (Japura/Caquetá, Içá/Putumayo, in Brazil and Colombia) and Orinoco (Venezuela) basins.*

17.2 *Tursiops* populations occurring in estuarine areas in southern Brazil

Discussion focused on two populations of Lahille's bottlenose dolphins (*Tursiops truncatus gephyreus*) in Patos Lagoon Estuary (PLE) and Laguna (LGN), Brazil. Both have been the focus of long-term ecological studies that provide a good source of information on the conservation status of the subspecies. Mark-recapture studies indicate year-round residency and permanent emigration is unlikely. Population sizes are small (85 dolphins in PLE and 60 in LGN) with low to moderate genetic diversity (mtDNA and nuclear DNA variation) in both areas. Pollutant analyses indicated moderate levels of persistent organic pollutants (POPs). Of additional concern is a chronic dermal infection which is apparent in 14% of the LGN population, which may be related to pollution but this is not clear. The greatest threat to both populations is bycatch in artisanal gillnet fisheries. Whilst there is no clear evidence of a negative trend in abundance, there is a high probability of population decline in the near future, given the small population, the high degree of residency and the continuing mortality as a consequence of IUU (illegal, unreported, unregulated) fishing and other human activities in these areas.

In Santa Catarina, Paraná, and São Paulo provinces, Brazil, north of LGN and PLE, a total of 119 bottlenose dolphins (sub species unknown) and 442 Guiana dolphins were recorded stranded over 2 years. There was strong evidence that entanglement was indicated as the cause of death for bottlenose dolphins. The Committee was informed that the Brazilian Government is looking into this issue and is seeking ways to improve legislative effectiveness in protecting dolphins and other threatened species in these locations.

Attention: SC, CG-R

*The Committee **draws the attention** of the range states (Argentina, Brazil, Uruguay) to its conservation concerns over the entire sub-species of Lahille's bottlenose dolphins (T. t. gephyreus) given their relatively small population sizes and constricted ranges, the high levels of bycatch and the high incidence of individuals with chronic dermatitis. The Committee therefore **recommends**:*

(1) immediate action to reduce the level of bycatch in the southern Brazil populations;
(2) continued monitoring and photo-identification work on the populations throughout the subspecies' range to refine survival estimates and to assess trends in abundance and the prevalence and etiology of the chronic skin infections; and
(3) that the conservation status of the subspecies be prioritised for assessment in the future.

17.3 Franciscana CMP

In 2016, the IWC created a Conservation Management Plan (CMP) for the franciscana – see Item 10.1.4. In 2019, a review will be presented to the Committee. The review will be jointly conducted by the SM and CMP sub-committees and will include input from other relevant sub-committees.

17.4 Report of the 2018 *Tursiops* Taxonomy Workshop

In 2014 (IWC, 2015b) it was agreed that the Committee would undertake a review of taxonomy and population structure in the genus *Tursiops*, over several meetings. 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. The review process concluded with an intersessional workshop, held in La Jolla in January 2018.

The 3-year review and workshop brought together researchers and experts from around the world to discuss this topic, motivated focussed research, and promoted new collaborations. Results from studies presented at previous meetings (2015-2017) and at the workshop itself were compiled and formed the basis for evaluation of taxonomic and population distinction issues in each geographic region.

Attention: SC, G

Having reviewed the extensive information included in the 2015-2017 review and 2018 workshop for evaluation of Tursiops *species, subspecies and population distinctions, the Committee **draws attention** to the need for* Tursiops *research in the areas identified as data deficient (the African coast of the eastern Atlantic, southern and eastern Mediterranean Sea, eastern South Pacific, Pacific coast north of California and off the Mexican mainland, Central American coast of the eastern North Pacific, Central American Atlantic and Caribbean Sea and Atlantic coast of northern and north-eastern Brazil, eastern Australia and in the western Pacific the islands of Micronesia, Melanesia, Polynesia, the Philippines and Vietnam). The Committee therefore encourages;*

(1) collection of additional data, including morphometrics, and high-resolution genetic analyses (e.g. ddRAD which may also be useful in other areas where there are similar questions requiring high-resolution analysis), to better characterise divergence between coastal and offshore forms in the western South Atlantic Ocean, to help confirm whether subspecies or species classification is more appropriate for T. t. gephyreus;
(2) further investigation of T. aduncus *lineages in the Indian Ocean and western South Pacific to assess potential subspecies recognition, extending the geographic coverage to include eastern Africa, the region between Pakistan and Indonesia, and the region between Australia and China;*
*(3) continued study of the genetics and morphology of southern Australia bottlenose dolphins with the "*T. australis*" mtDNA lineage, in the context of both* T. truncatus *and* T. aduncus;
(4) examination of the level of male-mediated gene flow between the coastal and offshore forms in the western North Atlantic to determine whether the coastal form should be elevated to species or subspecies status;
(5) more comprehensive morphometric analyses comparing T. truncatus in the Mediterranean, Black Sea, and eastern Atlantic to integrate with genetic data and evaluate whether any regions in addition to the Black Sea (T. t. ponticus) harbour a taxonomic unit above the level of population;
(6) comprehensive morphometric analyses of coastal and offshore T. truncatus in the eastern North Atlantic and comparison to those from the western North Atlantic to better evaluate potential regional differences;
(7) morphometric analyses of Gulf of California coastal and offshore dolphins relative to those from California and the eastern tropical Pacific, with a particular focus on the level of divergence of coastal dolphins in the upper Gulf of California to other areas; and
(8) the collection of additional genetic and morphological data throughout the eastern South Pacific and further studies to investigate coastal versus offshore forms throughout the region, including coastal and offshore waters from Central America to Mexico, and if possible around the southern tip of South America to Argentina.

*The Committee also **agrees** to continue compilation of specimen, study, and researcher details, and concentrated effort to improve our understanding of* Tursiops *in data-deficient areas.*

Finally, after reviewing the 2018 Tursiops *Taxonomy Workshop's evaluation of the support provided for taxonomic (subspecies, species) and population-level distinctions proposed in the publications reviewed, the subcommittee concludes that:*

(1) the current taxonomy provided for Tursiops by the Society for Marine Mammalogy's Committee on Taxonomy is well supported by morphological and molecular genetic data, as well as ecological and distributional data; and

(2) discordance in currently available results from morphometric analyses and across different genetic markers of the recently described 'T. australis' *from southern Australia calls into question its validity at this time.*

In addition to the information and recommendations on Tursiops, the Committee noted that the review provided an opportunity to formulate some generic conclusions on taxonomic issues related to small cetaceans.

Attention SC, G

After reviewing the development and use of a strategy for objective evaluation of species, subspecies, and population-level distinctions by the 2018 Tursiops *Taxonomy Workshop, the Committee:*

(1) ***agrees*** *with the strategy implemented at the workshop for the evaluation of species, subspecies and population level distinctions;*
(2) ***encourages*** *use of the criteria and guidelines in Reeves et al. (2004) for the assessment of species-level taxonomy, in Taylor et al. (2017) for subspecies-level taxonomy, and in Martien et al. (2015) for Demographically Independent Populations; and*
(3) ***concludes*** *that future taxonomic questions should be examined within an appropriately wide and inclusive geographic context and that multiple lines of evidence are necessary when positing taxonomic changes.*

The Committee applauded Natoli, Rosel and Cipriano for their considerable work and organisational skills during this effort.

17.5 Poorly documented takes for food, bait or cash and changing pattern of use

17.5.1 Intersessional Workshop on the use of Small Cetaceans for Food and Non-Food Purposes in South America

The poorly documented take of small cetaceans for use as wildmeat has been assigned as a priority topic. An ICG (and see Annex Y) has been tasked with the development of a toolbox of techniques that could guide and co-ordinate research into this topic, and as such a series of workshops were proposed to fulfil this task. The second of these workshops focused on South America and incorporated a detailed review of the use of Amazon river dolphins as bait in the piracatinga fishery, which, in turn, fed into the priority topic of the 2018 meeting.

Information was summarised for all countries, except Guyana and Suriname, and it was recognised that products from small cetaceans have been used throughout the region for both food and non-food purposes. This type of use is referred to as 'aquatic wildmeat'. The usefulness of various tools and techniques was discussed, including data gathering techniques and forensic investigation. A database, comprising more than 3000 references, was used to map existing knowledge and understand data gaps. A framework was also established that had the purpose of standardised future data collection. The workshop participants populated a database from which regional patterns were mapped. Areas that were highlighted as a cause of conservation concern were; Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Peru and Venezuela.

The take of Amazon river dolphins as bait in the piracatinga fishery was also reviewed. All range countries of *Inia* and *Sotalia* have laws in place to protect dolphins and prohibit intentional killing. Fishing for piracatinga is banned in Brazil and its trade is prohibited in Colombia, due to its impact on river dolphins and other wildlife. The practice of using dolphins as bait has recently expanded to Peru, Bolivia and Venezuela, following the imposition of restrictions in Brazil, however, no other range country has developed specific legislative or regulatory action, beyond the general protection of river dolphins, in response to the emergence of this practice.

The workshop concluded that some species and population required urgent attention both due to the extent of their use as wildmeat and from other threats.

17.5.1.1 SCIENTIFIC CONCLUSIONS AND RECOMMENDATIONS

Attention: SC, G, CG-A

The Committee ***endorses*** *the scientific conclusions and recommendations from the recent intersessional workshop on the use of Small Cetaceans for Food and Non-Food Purposes in South America aimed at improving regional knowledge and conservation research. In particular, the Committee:*

(1) ***agrees*** *that potential divisions within the genus Inia should be evaluated and genetic conservation units established;*
(2) ***agrees*** *that an evaluation of historical data on river dolphins should be undertaken to better understand other threats (e.g., from bycatch), to provide further insights into current trends;*
(3) ***encourages*** *the use of new technologies, such as drones and satellite telemetry, to establish trends, habitat use and dispersion patterns of Inia within Amazon River Basin; and*
(4) ***encourages*** *new efforts to improve regional research capacity.*

The Committee ***draws attention*** *to the evidence showing that several small cetacean species and/or populations are being negatively impacted by their use as wildmeat in South America, and therefore* ***recommends*** *that abundance and distribution surveys, in tandem with investigation into the magnitude of aquatic wildmeat use, be conducted on these species. Appropriate survey designs should be implemented that consider the statistical power required to detect trends and the resultant data should then be used to estimate the impact of deliberate take for wildmeat on the following populations:*

(1) Boto in Purus and Japurá rivers, Brazil, and Içá/Putumayo river in both Brazil and Colombia, using previously established standardised methods (studies should also be expanded into other areas where take for bait may be a cause for concern);
(2) Chilean dolphin in Chile;
(3) Burmeister's porpoises in both Chile and Peru, noting that current evidence suggests that the Peruvian population is distinct;
(4) Dusky dolphins in Peru, noting that evidence shows that landings of this species has decreased and populations may have been heavily impacted;
(5) Guiana dolphins and other small cetaceans in Amapá, Pará, Maranhão, Piauí, Ceará, Espírito Santo, São Paulo and Paraná, in Brazil, where there is a documented use of bycatch for wildmeat purposes;

(6) *Bottlenose dolphins and pantropical spotted dolphins) in Bahia Solano, Colombia, noting that deliberate takes for a long line fishery is ongoing;*
(7) *Tucuxi throughout its range, in Brazil, Colombia, Ecuador, as it shares most of the same threats as Inia geoffrensis, and may also be used as bait in the piracatinga fishery; and*
(8) *Guiana dolphin (Sotalia guianensis) in Lake Maracaibo in Venezuela, noting that deliberate take for food is ongoing.*

*The Committee also **draws attention** to the Boto dolphins that have been isolated within the dam system of the Tocantins and Maderia Rivers in Brazil. Given the confined condition of the dolphins' habitat, the Committee **agrees** that the status of these dolphins be evaluated, to include abundance, genetic, habitat, prey availability assessments, with a view to developing a translocation protocol, including under what circumstances such a protocol should be enacted.*

*Finally, given the concerns over the extensive habitat modification that will result from the Mega Project 'Arco Minero del Orinoco', a large scale mining operation proposed along the river and watershed of Venezuela, the Committee **recommends** that population sizes and trends of both Inia geoffrensis and Sotalia guianensis, in the Orinoco River basin, be monitored before and during this project.*

17.5.1.2 CONSERVATION AND MANAGEMENT ISSUES

Attention: CG-R, S, CC

*The Committee **draws attention** to the management recommendations within the Report of the Workshop on the Use of Small Cetaceans for Food and Non-Food Purposes in South America, in particular, the need to have a regionally co-ordinated fisheries management plan for the Amazon River basin and a regional strategy for the conservation of river dolphins. Given continued concern over the use of dolphins as bait in the piracatinga fishery, the Committee:*

(1) ***commends** the Government of Brazil on its swift action in declaring a moratorium on the piracatinga fishery and respectfully requests that it maintains the moratorium to allow sufficient time to evaluate the effectiveness of protective measures and ensure the necessary protection of river dolphins;*
(2) ***reiterates** previous recommendation of the IWC Scientific Committee that range states (Bolivia, Brazil, Colombia, Peru and Venezuela) engage in a co-ordinated effort to strengthen legislative, enforcement, management and scientific efforts to ensure protection of the Amazon River dolphins;*
(3) *encourages range state authorities to work together and exchange information on the movement of piracatinga products across international borders;*
(4) ***requests** that progress reports be submitted to the Scientific and Conservation Committees; and*
(5) ***recommends** that the Commission asks the IWC Secretariat to send a letter to the Buenos Aires Group highlighting the issue of dolphins being used as bait in the piracatinga fishery and requesting joint efforts to enhance enforcement on wildlife and trade laws.*

17.5.2 Wildmeat Database

In 2016 (IWC, 2017) an intersessional group was established to work with the IWC Global Database Repositories Convenor, to develop an overarching aim for any future cetacean wildmeat database and identify the specific questions that such a database might address. The results of this work were presented, including a research agenda the formulation of key questions that could be addressed through the development and analysis of an aquatic wildmeat database. The Aquatic Wildmeat Database, developed independently of the IWC, was presented again and the Committee was updated on its improvements made following suggestions made last year. The future value of this data repository was highlighted and this and related issues will be considered intersessionally (see Annex Y).

The work of the Steering Group (see Annex Y) will continue and a third workshop, focusing on Africa, will be conducted intersessionally. The framework for an IWC Wildmeat database established at the workshop in South America will be further refined and will be used at the forthcoming workshop.

17.6 Small cetacean task team

The Scientific Committee continues to support the Task Team Initiative and the latest Task Team, for the South Asia River Dolphin, is in the process of being established with Dipani Sutaria and Nachiket Kelkar nominated as co-conveners. The task team currently comprises 14 members with representation from Bangladesh, India, Nepal and Cambodia and includes university associated researchers and NGOs (WWF and the Wildlife Institute of India).

*Under its Task Team Initiative (e.g. IWC, 2016), the Committee **strongly supports** the work of a Task Team for the South Asia River Dolphin and **agrees** that its first meeting which will occur before the 2019 meeting, if sufficient funding is available.*

17.7 Progress on previous recommendations

17.7.1 Vaquita

The Report of the Tenth Meeting of the International Recovery Team for Vaquita (CIRVA-10) was summarised and the results of the acoustic monitoring program for vaquitas were presented (SC/67b/SM01). This shows a continued decline in vaquita detections with no change in the trend since the last report in 2016. A brief review of the VaquitaCPR project was presented. This initiative, conducted in October and November 2017, aimed to capture vaquitas and bring them into human care. Ninety experts from nine countries were involved, including researchers experienced in the capture and handling of harbour porpoises, animal care professional, and veterinarians. Two vaquitas were successfully captured (an immature female [V01F] and an adult female [V02F]). In both cases, medical and behavioural evaluations were conducted to determine the suitability of the animals for transport to the floating pen or shore-based facility. Through the whole process the animals' health was continuously monitored by a team of experienced marine mammal veterinarians. The first vaquita caught (V01F) was in good condition initially, but did not acclimate to either the vaquita care centre pool or to the sea-pen facility, and the vaquita was released. V02F was also considered to be in good condition for transport to the sea-pen, however, after initially showing signs of adapting to the facility, the animal stopped swimming and an emergency release was initiated. The release was unsuccessful and the vaquita was quickly recaptured for administration of emergency care. Following three hours of emergency response, the animal went into cardiac arrest and did not respond to resuscitation attempts. Analyses of tissues and material obtained from VH02 is ongoing and a full report on VaquitaCPR will be reported at SC68A.

The survival of the vaquita depends on gillnet-free habitat and efforts to remove gillnets, both derelict and active, have increased dramatically in the last three years, particularly, during the ongoing 2017-18 totoaba season. The net removal programme demonstrates that illegal totoaba gillnets are still routinely set in great numbers in vaquita habitat. Despite enhanced enforcement efforts, there is a continued failure to prevent illegal fishing. CIRVA have stated that immediate action is needed to improve the situation through implementation of a series of recommendations. In particular, CIRVA recommended that the Government of Mexico establish an enhanced enforcement area, extending the boundaries of the existing vaquita refuge.

Attention: SC, CC, CG-R

*The Committee has **stressed** for many years that the vaquita population is at a critically low level, and the most recent evidence demonstrates that the cause of the decline – use of illegal large-mesh gillnets – continues, making extinction in the wild increasingly likely; the long-term decline in the vaquita reported previously has continued in 2017. The Committee yet again **re-emphasises** the serious concerns it has raised on the status of the vaquita, and in particular its recommendations of the past two Committee meetings. Whilst again **commending** the Government of Mexico for its attention and response to the CIRVA findings and recommendations, the Committee:*

*(1) **respectfully requests** that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards saving the vaquita;*
*(2) **strongly endorses** the recommendations of CIRVA10 that:*
   (a) the CIRVA10 acoustic monitoring programme, critical for evaluating the effectiveness of conservation actions, be continued as in previous years to provide an annual empirical estimate of population trend;
   (b) all Mexican enforcement agencies increase their efforts on land and in water immediately and continue this enhanced enforcement programme for the duration of the period of illegal totoaba fishing (at least until June 2018) to eliminate all setting of gillnets in the range of the vaquita; and
   (c) emergency regulations be promulgated immediately to strengthen the current gillnet ban and enhance enforcement and prosecution by:
      (i) eliminating all fishing permits for transient fishermen and limiting fishing access to only those fishermen who can demonstrate residency in the fishing villages;
      (ii) confiscating any vessel that does not have the appropriate vessel identification, permits, and the required vessel monitoring system;
      (iii) requiring vessel inspection for each fishing trip at the point of departure and landing;
      (iv) prohibiting the sale or possession of gillnets on land and at sea within the area of the current gillnet ban and on adjacent lands within a specified distance of the coastline;
      (v) requiring that all gillnets be surrendered or confiscated and destroyed; and
      (vi) eliminating the exemptions for all gillnet fisheries, including the curvina and sierra

17.7.2 Yangtze finless porpoise

A rangewide survey of Yangtze finless porpoises (*Neophocaena asiaeorientalis asiaeorientalis*) was conducted in 2017, giving a preliminary abundance of around 1,000 individuals. This indicates that the rapid decline observed between 2006 and 2012 has now slowed, and that numbers may even be increasing in some areas. Nevertheless, the Critically Endangered status of this species remains unchanged. The survey results were encouraging and regarded as a possible indication that *in situ* conservation of Yangtze finless porpoises is feasible, given the marked increase of the number of individuals in Dongting and Poyang Lakes. For the population to make a sustained recovery in both numbers and range, current measures directed towards improving the habitat in the Yangtze River as well as the Dongting and Poyang Lakes must be continued and expanded. The Government of China was commended for the efforts undertaken to improve the YFP habitat. Nevertheless, concern remain over threats such as vessel strikes, bycatch, underwater noise and bridge construction. In addition, the planned construction of a dam across the channel connecting Poyang Lake to the river is an additional concern.

Attention: SC, CG-R

Given the extensive and pervasive nature of the threats facing the Yangtze finless porpoise population, the Committee:

*(3) **commends** the efforts of the Government of China to improve its habitat; and*
*(4) **reiterates** that the primary conservation actions should focus on (a) restoring and maintaining suitable habitat throughout the Yangtze River and associated lakes, including the maintenance of a network of in situ reserves and (b) ensuring that genetic diversity is preserved and that harmful human activities are limited.*

17.7.3 Maui Dolphin

The Government of New Zealand reported that its review of management measures is scheduled for later this year. An update was provided on observer coverage of the set net fishery in Taranaki and the trawl fisheries adjacent to existing closure areas (95.5%, and 88.3%, respectively). Outside of this target coverage area, an additional 114 trawl fishing days were observed. No captures of Māui dolphins were reported by observers or fishermen in commercial fisheries in the 12-month reporting period to 31 March 2018. A species-specific, spatially explicit, multi-threat risk assessment is being developed for Māui and Hector's dolphins, the results of which will inform an updated Threat Management Plan later in 2018.

Attention: SC, CG-R, CC

*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) **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;*

(2) ***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);*
(3) ***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;*
(4) ***welcomes*** *the update on Maui dolphins provided and looks forward to receiving the species-specific, spatially explicit, multi-threat risk assessment in 2019;*
(5) ***respectfully encourages*** *the New Zealand; Government to commit to specific population increase targets and timelines for Māui dolphin conservation; and*
(6) ***respectfully requests*** *that reports be provided on progress towards the conservation and recovery goals as updates become available.*

17.7.4 Cruise report from North Western Africa
For the third year, survey results were reported from cruises conducted in north western Africa waters. Fourteen schools comprising some five species and totalling 433 individuals were sighted, including bottlenose dolphins, both pantropical and Atlantic spotted dolphins and, spinner dolphins. This area is poorly surveyed and the continuation of this work was encouraged. The Committee **suggests** that a more substantive analysis of the data from all surveys be conducted and reported back next year, particularly as SC68A priority topic will be on African small cetacean species.

17.7.5 Monodontids Workshop Report
NAMMCO hosted a workshop and produced a Global Review of Monodontids. Researchers and subsistence hunters from across the Arctic and subarctic participated. Several IWC scientists also participated, including Litovka, Reeves, and Suydam. The report[9], summarises what is known about the status of 12 stocks of narwhals and 22 stocks of white whales. There may be more stocks than this as information on stock structure is incomplete for some areas. The summary information and identification of threats and concerns within the report will be helpful in prioritising future research. Some stocks are doing well, but conservation actions are desperately needed for some others. The IUCN Red List status and documentation for both species was updated to Least Concern in December 2017 and that the information summarised in the NAMMCO review was very useful for those assessments.

Attention: C-A

The Committee ***welcomes*** *the report of the NAMMCO workshop reviewing the monodontids[9]. It* ***draws attention*** *to the recommendations contained in the report and encourages their implementation, particularly those pertaining to the stocks of greatest concern.*

17.8 Takes of small cetaceans

17.8.1 New information on takes
The Committee received the summary of takes of small cetaceans in 2016–17 extracted from the online National Progress Reports and prepared by the IWC Secretariat, in addition to information obtained online.

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[10], was summarised. It was noted that catch statistics in the Japan Progress Report on small cetacean cover catches in the calendar year, that is, from 1 January to 31 December, following the guidelines for IWC National Progress Report, while the catch quota of small cetacean fisheries are set seasonally. Thus, in some cases, the calendar yearly catch may exceed the seasonal (yearly) catch in appearance, but in such cases, the actual seasonal catch is aligned with the allocated catch quota. The Committee noted that the catch of 1,057 Dall's porpoises in the hand harpoon hunt was significantly lower than previously recorded reported and below the quota. It was stated that this is a result of the destruction of the community that conducts this hunt, rather than a change in the cetacean population, following the earthquake and tsunami of 2011.

17.8.2. Live captures
The Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO) will consider a quota of 13 killer whales for 2018 and a public hearing was held on 3 May 2018 to make comments on this plan. This proposed new quota considers killer whales in the Sea of Okhotsk as one population, which is estimated to have an abundance of over 3,000 individuals. This number is considered minimal as only 50% of the sea was surveyed. In addition, the information available to the Russian Government on colour and fin patterns, feeding behaviour and distribution do not allow clear identification of different ecotypes, and that all genetic samples analysed to date belong to a single population. It was noted that most published information on Okhotsk Sea killer whale abundance and stock structure is in Russian-language literature, or as part of internal documentation.

Attention: C-A, CG-A

With respect to live captures, and specifically the capture of killer whales from the Sea of Okhotsk, the Committee:
(1) ***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;*
(2) ***notes*** *that 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; and*
(3) ***reiterates*** *its concern that removals of killer whales are occurring from the Okhotsk Sea population.*

In light of the verbal report received at this meeting that Russian authorities intend to proceed to consider limits of allowable live-capture removals of killer whales in the Sea of Okhotsk on the basis that there is no stock structure and there are no ecotype differences between the populations in this region, the Committee:

[9] *https://nammco.no/wp-content/uploads/2018/05/report-global-review-of-monodontids-nammco-2018_after-erratum-060518_with-appendices_2.pdf*

[10] *http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-9.pdf*

(1) ***encourages*** *more extensive effort to examine these issues; and*
(2) ***requests*** *that relevant analyses be provided for the Scientific Committee's consideration at its next meeting.*

17.9 Status of the voluntary fund for small cetacean conservation research

In 2017, donations for the Voluntary Fund for Small Cetacean Conservation Research totalling £13,122 were received from the Government of Italy. At the end of the financial year 2017, this brought the total of the fund to £81,077.

The Committee **expresses its sincere gratitude** for Italy's contributions and notes that these funds support critical conservation research projects of direct relevance to the work of the Committee.

Five projects were offered funding in 2016 and were implemented in 2017. One of the projects has since been withdrawn and one project, the Indus river dolphin abundance survey, was completed and reported on in 2017. The remaining three projects, on the 'Chilean Dolphin' in Chile, the 'Use of small cetaceans as wildmeat in China' and the 'Development of a business model for sustainable fisheries in the Upper Gulf of California, Mexico', are all near completion and will be reported on fully next year. Updates are available on the IWC website.

17.10 Work plan and budget requests

17.10.1 Priority topics for 2019 to 2024

The sub-committee on Small Cetaceans discussed ongoing priorities and will continue the development of these intersessionally; however, given the location of the meeting it is likely that the focus will be on African species or areas during 2019-20. Other potential priorities identified in discussions were *Inia* (e.g. taxonomy), *Sotalia guianensis*, *Phocoena phocoena*, *Delphinus delphis*, southern hemisphere beaked whales, *Steno bredanensis*, Northwest Pacific *Orcinus orca* and 'the Caribbean'.

17.10.2 Work plan for 2019 – 2020

The work plan on issues related to small cetaceans is given in Table 23.

18. WHALE WATCHING[11]

The report of the sub-committee on whale watching is given as Annex N.

18.1 Assess the impacts of whale watching and swim-with-whale operations on cetaceans

18.1.1 Review progress of Modelling and Assessment of Whale Watching Impacts (MAWI)

Modelling and Assessment of Whale Watching Impacts (MAWI) has been on the Committee's agenda for several years. In April 2018, an intersessional workshop was held to identify the key research questions for understanding the potential impacts of whale watching on cetaceans (SC/67b/Rep03). A number of issues were highlighted, including: (a) the need to better understand the impact of recreational whale watching vessels as compared to commercial vessels; (b) the importance of looking at the potential impact of whale watching at short-term (e.g., behaviour change), mid-term (e.g., shift in habitat use) and long-term (e.g., population dynamics) time scales; (c) the use of existing and new data to explore the mid- and long-term impacts, as opposed to replicating short-term studies; and (d) the importance of building scientific capacity in the locations where the research would take place. More information can be found in Annex N, item 2.1.

Attention: SC, C-R

The Modelling and Assessment of Whale Watching Impacts (MAWI) initiative held a workshop in Italy in April 2018, in conjunction with the 32nd European Cetacean Society conference.

The Committee ***endorses*** *the following recommendations from this workshop:*

(1) *the incorporation of both social and natural sciences to better understand whale watching impacts;*
(2) *the development of a Strategic Framework, supported by a Decision Tree, to aid in the prioritisation of policy and research choices;*
(3) *the development of toolkits and resources that can be accessed globally; and*
(4) *the standardisation of data collection.*

The Committee also ***agrees*** *that a third MAWI workshop be held intersessionally, ideally just before or after the 2nd World Marine Mammal Science Conference in 2019, in Barcelona, with the following objectives:*

(1) *to determine in detail which data should be collected to best answer the natural and social science research questions developed in SC/67b/Rep03;*
(2) *to identify the best locations for conducting research projects that address these questions; and*
(3) *to continue to develop modelling approaches for assessing the long-term impacts of whale watching on cetacean populations (using data on short- and mid-term impacts).*

18.1.2 Review specific papers assessing impacts

The Committee received several papers regarding impacts to cetaceans from whale watching activities. Those papers included (1) efforts to assess stress hormones in baleen of southern right whale calves, (2) 'solitary sociable' cetaceans, (3) land-based observations in the Canary Islands to assess and mitigate potential impacts of whale watching vessels on cetaceans, (4) a Whale Welfare Assessment Tool (also presented and discussed in Plenary) and (5) the 15th year of a summary of papers published in the previous year related to a better understanding of impacts, mitigation and compliance to regulations. Additional details on these papers and projects can be found in Annex N, item 2.2.

Attention: SC, CG-A

The term 'solitary sociable dolphin' or cetacean is usually taken to apply to cetaceans that have little or no contact with conspecifics and who regularly closely approach humans, often including touch, social, sexual and play behaviours (Wilke et al., 2005). Given that solitary sociable cetaceans often end up in circumstances where they are harmed and killed and that they may come to present a threat to human swimmers, the Committee:

(1) ***agrees*** *to continue intersessionally to monitor the phenomenon of solitary sociable cetaceans as part of its work;*
(2) ***advises*** *that, where these animals occur, research be conducted to determine whether the emergence of harmful behaviours either to the animal or to people can be reversed; and*

[11] In response to a request from the Chair of the Whale Watching Working Group of the Conservation Committee, we have changed our past pactice of treating whalewatching as a single word to the use of two words.

*(3) **advises** local authorities and other concerned parties to keep people away from them in order not to encourage behaviour that may prove harmful to the animal or swimmers.*

*In addition, the Committee **agrees** that the Whale Welfare Assessment Tool (currently being developed at the Royal Veterinary College, University of London, in the context of the IWC Whale Killing Methods and Welfare Issues Action Plan), for which a hypothetical whale watching case study was trialled (Annex N, item 2.2), be applied to real-world whale watching situations. The southern resident killer whales in Washington, USA and the bottlenose dolphins in Bocas del Toro, Panama were proposed. These two populations are subject to intense whale watching pressure and may be suffering welfare and health impacts related to this pressure. Both locations have data relevant to the assessment tool and therefore seem ideal as pilot projects for its application.*

18.1.3 Consider documented emerging areas of concern (e.g., habituation, new areas/species, new technologies, in-water interactions) and how to assess them

The Committee received several papers about emerging areas of concern regarding whale watching, including: (1) human-induced behavioural changes; (2) impacts from recreational in-water interactions with cetaceans; and (3) purposeful and inadvertent feeding by humans.

The Secretariat for the Convention of Migratory Species (CMS) submitted several documents to SC/67b including a global review of in-water interactions with aquatic mammals. That review had resulted in a CMS resolution that encouraged Parties to facilitate research allowing for an assessment of the long-term effects and biological significance of disturbances from 'swim-with-marine-mammal' programmes. The topic of swimming with cetaceans is also addressed under Item 18.6.

The Committee received reports about several studies to assess the impacts and compliance with regulations of commercial 'swim-with-whale' operations in Australia. The discussion of this issue can be found in Annex N, item 2.3.

Attention: SC, CC, S

*The Committee **agrees** that the habituation intersessional correspondence group, now named human-induced behavioural changes of concern, should continue (see Annex N, table 3).*

Given the substantial effort the Convention on Migratory Species (CMS) Secretariat has made in preparing several documents for the Committee to consider this year, the Committee:

*(1) **recommends** a continuation and an expansion of this exemplary collaboration between the IWC and CMS Secretariats and their various committees;*

*(2) **endorses** the intention of CMS to work with the IWC Scientific Committee on guidelines for in-water interactions with aquatic mammals and offers to provide the scientific underpinning for these guidelines;*

*(3) **agrees** that the Committee's intersessional correspondence group on swim-with-whales work intersessionally with the CMS Aquatic Mammals Working Group to develop draft guidelines; and*

*(4) **offers** to review draft guidelines when they are ready, with a view to agreeing a joint product of the IWC and CMS and hosted by both websites as a global resource.*

See also Item 18.6 for additional recommendations related to swimming with cetaceans.

18.2 Consider information from platforms of opportunity of potential value to the Scientific Committee

The Committee received examples of several platforms of opportunity where data have been collected concerning habitat use, behaviour, changes in distribution and potential risks from shipping for multiple different species in several different areas. Of particular interest was Peninsula Valdés, Argentina, where approximately 460,000 photographs have been taken from whale watching boats and provided to researchers from the Instituto de Conservación de Ballenas and Ocean Alliance (SC/67b/WW04). See Annex N, item 3.

The Committee offered numerous suggestions as to how to handle the large number of images and encourages the researchers to network with other researchers around the world, particularly humpback whale researchers dealing with similarly large numbers of photographs and multiple catalogues, to improve the processing time of the photographs.

18.3 Whale watching in east Africa and the wider Indian Ocean

A proposal for Concerted Action for Arabian Sea humpback whales was passed by CMS with strong support from range states. This was discussed in Annex N, item 4.

Attention: CC, S, CG-A

Noting the Committee's discussions over several years on the status of the Arabian Sea humpback whales (see Item 10.2.1), the Committee:

*(1) **welcomes** the CMS proposal for Concerted Action for Arabian Sea humpback whales;*

*(2) **notes** that humpback whales are the target of one emerging whale watching operation in the south of*

Table 23

Work plan on small cetaceans.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Franciscana CMP	ICG (Annex Y) to co-ordinate outcomes of CMP across sub-committees	Report	ICG (see Annex Y) to synthesis actions from 2019 SC report and develop a work plan	Report
Wildmeat	ICG (Annex Y) to plan and conduct African workshop	Report	ICG (see Annex Y) group to summarise workshop series and develop future work plan.	Report
Small Cetacean Task Team	Intersessional workshop on South Asian river dolphins	Report	Act on recommendations from 2018/19 River dolphin workshop.	Report
Sotalia	SG (see Annex Y) to plan and conduct workshop no.1 (at SOLOMAC)	Report	SG (see Annex Y) to plan and conduct workshop no.2	Report

Oman and highlights the likelihood that the population could become the target of future whale watching activities; and

*(3) **emphasises** the need for regulators and scientists to work with the industry to ensure that whale watching does not add to the many other pressures on this small, isolated, non-migratory and endangered population.*

The Committee therefore:

*(1) **recommends** that building capacity to conduct needed research and to ensure consistent training of whale watching operators be a high priority for Omani authorities and other parties working on the recovery of the endangered Arabian Sea humpback whale population;*

*(2) **notes** that boat operators for cetacean watching operations appear to turn over at a high rate in this area, and recommends that training workshops should be regularly offered and conducted;*

*(3) **welcomes** the offer from the Pacific Whale Foundation to help organise and conduct another training workshop, but recommends a more comprehensive plan be implemented by the Omani authorities, working with the IWC and other interested parties, to build local capacity for such training; and*

*(4) **agrees** to retain a review of whale watching in east Africa and the wider Indian Ocean region in its work plan (see Annex N, table 4) and to conduct an intersessional review of whale watching in these areas, to be presented at SC/68a.*

18.4 Review Whale Watching Strategic Plan (2018-2024) and joint work with the Conservation Committee

18.4.1 Review and provide recommendations on the draft Strategic Plan

At SC/67a, the Conservation Committee's SWG on Whale Watching requested the Scientific Committee to review a draft of the next iteration of the IWC's Strategic Plan (2018-2024) on Whale Watching (see SC/67b/WW02). This was accomplished primarily during a SC/67b pre-meeting and then further discussed in Annex N (item 5 and appendix 2).

Attention: CC

*The Committee **draws the attention** of the Conservation Committee's Standing Working Group on Whale Watching (SWG) to Annex N, appendix 2, which provides a full set of comments on the draft Strategic Plan (2018-2024) on Whale Watching. The most important comments and recommendations from the appendix are highlighted below:*

(1) The addition of an Action 1.5: Develop a communications strategy to actively promote IWC whale watching resources (e.g., the Handbook, reports and training opportunities), with approaches tailored to target key audiences. These audiences include the public and whale watching managers, researchers, operators, and on-board naturalists. Communication actions could include preparing publicly accessible summaries of IWC whale watching reports, improving the whale watching pages on the IWC website (which is already underway with the new Whale Watching Handbook, see Item 18.5), and promoting resources on social media, at key meetings and via press releases to industry bodies and trade publications. The implementation of this action could be coordinated intersessionally via the Secretariat. A joint intersessional working group, which includes key Secretariat staff, could develop a communications strategy for consideration at IWC/67 (the Brazil Plenary meeting) and/or the joint session of the CC/SC at SC/68a.

(2) The replacement of the actions of Objective 2 in the draft Strategic Plan with the following:

Action 2.1 – Continue the Modelling and Assessment of Whale Watching Impacts (MAWI) initiative, to develop tools and methodologies to assist researchers and managers in their efforts to assess potential impacts of whale watching on cetaceans and to mitigate them. This initiative is ongoing and could focus on:

Investigating modelling methods to link short- (e.g., behavioural reactions) and medium-term (e.g., changes in population distribution) responses with potential impacts from whale watching to long-term (i.e., >10 to 20 years) consequences (e.g., vital rates).

Establishing standard data collection methodologies, including from platforms of opportunity.

Identifying key locations for whale watching research projects and programmes, taking into consideration logistics, capacity and management urgency;

Action 2.2 – Develop a long-term integrated research programme to better understand the potential impacts of whale watching on the demographic parameters of cetacean populations. Seek to:

Investigate whether there is a causal relationship between whale watching exposure and the survival and vital rates of exposed cetacean individuals and populations;

Understand the mechanisms involved in causal effects, if they exist, in order to define a framework for improved management;

Action 2.3 – Develop processes and mechanisms for whale watching activities to collect and provide scientifically robust and useful data to researchers and research programmes; and

Action 2.4 – Develop an approach (e.g., hold an intersessional workshop; establish a joint intersessional working group) to integrate social and ecological scientific research within the IWC to inform whale watching management and promote potential benefits. This is a coordinated action between the SWG and the sub-committee.

In particular, Action 2.2 will require a dedicated person to guide and coordinate the development and implementation of a research programme or plan. The best option would be for the SWG to contract with someone, full- or part-time, to carry out this task, whilst recognising the budgetary concerns. Therefore, the Committee recommends that the search for funding for this and all other actions in the Strategic Plan be focused, broad-ranging, and innovative. An alternative, if budgetary issues are prohibitive, is to have the research programme developed intersessionally by an intersessional correspondence group or the convenor and co-convenor of the Committee's sub-committee on whale watching.

*Lastly, the Committee **reiterates** its previous recommendation to improve the coordination between the SWG and the Committee's sub-committee on whale watching in the development and implementation of a Strategic Plan on Whale Watching. This year's 21 April pre-meeting to* *review the draft Strategic Plan was intended to improve coordination and provided an opportunity to contribute to the draft Strategic Plan but it did not completely achieve the goal of coordination, as a limited number of SWG members were able to attend the pre-meeting.*

18.4.2 Develop procedures to provide scientific advice as requested in the plan (including the online handbook) and make the Committee more effective at providing information to the Commission

The revised Actions 2.1-2.4 in Item 18.4.1 outline how the sub-committee on whale watching will collect information needed to inform the Conservation Committee's SWG on Whale Watching. Procedures for providing this advice will be discussed and determined cooperatively with the Conservation Committee, during the joint meeting immediately after SC/67b and intersessionally through the intersessional correspondence group (see Annex N, table 3,).

18.5 Whale Watching Handbook

18.5.1 Review and provide comments on the IWC's Whale Watching Handbook

The Whale Watching Handbook (Handbook) was presented. Before being made available to the public it will also be translated into French and Spanish with support from CMS. Annex N (item 6) provides additional comments and suggestions for fine-tuning and improving the already-admirable Handbook.

Attention: CG-R, SC, S, CC, C-R

*The Committee **welcomes** the presentation of the online Whale Watching Handbook and agrees that it is comprehensive, scientifically substantive, user-friendly and well designed.*

*To ensure the IWC Whale Watching Handbook comes to the attention of the international whale watching community, including managers, operators and the public, the Committee **recommends** that all Contracting Governments provide a link to the Handbook on the relevant agency pages of their own government websites once the Handbook goes 'live'.*

*The Committee also **recommends** that the Conservation Committee and the Commission develop a plan for identifying and securing long-term funding for the further development (e.g., translations into additional languages, writing additional case studies or country profiles) and the ongoing maintenance (e.g., periodic reviews of content) of the IWC Whale Watching Handbook. The Handbook must be updated regularly to remain a vibrant, living document.*

18.6 Review reports from intersessional correspondence groups

The Committee received information from the intersessional correspondence groups (ICG) of swim-with-whale operations and communication with IORA. Annex N provides details of (1) the discussion related to the intersessional work of the ICG on swim-with-whale operations (item 7.1) and (2) the discussion related to the intersessional work of the ICG on IORA communication (item 7.2).

Attention: S, SC, CC, CG-A, CG-R

Regarding swim-with-cetacean operations, the Committee:

*(1) **agrees** that the intersessional correspondence group on swim-with-whale operations (Annex N, table 3) should continue;*

*(2) **draws attention** to guiding principles for whale watching, including in-water interactions, that are being or have been developed by various regional bodies, such as the Convention on Migratory Species and UNEP in the Wider Caribbean (see Annex N, item 2.3 and UNEP-CEP, 2012), that advise that swimming with cetaceans be discouraged where it is not already established; and*

*(3) **recommends** that, in jurisdictions where swim-with-cetacean activities have not been occurring or are just starting, this practice be prohibited until there is scientific evidence that supports allowing it, noting that the risks to both humans and cetaceans are substantial if operators are inexperienced and not following any relevant guidelines.*

*The Committee also **welcomes** the increased communications between IORA and the IWC over the past year. The IORA Sustainable Whale and Dolphin Watching Tourism Network was established and Australia will convene the Network in its first year of operation and will produce a biannual newsletter. Consequently, the Committee:*

*(1) **agrees** that the intersessional correspondence group on communication with IORA (Annex Y) should continue; and*

*(2) **encourages** greater engagement between the IWC and IORA on whale watching, beyond the exchanges amongst the intersessional correspondence group (Annex N, table 3).*

18.7 Review progress on scientific recommendations

18.7.1 Global influence of recommendations

The Committee received information about the influence of previous recommendations in numerous countries. Details can be found in Annex N, item 8.1.

18.7.2 Tracking progress on previous recommendations

The sub-committee on whale watching reviewed 27 of its recommendations and agreed statements from the past two years. Of those, 15 were completed or partially completed, nine are on-going, and three have not yet been addressed. Annex N, item 8.2, provides details about those recommendations and agreed statements. There is also ongoing work to update and finalise the terms of reference for the sub-committee on whale watching.

18.7.3 Update on dolphin watching in Bocas del Toro, Panama

Concern continues about the number of dolphins from the small population in Bocas del Toro, Panama that are found dead. Nine deaths in 2016 and 2017 are known to have occurred, five of them confirmed boat strikes. These losses are unsustainable. Research to better understand impacts on the population includes measuring stress hormones in biopsy samples and acoustic monitoring. A regulatory update to strengthen management of whale and dolphin watching in Panama, including Bocas del Toro, was released in October 2017, with the support of the Ministry of Environment.

Attention: SC, C, CG Panama

*The Committee **reiterates** its grave concern regarding the intense and uncontrolled dolphin watching in Bocas del Toro, Panama. This concern has been expressed and reiterated for several years due to continuing mortalities, including from vessel strikes, in this small population (probably fewer than 100 animals). In this regard, the Committee:*

(1) ***welcomes*** *the ongoing research to monitor this dolphin population and the impacts it is facing from dolphin watching;*
(2) ***reiterates*** *its welcome of Panama's increased responsiveness to protect the local dolphin population by minimising negative impacts from dolphin watching (IWC, 2018a) and welcomes the regulatory update, supported by the Ministry of Environment, which is meant to lead to stronger management of whale and dolphin watching in Panama, including Bocas del Toro; and*
(3) ***expresses serious concern*** *at the number of deaths reported in 2016 and 2017 and recommends action from the Government of Panama as a matter of urgency, including the immediate and committed implementation of the updated regulations.*

18.8 Work plan and budget requests for 2019-2020

18.8.1 Work plan for 2019-2020

The work plan for matter related to whalewatching is shown in Table 24.

19. SPECIAL PERMITS

19.1 General considerations on improving the evaluation process

This issue is considered as part of the process to revise 'Annex P' (see discussion in Item 28.3).

19.2 NEWREP-A

Summaries of NEWREP-A papers are given in Annex U1.

19.2.1 Report on ongoing research

In plenary, the Committee received and briefly discussed four papers on ongoing work – as indicated below, some of these were discussed more fully in sub-groups.

SC/67b/SP08 presented the results of the third biological field survey of NEWREP-A during the 2017/18 austral summer season. In discussion, it was noted that the high apparent pregnancy rate (95.3%; 122 of 128 mature females) of Antarctic minke whales was consistent with previous results (e.g. from JARPA and JARPA II).

SC/67b/ASI07 presented a summary of results of the NEWREP-A dedicated sighting survey during the 2017/18 austral summer season whilst SC/67b/ASI11 presented the research plan for the next systematic vessel-based sighting survey in the Antarctic under NEWREP-A 2018/19. The new NEWREP-A 2018/19 sighting survey plan has been endorsed by the Committee; Annex Q (item 4.2) provides more details on both these papers.

SC/67b/EM05 presented results of the krill and oceanographic surveys undertaken during the third NEWREP-A survey in Area V-E and VI-W (see Annex L, item 6.1 for details).

19.2.2 Update on previous recommendations

19.2.2.1 AGE DATA AND RMP/IST (RECOMMENDATION 1)

SC/67b/RMP03 provided updated draft specifications for an RMP/IST type simulation exercise to evaluate management procedures based on modified catch limit algorithms that use information on recruitment inferred from age data from Antarctic minke whales. Details and discussion are given in Annex D, section 2.3.2.

Attention: S

The Committee ***agrees*** *that methods currently used or proposed to be used in the Committee that use age data should (as necessary) be investigated to evaluate the relationship between their results and the accuracy and precision of the age data that they use where this is pertinent to the results of import from these methods. The Committee* ***agrees*** *to include this as an agenda item for next year's meeting.*

19.2.2.2 BIOPSY SAMPLING AND TELEMETRY FEASIBILITY STUDIES (RECOMMENDATIONS 4 AND 5)

SC/67b/SP04 summarised the results of a feasibility study on biopsy sampling and satellite tagging of Antarctic minke whales under NEWREP-A. The authors concluded that in the context of the NEWRREP-A objectives, (a) the efficiency of biopsy sampling is much lower than that of lethal sampling for Antarctic minke whales and (b) that the amount of tissue derived from biopsy samples is insufficient to conduct the suite of biomarkers targeted by NEWREP-A. They therefore concluded that biopsy sampling was not a feasible approach to fulfil the objectives of NEWREP-A.

This paper prompted considerable discussion in the Committee, both with respect to 'efficiency' of the method and the amount of material required.

One issue raised was that there was the need for better clarification of terminology used in the paper (e.g. 'sampling' versus 'killing) in order, for example, to interpret properly the conclusion that biopsy sampling took approximately three times longer than lethal sampling. It was not clear, for example, whether the median times for biopsy and lethal sampling provided were truly comparable because of the lack of information on when the time for these methods started and ended. In particular, handling time for lethal sampling appeared to not be included in the total time calculations.

The authors responded that in SC/67b/SP04 'the efficiency' of sampling techniques was defined as 'Success Proportion' rather than 'Time of Experiment' because 'Success Proportion' represents a better indicator of the efficiency. To fulfil the purposes of NEWREP-A, random sampling is required in which generally only one animal from a school is sampled. Notwithstanding this clarification, they provided definitions of 'Time of Experiment' (see details in Yasunaga *et al*. in Annex U2).

Another issue raised was that the NEWREP-A review workshop had suggested 'involving people with expertise in successfully biopsy sampling common minke whales in the North Atlantic', meaning collaborating in the field with experienced foreign experts. However, Table 2 of SC/67b/SP04 showed an ongoing decline in success proportion (number of biopsy samples/number of targeted whales which were chased for sampling by the SSVs) between 2015/2016 and 2017/2018 rather than the increase one would expect with increasing experience. The authors responded that they had consulted with foreign scientists although they were not on the vessels, that they used experienced marksmen and that the decline was an artefact of weather and sea state conditions under which samples were collected. However, the counter-comment was made that in authors' analyses, the best model did not include "weather conditions" as a significant factor.

In response the authors provided results of a GLM analysis based on the binomial distribution assumption to examine the differences in success proportion in the biopsy sampling experiment using research seasons as explanatory variables. The coefficients for each year were not significant, suggesting that the differences of success proportions among the seasons are not statistically significant and consequently provide no evidence that shooters' efficiency has decreased significantly over the three research seasons (see details in Yasunaga *et al*. in Annex U2).

Some Committee members (see Clapham *et al.* I, in Annex U2) disagreed with the authors' conclusion that the study revealed that biopsy sampling was not feasible for the NEWREP-A programme. Rather, they believed that it showed that it was both feasible and appropriate. They also disagreed that the amount of tissue obtained was insufficient, citing the large number of research programmes that successfully use biopsy samples to fulfil research objectives including using a single sample for a variety of biomarkers (e.g. stable isotopes, fatty acids, hormones, genetics).

In response, the authors agreed that the amount of epidermal tissue collected by biopsy sampling is enough for the requirement of genetic, epigenetic and stable isotope analyses. However, they stressed that the amount of adipose tissue collected by biopsy sampling was not large enough to measure progesterone, lipid content and fatty acid in the context of the objectives of NEWREP-A (see details in Yasunaga *et al*. in Annex U2).

In their closing comments, the authors stated that in response to the recommendation of the Expert Panel, dedicated experiments for biopsy sampling of Antarctic minke whales had been carried out which had generated the results presented at this meeting and from which the authors had drawn their conclusions. No further dedicated time for biopsy experiments was planned at this stage, but this could be reconsidered at the mid-term review. Meanwhile, NEWREP-A will only collect additional biopsy samples opportunistically.

With respect to the best approach to assess the efficiency of biopsy versus lethal sampling, a standard approach for measuring the efficiency of biopsy sampling and to compare this to the process of lethal sampling was proposed (Clapham *et al.* II, in Annex U2).

Attention: S

The Committee had last year agreed on establishing an intersessional Advisory group tasked 'to provide advice on developing an experimental protocol for ascertain whether it is possible to reliably biopsy minke whales and, if so, under what circumstances (experience, vessel type, equipment, environmental conditions, etc.). This group could use as starting point the advice provided by the Expert Panel' (JCRM 19 suppl:431-490). Due to a clerical error the group did not convene. Attention was drawn to a protocol to evaluate non-lethal techniques presented to SC66b (Mogoe et al., 2016). This protocol included four questions to help identify the feasibility and practicability of non-lethal methods.

The Committee ***agrees*** *to re-establish the Advisory group (Annex Y), under Palka for consideration at SC68a. It also* ***agrees*** *that suggestions for refining questions in the method used by Mogoe and colleagues (2016) should be added to the tasks of this group.*

19.2.2.3 EPIGENETIC AGEING (RECOMMENDATION 8)

Recently, epigenetic (DNA-methylation) ageing has been successfully used to estimate age in humpback whales (Polanowski *et al.* 2014). As noted under Item 11.4.4, this year, the Committee invited Jarman, the leading specialist in this technique to give an overview presentation to the Committee as a special night session. This covered topics such as current and future prospects for this class of methods (see Annex I, item 5.5).

SC/67b/SDDNA04 presented a feasibility study on epigenetic ageing in Antarctic minke whales in response to Recommendation 8 from the Expert Panel (for details see Annex I, item 5.5).

Some suggestions were made on how to improve resolution (in particular, evaluate more loci and then restrict to those loci highly correlated with age); the current set of loci do not provide sufficient precision for use in the population dynamics modelling exercise recommended for NEWREP-A. Given that there is an upper limit to the degree of precision that can be achieved using this technique, the Committee noted that the utility of epigenetic age estimation (and other methods of age determination) will depend on the degree of precision needed for the specific application of interest (see recommendation under Item 11.4.1).

19.2.2.4 DETERMINING SEXUAL MATURITY IN BLUBBER (RECOMMENDATION 9)

SC/67b/SCSP05 presented results from the NEWREP-A research component focused on determining sexual maturity in female Antarctic minke whales, during the feeding season based, on concentrations of progesterone in blubber. The authors concluded that the progesterone concentration in blubber samples cannot be used as a diagnostic index to discriminate between mature and immature female Antarctic minke whales and that lethal sampling is required to obtain information on sexual maturity for use in population dynamic models.

Some members of the Committee disagreed with that conclusion, as they demonstrated that the amount of misclassification in immature versus mature females would be small (~1%, see Wade *et al.* in Annex U2) and thus that progesterone levels in biopsy samples would allow discrimination between mature and immature animals.

Table 24

Summary of the work plan for matters related to whale watching. Many of these items have intersessional correspondence groups (ICG) or intersessional advisory groups (IAG). Those groups will work intersessionally and provide updates at SC/68a (see Annex Y).

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Assessing impacts	-	Papers to be presented	-	Papers to be presented
Third MAWI Workshop	Workshop planning	Receive update on planning	Workshop (see Annex Y)	Report
Update IWC whale watching guidelines and principles	Revise guidelines and principles	Review	Continue if needed	Receive update
Indian Ocean review	ICG (Annex Y)	Papers to be presented	-	-
East Africa review	Work to prepare review	Paper to be presented	-	-
Intersessional correspondence groups	See Annex Y	Receive reports	See Annex Y	Receive reports
Joint meeting with Conservation Committee Standing Working Group on Whale Watching (SWG) to discuss incorporation of social science in joint work streams	Meeting planning	Receive update	Meeting planning	Joint meeting with SWG
IWC Whale Watching Handbook	-	Receive updates	-	Receive updates

They noted that the stated purpose of the study was to discriminate between immature and mature females for fitting population dynamics models such as the catch-at-age analysis; the only misclassification that occurred was a total of 3 (out of 230) whales between the resting and the immature classes, and therefore the only misclassification rate that is important remains ~1% of the total sample.

Some other members noted, also in relation to recommendation 10, that misclassification for discriminating between resting and immature animals was higher and thus the method less reliable for that task.

In response to a request, the authors provided a histogram showing the numbers of immature, resting, ovulating and pregnant animals (Figure 1 of Yasunaga *et al*. in Annex U2). Based on the assumption of cut off values (1.0 ng/g) of progesterone set in Wade *et al.* (see in Annex U2), six of 56 immature whales and three of 11 resting whales were misclassified. Misclassification ratios were thus10.7% and 27.2%, respectively, and these were not considered negligible by the authors (see details in Yasunaga *et al*. in Annex U2).

19.2.2.5 SAMPLE SIZES REQUIRED TO DETECT CHANGE IN ASM (RECOMMENDATION 26)

SC/67b/SCSP01 focused on the need to complete NEWREP-A recommendation 26 on the calculation of sample size. The Committee discussed its previous conclusions in this regard. In 2016, the Committee assessed that three of six aspects of the Expert Panel's recommendations had been adequately addressed in relation to sample sizes. Some members of the Committee consider that until the proponents fully implement the Expert Panel recommendations for calculating sample sizes, the proponents have not demonstrated that they are able to meet their stated objectives in relation to the NEWREP-A programme. The proponents' position and that of some Committee members is that the work has been completed to a reasonable level and that any further work on sample sizes will be afforded a low priority.

The Proponents reiterated their position regarding the work on and status of recommendation 26 ('Provide a thorough power analysis of sample sizes required to detect change in ASM and follow the other recommendations in this item') from the NEWREP-A Review Workshop (IWC, 2016). In view of the proponents, the work on recommendation 26 has been completed to a reasonable level. Details can be found in GOJ (2015; 2016a) and GOJ (2016b). The IWC SC has already concluded that the approach being taken to address the recommendation is appropriate (IWC 2018). Consequently, the proponents have concluded that the reasonableness of the proposed sample size (333) has been adequately demonstrated. The proponents recognize that in 2016 the Scientific Committee suggested some further refinement work; however, they consider that such refinement work goes beyond the original scope of recommendation 26 from the NEWREP-A review workshop. Nevertheless, in deference to the Committee, it was the proponent's intention to address the refinement work for this year's Scientific Committee. However, because of unanticipated specialist personnel unavailability, this has had to be postponed. The proponent's intention is to continue contributing to this work subject to logistical constraints and the availability of specialist analysts.

19.2.2.6 COMMITTEE'S ADVICE

The table in Annex U4, provides a detailed update of the Committee's view of progress on previous recommendations. An overview is given in Table 25.

19.3 JARPN II

The new information provided on JARPN II is relevant only to the discussion of the NEWREP-NP 'non-lethal vs lethal' feasibility study (see Item 19.3).

19.4 NEWREP-NP

19.4.1 Report on ongoing research

Three papers were presented on progress made during the 2017 surveys of different aspects of the NEWREP-NP programme (SP03, 06, 07, see Annex U3 for summaries).

In particular, SC/67b/SP03 reported the results of the satellite tagging ofn North Pacific sei whales. A total of 44 tagging attempts were made using SPOT6 tags with the LKArts attachments system. A total of 15 tags were deployed on sei whales, and eight whales were tracked. Two sei whales were tracked for more than 35 days, and both showed longitudinal movement. The authors concluded that the tagging experiment showed that deploying such tags from sighting/sampling vessels was practical, but identified technical improvements to try to increase the tracking period.

In discussion, it was noted that the proportion of successful deployments was low (7 failures in 15 attempts); and suggestions on how to improve this included: (a) strategic placement of tags on the upper body of whales to ensure tag longevity and reduce potential physical impacts (e.g. lesions) and (b) replacement of the current screw-on anchor system with an integrated tag design to decrease the possibility of tag breakage. It was noted that guidelines for cetacean tagging should become available within the next year and published in the IWC Journal. It was noted by the authors that the cause of the failures in SP03 were difficult to evaluate since a tag in an optimal position on the whale had also failed. New tags with a modified anchor system and stopper will be used during the next season.

The Committee welcomes new information on the feasibility of satellite tagging sei whales and notes the valuable movement data collected from two of the longer-term (>35 days) deployments. The Committee **encourages** the collection of more telemetry data and notes that this may help improve abundance estimation (by providing information on correction factors) and provide inferences on stock structure.

SC/67b/ASI10 presented a summary of results of the NEWREP-NP dedicated sighting survey in the western North Pacific in 2017 whilst SC/67b/ASI06 presented the research plan for the next systematic vessel-based sighting survey in the western North pacific under NEWREP-NP in 2018 and 2019. As indicated under Item 24.3, the new NEWREP-NP sighting cruise plan has been endorsed by the Committee; Annex Q (item 4.2) provides more details on both these papers.

19.4.2 Update on previous recommendations

The table in Annex U4, provides a detailed update of the Committee's view of progress on previous recommendations. An overview is provided in Table 26.

20. WHALE SANCTUARIES

20.1 Review of the Southern Ocean Sanctuary Management Plan

The Schedule amendment establishing the Southern Ocean Sanctuary (SOS) requires the Sanctuary to be reviewed at succeeding ten-year intervals, unless otherwise revised by the Commission. The first review of the SOS took place in 2004 (IWC, 2005) and the second review was completed in 2016 (IWC, 2017). In 2014 (IWC, 2015c), the Commission adopted eight objectives for the SOS (summarised in Annex R, item 3). The Commission also provided terms of reference for the review to be undertaken by the Scientific and Conservation Committees. The Scientific Committee review made several recommendations (IWC, 2017c). These recommendations were taken into account in a draft Southern Ocean Sanctuary Management Plan (SC/67b/SAN01) developed by Australian scientists and discussed in Annex R (item 3). It was noted that, while the draft Plan does contain performance measures, it does not contain criteria for its own review.

The purpose of the draft Management Plan is twofold: (1) to inform the Commission and public about the sanctuary objectives and actions planned for the next ten years; and (2) to propose strategies toward the achievement of the SOS's goals using the best means available and provide clear performance measures for each proposed action.

The operative part of the Plan is a Research and Action Plan that involves assessing and addressing threats and research on the recovery of whale populations and their habitats. The Research and Action Plan is structured based on the Commission's agreed objectives for the SOS. Each objective is linked directly to a measurable objective, action or approach and performance measure.

The Committee also discussed the potential contributions that data and results from the Japanese whale research programme in the Southern Ocean (NEWREP-A) could make to the objectives and goals of the Plan and the Committee agrees to incorporate reference to NEWREP-A under Objectives 4-6.

The amended Plan, with Objectives 1 and 8 (relating to policy) and the chapeau of Objective 5 redacted to clarify that the Committee did not address these elements of the Plan, is given as Annex R (Appendix 2).

A statement from the Government of Japan regarding its position on the SOS and this draft Management Plan is attached as Annex R, Appendix 3.

Attention: C-A, CC, SC,

The Committee reviewed the components of a draft Management Plan for the Southern Ocean Sanctuary (SOS) that are related to science and therefore within its remit and:

*(1) **endorses** the measurable objectives, approach/actions and performance measures of Objectives 2 -7 of the amended draft Southern Ocean Sanctuary (SOS) Management Plan (Annex R, appendix 2); and*

*(2) **agrees** to include a new standing item on the agendas of all relevant sub-committees and working groups: 'new information relevant to the SOS Management Plan' in order to assist the Commission in monitoring and measuring progress on the scientific objectives of the Plan.*

21. SATELLITE TAGGING DEVELOPMENT AND BEST PRACTICES

21.1 Tag Workshop Meeting, Silver Spring, MD, USA 6-8 September 2017

A workshop on cetacean tag development, tag follow-up and tagging best practices was held at the National Marine Fisheries Service in Silver Spring, Maryland, USA from 6-8 September 2017. The workshop was co-sponsored by the Office of Naval Research (ONR), the International Whaling Commission (IWC), and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA/NMFS). The purpose of the workshop was to review and evaluate progress in tag design and attachment since the 2009 ONR Cetacean Tag workshop (ref - attached), with an emphasis on (a) recent tag attachment improvements, (b) follow-up studies that examined the effects of tagging, and (c) reviewing and providing input on draft cetacean tagging best practices guidelines.

Several presentations were made, with a focus on sharing information and discussion of the best available science of design and effects of tagging to facilitate future advancements in tag design and application, maximising attachment durations to the extent required to answer the questions being posed, whilst minimising potential impacts to the animals.

Discussion on the status of tag attachment development and follow-up studies occurred, along with extensive discussion regarding the cetacean tagging best practices guidelines. While much was accomplished towards the collective goals of the workshop, one item not covered in sufficient detail was discussion on the future directions in tag attachment technology. Therefore, a second smaller workshop will be convened in June of 2018 with a subset of the original attendees that focus specifically on tag attachments. The final report will merge the results of the September 2017 workshop and the June 2018 workshop.

22. IWC LIST OF RECOGNISED SPECIES

The Committee has agreed to follow the guidance of the Society for Marine Mammalogy's Committee on Taxonomy. This year (see Item 17.5), in completing its review of the taxonomy of *Tursiops*, the Committee noted that the current taxonomy provided by the SMM Committee for *Tursiops* was well supported by morphological and molecular genetic data, as well as ecological and distributional data.

23. IWC DATABASES AND CATALOGUES

23.1 Guidelines for IWC catalogues and photo-ID databases

At last year's meeting, the Committee agreed IWC Guidelines for Photo-identification Catalogues (IWC, 2018f), noting that adding technical Appendices would be valuable in the future. Draft items for inclusion as Appendices were discussed by the *Ad hoc* Working Group on Photo-identification (Annex S, item 5.1) covering five issues: (1) cataloguing software; (2) image matching software; (3) seminal papers defining individual identification, by species; (4) photo quality guides; and (5) photo/data collection apps. Work will continue on developing these appendices intersessionally (Annex Y).

23.2 Progress with existing or proposed new catalogues

23.2.1 Integration of eastern South and Central Pacific blue, humpback, and fin whale photo-catalogues

There was no new information specific to this item this year.

23.2.2 Southern Hemisphere and Indian Ocean humpback whale catalogues

23.2.2.1 ANTARCTIC HUMPBACK WHALE CATALOGUE

The Antarctic Humpback Whale Catalogue (AHWC), maintained at College of the Atlantic, USA, was established in 1987 and during the past 30 years its data have been used in dozens of studies and publications (Stevick *et al.*, 2017). With a recent loss in funding, the catalogue database is now 'frozen' and is not being actively updated. The Working Group expressed strong disappointment at this news as well as the hope that the AHWC's funding situation will change and enable the catalogue to continue.

Table 25

NEWREP-A – Overview on progress with recommendations.

Recommendations in are not in priority order. Recommendations that relate to purposes A, B, C and D are higher priority for completion. Recommendations coded uniquely as '*E: Relevant to improve existing components of the proposed programme*' are excluded from this table as they were optional. Key for 'Purpose': *A: To evaluate the contribution of a particular objective or sub-objective of the programme to meet conservation and management needs*; *B: To evaluate the 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)*.

Recommendation	Purpose	Deadline	Proponents self-evaluation on progress as of SC/67b	Committee's comments
(1) Age data and RMP/IST	A, C, D	August 2015	Completed to a reasonable level	SC/66b: A range of opinions as to the extent to which this recommendation has been addressed. SC/67a: No new information. SC/67b: Some information presented (see Item 19.1.2.1).
(2) Stock definition	A, D	May 2015	In progress	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: As in SC/66b.
(3) Mixing rates (simulations on precision and bias)	A, D	May 2015	To be completed by the mid-term review	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: As in SC/66b.
(4) Biopsy feasibility study	B, C, D, E	Field season 2016-17	Completed	SC/66b: Some progress (SC/66b/IA05). SC/67a: Some progress (SC/67a/ASI07). SC/67b: Partially completed, further refined analysis is needed (see 19.1.2.2). A WG was formed to review and improve methods.
(5) Telemetry feasibility study	B, E	Field season 2017-18	Completed.	SC/66b: Some progress (SC/66b/IA05). SC/67a: Some progress (SC/67a/ASI07). SC/67b: Completed.
(8) DNA methylation ageing technique	B, C, D	March 2016	Completed	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: Partially completed, further refined analysis is encouraged. See Item 19.1.2.3.
(9) Hormones in blubber and sexual maturity	B, C, D	March 2017	Completed	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: Blubber hormones analysis completed. On accuracy see Item 19.1.2.4.
(10) SCAA and misassignment 'resting' females/immature females.	A, C, D	August 2015	To be completed by the mid-term review*	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: New information presented (SC/67b/SCSP05).
(11) SCAA, density- dependence, and stock mixing	A, C, D	May 2015	Completed*	SC/66b: Partially completed: updates on stock mixing and mixing rates still necessary. SC/67a: As in SC66b. SC/67b: As in SC66b.
(12) Time-varying natural mortality and SCAA	A, C, D	August 2015	To be completed by the mid-term review*	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: As in SC/66b.
(13) Time varying ASM data and SCAA	A, C, D	May 2015	To be completed by the mid-term review*	SC/66b: No progress. SC/67a: As in SC/66b. SC/67b: As in SC/66b.
(15) Krill acoustic sampling	B, E	March 2016	Completed	SC/66b: Completed.
(17) Power analysis for krill abundance	A, E	August 2015	To be addressed	SC/66b: Will be addressed in consultation with CCAMLR specialists SC/67a: No progress. SC/67b: As in SC/66b.
(18) Stomach contents vs krill survey	A, B, C	May 2015	To be addressed	SC/66b: Will be addressed in consultation with CCAMLR specialists SC/67a: No progress. SC/67b: As in SC/66b.
(22) Energy intake (requirements)	A, B, D	August 2015	To be addressed. Need clarification from the IWC SC	SC/66b: No Progress. SC/67a: As in SC/66b. SC/67b: As in SC/66b.
(23) Stable isotopes in baleen plates	B	August 2015	Completed	SC/66b: Will be addressed in consultation with other research institutions. SC/67a: Some progress presented. SC/67b: Completed.
(26) Sample sizes required to detect change in ASM	D	May 2015	Completed to a reasonable level	SC/66b: Overall, the approach being taken to address the recommendation is appropriate, but some further refinements are required. SC/67a: No progress. SC/67b: As in SC/67a.

*See note in table in Annex U4.

Table 26

Summary of status of recommendations relevant to NEWREP-NP.

No. of recommendation	Priority by the Committee	Timeline	Proponents self-evaluation on progress as of SC/67b	Scientific Committee evaluation
(1) Lethal *vs* non-lethal quantitative review of data	Very high	Before start	SC/67a: Completed	SC/67a: Different opinions as to whether the recommendation has been met. SC/67b: No progress.
(3) Sexual maturity (blubber and serum)	High	Before start	SC/67a: Completed	SC/67a: The Proponents demonstrated intention to include analysis of blubber for progesterone, but there are few details of how. SC/67b: Partially addressed.
(4) Sightings surveys	High	Before start and annually	Addressed and ongoing	SC/67a: Completed: survey plan was presented. SC/67b: Completed: survey plan was presented.
(5) Stomach contents	High	Before start	SC/67a: Completed	SC/67a: Completed.
(7) Immune function assays	High	Before start	SC/67a: Completed	SC/67a: Completed.
(8) Lipophilic compounds	High	Before start	SC/67a: Completed	SC/67a: Completed.
(10) Coordination with IWC-POWER	High	Before start and annually	Addressed and ongoing	SC/67a: Completed annually.
(11) Coastal component: sampling strategy	High	Before start	Disagree with Panel	SC/67a: No progress as proponents disagree with Panel. SC/67b: No progress.
(12) Offshore components: sampling strategy	Very high	Before start	SC/67a: Completed	SC/67a: Completed.
(13) downweight historical age-composition data	Very high	Before start	Disagree with Panel	No progress.
(15) efficiency of biopsy sampling (additional captures unnecessary)	Very high	High priority ASAP in 2017	Disagree with Panel	No progress.
(17) Telemetry	High	Before start	Ongoing	SC/67a: Partially addressed. SC/67b: New information (SC/67b/SCSP03).
(21) Sample size (potential reduction of lethal sample size)	Very high	Before start	To be considered by the mid-term review	SC/67a: The possibility for further work has been considered. SC/67b: No progress.
(22) Sample size (in general)	Very high	Before start	Not relevant	SC/67a: Small progress. SC/67b: No progress.
(23) Impact of catches on common minke whales (subset of 2013 *Implementation*)	Very high	Before start	Disagree with Panel	SC/67a: Major concerns addressed. SC/67b: Completed. Refined analyses were presented. It could be reconsidered in the next *Implementation Review.*
(24) Impact of catches on common minke whales (new abundance)	Very high	Before start	Disagree with Panel	SC/67a: Major concerns addressed. SC/67b: Completed. Refined analyses were presented. It could be reconsidered in the next *Implementation Review.*
(25) Sei whale (abundance, $MSYR_{1+}$=1%, $MSYR_{mat}$=4%)	Very high	Before start	SC/67a: Completed	SC/67a: Completed.
(27) Higher priority to analyses and modelling	High	Before start	Ongoing	SC/67a: It is not clear that additional qualified personnel have been hired. SC/67b: No progress.
(28) Sample and data archiving, relational database(s)	High	Before start	Ongoing	SC/67a: Partially addressed for DNA data and associated biological information.
(29) Contingency plan	High	Before start	Ongoing	SC/67a: Partially addressed.

Attention: SC, G

The Scientific Committee has been informed that due to a loss of funding, the Antarctic Humpback Whale Catalogue curated by the College of the Atlantic, USA will no longer be updated. The Committee:

(1) ***draws attention*** *to the great value this catalogue (established in 1987) has provided to the Committee, including receiving photographs from the IWC IDCR and SOWER cruises and providing information for the Committee's Comprehensive Assessment of Southern Hemisphere humpback whales;*
(2) ***welcomes*** *news that the existing catalogue will remain a resource for scientists; and*
(3) ***encourages*** *potential funders to support future continuation of the catalogue.*

The Committee also received an update on the development and status of 'Happywhale', a web-based marine mammal photo-ID crowd-sourcing platform (SC/67b/PH05)[12]. This is discussed in Annex S (item 2.2). In recent months Happywhale provided images to catalogues relevant to the IWC and IWC-SORP of Southern right whales, Antarctic blue whales, and Antarctic killer whales. It will also contribute to the ongoing in-depth assessment of North Pacific humpback whales (see Annex F item 4.2.1).

23.2.2.2 ARABIAN SEA WHALE NETWORK'S FLUKEBOOK

In 2016 (IWC, 2017), the IWC approved funding for the development of a regional data platform for the Arabian Sea Whale Network (ASWN), to be implemented in collaboration with Wild Me, the developers of Flukebook. This year the Committee received information SC/67B/PH/03 that described Flukebook, a non-profit, open source cetacean data archiving and photo matching tool as discussed in Annex S (item 2.1; SC/67B/PH/03). The ASWN is joining Flukebook with two primary objectives: (1) to consolidate and more effectively manage humpback whale and other cetacean data collected in Oman over the

[12]*https://happywhale.com*

past 20 years; and (2) to provide an online platform that will allow comparison and regional-level analysis of cetacean data collected by different research groups throughout the Arabian Sea (so far photographs are mainly from Oman, with a few from Pakistan and India). The Committee looks forward to updates on this work.

23.2.3 Southern Hemisphere Antarctic and pygmy blue whales: Catalogues and databases

23.2.3.1 SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE (SHBWC)

The SHBWC has become the largest repository of Southern Hemisphere blue whale photo-identifications. It now includes a total of 1,519 individual blue whale photo-identifications from areas off Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific (ETP), Australia, Timor Leste, New Zealand, southern Africa, Madagascar and Sri Lanka. The Committee received information on the progress made with the catalogue (SC/67B/PH/04), especially in light of the recommendations made last year to conduct catalogue comparisons in the Indo-Australian region (IWC, 2018b). This is discussed in more detail in Annex S (item 3.2). Comparison work (SC/67B/SH16) found (a) no matches between Australia, New Zealand and Sri Lanka, reinforcing the hypothesis of separate populations; and (b) exchange within Australia, suggested a single population; and (c) re-sights found in New Zealand suggest some site fidelity. Additional work is underway. The relevance of the catalogue to population assessments is discussed in Annex H Item 7.1.1.2.

23.2.3.2 ANTARCTIC BLUE WHALE CATALOGUE (ABWC)

In 2017, the Antarctic Blue Whale Catalogue compared photographs from the IWC IDCR/SOWER cruises in 1989/1990, 1993/1994, and 1997/1998 as well as opportunistic photographs collected by collegial scientists, naturalists, and tourists 2015-2018. The catalogue now contains almost 460 individuals. The results of the comparison of new Antarctic blue whale identification photographs to the ABWC is summarised in SC/67B/PH02 and discussed in Annex S (item 3.1); 17 new individual blue whales were identified. The collection of Antarctic blue whale identification photographs provide data for capture-recapture estimates of abundance (SC/67B/SH08) as well as information on the movement of individual blue whales within the Antarctic region. The relevance of the catalogue to population assessments is discussed Annex H, Item 7.1.1.1.

Attention: SC

(1) The Southern Hemisphere Blue Whale Catalogue provides data useful for estimating abundances and examining connectivity between feeding and breeding grounds. The Committee ***agrees*** *that the catalogue continue.*

(2) The Committee ***agrees*** *that the Antarctic Blue Whale Catalogue continue its work collecting adding photo-identification data to the catalogue in order to assist with developing estimates of population abundance for Antarctic blue whales.*

(3) The Committee ***agrees*** *that the development of a simple guide (physical and electronic versions) to help tourists and naturalists take photos that are suitable for photo-identification should be undertaken. This will support the photo-ID catalogues from the Antarctic region for use in population assessments by the IWC, particularly for blue whales, right whales, fin whales, and humpback whales.*

23.2.4 Southern Hemisphere fin whale photo catalogues

The Committee received information on on a new photo-identification catalogue of Antarctic fin whales. Photographs from SOWER cruises 2004-2008 are included as well as those collected opportunistically near the South Orkney Islands during a Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) fisheries research voyage (SC/67B/PH01). This is discussed in Annex S (item 4.1). The catalogue serves as a foundation for future photo-ID studies, especially those proposed for the western Antarctic Peninsula. The relevance of the photo-identification of fin whales to population assessments is discussed Annex H, Item 7.1.2.

Attention: S, SC

(1) The Committee ***encourages*** *continuation of the Antarctic Fin Whale Catalogue which can potentially provide data toward estimating abundance or identifying movement patterns.*

(2) The Committee ***agrees*** *that an exhaustive search be conducted to locate SOWER photos that are missing from the IWC archives, including those of fin whales.*

23.2.5 Western Pacific gray whale photo catalogues

The Committee received information on two photo-identification catalogues relating to the Sakhalin Island

Table 27

Work plan on issues related to catalogues.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Appendices for IWC Guidelines for Photo-identification	Continue compilation	Appendices ready for review	Continue compilation	Appendices ready for review
Upload all available New Zealand blue whale identification photographs to SHBWC (also pertains to Annex H, item 7.1.1)	Cross-reference between separate area catalogue holdings before uploading to SHBWC avoid duplication; intersessional correspondence group (see Annex Y)	Included in SHBWC report		
Development of how-to photo-ID materials for naturalists and citizen scientists (also pertains to Annex H, item 7.1.1.2)	Prepare hard copy and PPT photo-ID guides	Guide completed and available (pending funding)		
Search for missing SOWER photographs, especially fin whale photos from 2006/07	Search Secretariat archives and contact SOWER researchers for personal copies of photos	Report		

feeding aggregation: one (SC/67B/ASI04), based on work undertaken as part of an industry-sponsored Exxon Neftegas Limited-Sakhalin Energy Investment Company joint monitoring program discussed in Annex S, item 4.2); and the other conducted by the Russia gray whale project (SC/76b/CMP/7) discussed in Annex O (item 2.1.3). The Committee welcomed news that the two catalogues would be unified under the auspices of the IWC.

23.3 Work plan

The work plan on work related to catalogues is provided in Table 27.

23.4 Potential future IWC databases

23.4.1 Global database for disentanglement activities

As discussed under Item 13.2, development of a dedicated entanglement database will be considered further at the June 2018 meeting of the Global Whale Entanglement Response Network (see Annex J, item 2.3).

23.4.2 Global bycatch database

No new information was presented on the development of a global bycatch database was presented this year. Consideration of such a database could take place as part of the Bycatch Mitigation Initiative and should it be taken further, follow the guidelines for the proposal of new databases developed last year (IWC, 2018, pp. 403-404).

23.4.3 Development of simple technical guidelines for new proposals

No changes were suggested to the guidelines developed at last year's meeting (IWC, 2018, pp. 403-404).

24. IWC MULTINATIONAL RESEARCH PROGRAMMES AND NATIONAL RESEARCH CRUISES THAT REQUIRE IWC ENDORSEMENT

24.1 IWC-POWER

The Committee received the results of the 8th annual IWC-POWER cruise conducted between 3 July and 25 September 2017 in the eastern Bering Sea. Researchers from Japan, USA and IWC participated on the surveys (SC/67b/ASI12). The Committee also received the report of the planning meeting for the 2018 IWC-POWER cruise, which will be conducted in the central Bering Sea, and cruise plans for the 2019 and 2020 cruises (SC/67b/Rep02). Details and preliminary results of the 2017 IWC-POWER survey and future plans for 2018, 2019 and 2020 are provided in Annex Q, item 4.1.

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** Japan who generously supplies the vessel and crew, for their continued support of this IWC programme;*
*(2) **thanks** the USA who provided an acoustician and acoustic equipment for the 2017 cruise and will do so for the 2018 cruise;*
*(3) **agrees** that the 2017 cruise was duly conducted following the requirements and guideline of the Committee (IWC, 2012) and looks forward to receiving abundance estimates based on these data;*
*(4) **endorses** the plans for the 2018, 2019 and 2020 POWER cruise and **recommends** a meeting of the Technical Advisory Group along with the planning meetings for 2019 and 2020 cruises;*
*(5) **strongly recommends** that Russia facilitates the proposed research by providing permits for the IWC-POWER cruise to survey the Russian Exclusive Economic Zone in 2019; and*
*(6) **looks forward** to receiving a report from the 2018 survey at the next SC meeting.*

24.2 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 programme 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 2017/18 on the continued progress of research undertaken researchers involved in the five themes since last year (SC/67b/SH21). This progress includes the production of 33 peer-reviewed publications during 2017/18, bringing the total number of peer-reviewed publications related to IWC-SORP since the start of the initiative to 126. In addition, 125 IWC-SORP related papers have been submitted to the Scientific Committee, 22 of them this year.

Fieldtrips were undertaken to a variety of places during the past year, including the western Antarctic Peninsula, Marion Island, the Ross Sea, the Chesterfield-Bellona Reef complex west of mainland New Caledonia, and the Great Barrier Reef, Australia. 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 as well as biopsy samples collected from these same species; video suction cup tags have been deployed on Antarctic minke whales and humpback whales; and hundreds of hours of acoustic recordings have been made and analysed. The support of tour companies in providing opportunistic research platforms to facilitate these activities and external data contributors were acknowledged by the Committee.

Attention: SC, G

*The Committee **reiterates** the great value of the IWC-SORP (Southern Ocean Research Partnership) programme to its work. The Committee:*

Table 28

Workplan for the Southern Ocean Research Partnership.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Analyses	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report
Voyages	Argentine coastguard '*Tango'* voyage along Western Antarctic Pensinsula (early 2019)	Cruise report		
	Almirante Maximiano voyage along Western Antarctic Pensinsula (early 2019)	Cruise report		
	Australian-led *RV Investigator* voyage to Ross Sea (early 2019)	Cruise report		
	New Zealand-led *RV Tangaroa* voyage to Ross Sea (early 2019)	Cruise report		
	German-led *RV Polarstern* voyage to Scotia Sea (early 2019)	Cruise report		
	Baleen whale and krill research voyages along Western Antarctic Peninsula	Reports	Baleen whale and krill research voyages along Western Antarctic Peninsula	Reports
Ships of opportunity	Continued use of ships of opportunity to conduct cetacean research	Reports	Continued use of ships of opportunity to conduct cetacean research	Reports
Acoustics	Retrieval and redeployment of passive acoustic recorders	Report	Retrieval and redeployment of passive acoustic recorders	Report
	Completion of annotated library of acoustic detections	Report		

(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;

(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.

24.2.1 Work plan

The work plan for issues related to IWC-SORP is given in Table 28.

24.3 National cruises that require IWC oversight

The Committee welcomed plans for national research cruises to be conducted in the intersessional period of 2018-2019. Details on the cruise plans and cruise reports are presented in Annex Q, item 4.2.

Attention: SC, C-A

The Committee ***recognises*** *the great value to its work provided by data from national cruises. The Committee:*

(1) ***endorses*** *the proposed sighting survey plans for cruises to be conducted with IWC oversight in the southwestern Okhotsk Sea by Russia, and in the North Pacific and the Antarctic by Japan; and*

(2) ***encourages*** *submission of abundance estimates from these studies the future.*

24.4 Review of cruise reports from national programs with IWC oversight

The Committee considered a process to optimise the review of cruise reports from national research programs with IWC oversight. Details are given in Annex Q, item 2.7

Attention: SC, CG-R

The Committee ***recognises*** *the value of information provided by national cruises with IWC oversight. The Committee* ***noted*** *that a process to optimise the review of national cruise reports is needed and:*

(1) ***recommends*** *contracting governments to submit reports of multi-year cruises with IWC oversight biennially, in years between Commission meetings (e.g., SC "A" years);*

(2) ***agrees*** *that cruise reports will be summarised in a table;*

(3) ***notes*** *that that in certain circumstances, cruise reports may require additional evaluation; and*

(4) ***agrees*** *that the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' should be modified at next year's meeting to accommodate procedural changes with respect to the submission and review of national cruise reports.*

24.5 Work plan

The Committee's work plan for continuing the IWC-POWER programme in 2019 and 2020 is provided below in Table 29.

25. SCIENTIFIC COMMITTEE BUDGET FOR THE CURRENT BIENNUM

25.1 Status of previously funded research, workshop proposals, data processing and computing needs

25.1.1 Funded proposals for the current biennium 2017-2018

Table 30 summarises the status of the work funded by the Committee last year. The majority have been completed,

Table 29

Workplan for issues related to IWC-POWER.

Item	Intersessional 2018-19	SC/68a	Intersessional 2019-20	SC/68b
IWC-POWER Cruise	Conduct 2018 survey and planning meeting for the 2019 Cruise (Bering Sea)	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.	Conduct 2019 survey and planning meeting for the 2020 Cruise	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.

but several remain ongoing. The projects all contributed considerably to the work of the Committee and the Committee thanked all of those involved.

25.1.2 Funded proposals in previous years still ongoing

A number of projects from previous years are still ongoing (see Table 30). These are all still of great value to the Committee and should be completed before the next meeting. Details of all ongoing projects can be found in SC/67B/01 Rev1.

25.1.3 Report on funds reallocations and contingencies for the Research Fund, Voluntary Fund for Small Cetaceans and SORP Voluntary Fund

SC/67b/01Rev1 provides information on the actual position against budget for the Research fund for 2017 as well as the position to 31st March for the 2018 financial year. The paper gives summary level and detailed information for the Research fund as well as the expected level of contingency available, which remains static at around 10% of the Research budget, or £32k. The document also provides details of the reallocations of budget amongst budget headings for 2017 and the 2018 year-to-date. Annex 1 gives a detailed position along with a status report for each budget line. Section 3 also provides details of voluntary funds which relate to Scientific Committee business – the Gray Whale Tagging Fund, the Small Cetaceans Fund and the SORP fund. For each there is an update of 2017 expenditure and 2018 to-date information along with details of commitments to future work in these funds.

The Committee received a brief report on the IWC-SORP Research Fund. Following an open, competitive Call for Proposals (26 July to 17 August 2016) a total of £144,058 GBP was allocated from the IWC-SORP Research Fund to 10 research projects, ahead of the 2016-2017 austral summer survey season. Progress on these projects is detailed in SC/67b/SH18.

The Committee also noted that since SC67a, substantial vessel time has also been secured by IWC-SORP researchers for the 2019 and 2020 austral field seasons.

Attention: C, F&A, S

*A full report on the new Call for Proposals, opened in September 2017 and closed in January 2018, was also received. A total of 19 proposals were received and evaluated by the Assessment Panel under the coordination of the Chair of the Scientific Committee. The Committee **thanks** Fortuna for convening the Assessment Panel and expressed its gratitude to the Panel members who all provided valuable and thoughtful input into the assessment process. The Committee **welcomes** the outcome of the Assessment Group and **agrees** with the allocation of a total of £493,544 GBP from the IWC-SORP Fund to 15 projects (Table 31).*

*The Committee **agrees** on these recommended allocations and requests the Secretariat to submit them to the Finance and Administration Committee, as soon as feasible, for it consideration. Should the Commission **endorse** these financial recommendations, the Committee **requests** the Secretariat to inform successful and unsuccessful proponent immediately after the next Commission's meeting.*

Finally, the Committee was informed that the next Call should open prior to SC/68b (i.e. late 2019/early 2020) in readiness for IWC68 (2020). This timing would allow strategic prioritisation of the research toward which the Call is directed in order to meet IWC-SORP and IWC/SC priorities; allow knowledge gaps to be identified; and allow the IWC-SORP SSC to seek additional funding to augment the funds available in the IWC-SORP Research Fund.

26. COMMITTEE PRIORITIES AND INITIAL AGENDA FOR THE BIENNUM 2019-2020

The Committee's priorities and work plan by broad subject matter are provided in Tables under the relevant agenda items.

*The Committee **agrees** that the Chair, Vice-Chair and Head of Science, in co-operation with the Convenors, should examine the individual work plans by topic and develop an overall Committee biennial workplan and priorities taking into account the overall work load, meeting venues and efficiency. This should be submitted to the Commission meeting as an Annex to their two-year overview.*

27. SCIENTIFIC COMMITTEE BUDGET FOR THE BIENNUM 2019-2020

27.1 Budget for the next biennium

As in 2016, the Committee has developed a two-year budget, based on the proposed work plans*. The process given in Annex S IWC, 2016) was applied, with extensive discussion carried out in each of the sub-committees and Working Groups to establish priorities among the presented proposals. Funding was not approved for one project (*Gulf of Penas, Southern right whales*) as further information is needed before funding can be agreed. The savings from 2018, some self-reductions and adjustments between years allowed inclusion of all funding proposals for 2019 and 2020 in the new budget of £315,800 per year.

Table 33 shows the Committee budget requests for the biennium for each of the proposed priority activities.

27.1.1 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-Convenors and rapporteurs, subject area experts and Convenors of intersessional groups. All sub-committees and Working Groups benefit from this budget item. This year under this budget item, 62 scientists from Australia, Argentina, Belgium. Brazil, Canada, Chile, China, Colombia, France, Germany, Italy, Japan, Mexico, Netherlands, Norway, Oman, Peru, Slovenia, South Africa, Spain, UK, USA were supported.

27.1.2 Workshops

RP16 WESTERN GRAY WHALE UPDATE OF CMP AND CONSERVATION ISSUES WITHIN MODELLING FRAMEWORK

The CMP is over 10 years old and requires updating. Initial work has been undertaken but the results of the rangewide workshop need to be incorporated and conservation-related questions need to be developed that can be addressed within the new population modelling framework developed as a result of the Committee's work. This is primarily related to the CMP and AWMP groups, however, it is also of importance to the work of IA and ASI in terms of precedents for future assessments and the work of HIM in terms of examining scenarios that take into account bycatch and the uncertainty associated with estimating it.

*Japan referred to its statement on the adoption of the Agenda (Annex Z) and considered that several of the items for the proposed workshop (Item 16.4.4) are outside the competence of IWC. Therefore, it cannot support the proposed workshop or associated funding from the Committee's budget.

Table 30

Summary of progress on proposals funded at SC/67a.

SC/67a RP no.	Title	Status
SC01	Invited Participants - SC/67b	Completed
IA01(67a)	Workshop for an in-depth assessment of North Pacific humpback whales	Ongoing (Annex F)
EM01	Two joint SC-CAMLR and IWC-SC Workshops	Ongoing (Annex L)
AWMP01	AWMP first intersessional Workshop and genetic work	Completed (SC/67b/Rep06)
AWMP02	AWMP second intersessional Workshop	Completed (SC/67b/Rep06)
CMP01(67a)	5th Workshop on the rangewide review of population structure and status of North Pacific gray whales	Completed (SC/67b/Rep07rev1)
BRG04	Satellite tagging best practices Workshop	Ongoing, Item 21
WW01	Intersessional Workshop: data gaps and modelling requirements for assessing the impacts of whale watching	Completed (SC/67b/Rep03rev1)
RMP01	Intersessional Workshop: *Implementation Review* of North Pacific Bryde's whales	Completed (SC/67b/Rep02)
RMP01(67a)	Intersessional Workshop: *Implementation Review* for Western North Pacific minke whales	Completed (SC/67b/Rep05)
WW01(67a)	Review CC Strategic plan on whalewatching pre-meeting on intersessional workshop	Completed (Annex N)
E05/E01(67a)	Cumulative impacts - pre-meeting or intersessional meeting	Completed (Annex K)
SM01	Intersessional Workshop: resolving *Tursiops* taxonomy	Completed (SC/67b/SM18rev1)
SM01(67a)	Intersessional Workshop: boto mortality	Completed (SC/67b/Rep01)
SH07	Defining blue whale population boundaries and estimating associated historical catches, using catch data in the Southern Hemisphere and northern Indian Ocean	Completed (SC/67b/SH23)
AWMP02	AWMP developers fund	Completed (Annex D)
IA02	Assessment modelling for an in-depth assessment of North Pacific sei whales	Ongoing (SC/67b/IA01)
RMP02	Essential computing support to the Secretariat for RMP	Completed (Annex D)
Research		
BRG01	Aerial photographic survey of southern right whales on the South Africa Cape nursery ground	Completed (SC/67b/SH01)
BRG03	Passive acoustic monitoring of the eastern South Pacific southern right whales, improving CMP outputs	Completed (SC/67b/CMP18)
SH03a	Northern Indian Ocean humpback subspecies determination-genetics	Ongoing (Annex H)
IA03	IWC-POWER cruise	Completed (SC/67b/Rep04)
SH01(67a)	Coding for Australian blue whale photo catalogue	Ongoing (Annex PH)
E02(67a)	Mercury in cetaceans (requested by the Commission)	Ongoing (SC/67a/E08)
SH02	Southern Hemisphere Blue Whale Catalogue	Completed (SC/67a/PH04)
SH08	Development of a permanent blue whale song reference library	Completed (SC/67a/SH11Rev1)
HIM01	Ship Strike Database Coordinator	Completed (SC/67a/HIM11)
E01	Cetacean Diseases of Concern	Ongoing (Annex K)
E03(67a)	IWC strandings initiative	Ongoing (Annex K)
E04	SOCER (State of the Cetacean Environment Report)	Completed (SC/67a/E01)

RP06 MARINE DEBRIS WORKSHOP
There remains an urgent need to better understand and address the threats posed by marine debris to cetaceans. The most effective way to do this, building on earlier work by the IWC and taking into account the greatly expanded interest in this topic by many other international bodies, is to hold a workshop. It is proposed that the workshop is held in Barcelona in December 2019 just before the World Conference on Marine Mammalogy (the joint meeting of the SMM and ECS).

RP05 NOISE PRE-MEETING
The sub-committee on Environmental Concerns will address Anthropogenic Noise as a focus topic during the Scientific Committee meeting in 2020. A pre-meeting workshop is proposed for SC68b, to address emerging issues related to the management of underwater noise and its impacts on marine species.

RP08 CETACEANS & ECOSYSTEM FUNCTIONING: A GAP ANALYSIS
Experts on the role and impact of cetaceans on ecosystem functioning will participate in a workshop/pre-meeting to discuss the current state of knowledge on the ecosystem functioning provided by cetaceans as requested by the Commission in Resolution 2016-3. This Resolution directed 'the Scientific Committee to further incorporate the contribution made by live cetaceans to ecosystem functioning into [its] work' and 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'.

RP17 JOINT IWC-IUCN WORKSHOP TO EVALUATE HOW THE DATA AND PROCESS USED TO IDENTIFY IMPORTANT MARINE MAMMAL AREAS (IMMAS) CAN ASSIST THE IWC TO IDENTIFY AREAS OF HIGH RISK FOR SHIP STRIKE
The identification of 'high risk areas' for ship strikes of cetaceans is a key step toward establishing mitigation actions, through scheduling, re-routing or speed reduction. IUCN's proposed initiative to identify Important Marine Mammal Areas (IMMAs), would likely assist this effort. The SC has encouraged cooperation with the IUCN Task Force on this. The IUCN TF has completed three regional IMMA workshops, including the Mediterranean Sea. This proposed joint workshop will focus on identifying overlap between shipping and the IMMAs identified in the Mediterranean Sea.

RP19 COMPREHENSIVE ASSESSMENT OF NORTH PACIFIC HUMPBACK WHALES
At SC67a, following discussion of the results of an assessment workshop held in April 2017, a Steering Group was established to facilitate a second North Pacific humpback whale assessment workshop, and to coordinate work required for this meeting. This meeting was not held prior to SC67b and the workshop is now planned for prior to the 2019 meeting of the Scientific Committee, with a view to completing or significantly advancing the assessment.

RP37 BALAENID WORKSHOP: BIOLOGY, HEALTH, STATUS
The North Atlantic right whale's population rate of increase is much lower than that of all other well-studied balaenid populations. This workshop will compare reproductive biology, health and status of North Atlantic right whales with those of other balaenid populations with the goal of determining their potential for growth and assessing the role of anthropogenic mortality as a driver of current population decline. Possible causes of the NARW's lower reproductive rate need reassessment include: sub-lethal effects of entanglements; environmental contaminants or marine biotoxins; inadequate prey base; stress from noise; genetic factors; and infectious diseases. This review will also help understanding of population changes for other balaenid populations.

RP21 *IMPLEMENTATION REVIEW*: NORTH PACIFIC MINKE WHALES
These workshops are essential in order for the Committee to conduct a full *Implementation Review* for Western North Pacific common minke whales following the Committee's Requirements and Guidelines. Conducting *Implementation Reviews* are a required activity under the RMP.

RP29 CATCH SERIES: SOUTHERN RIGHT WHALES
A new review of available catch data for measuring regional takes of southern right whales is overdue and the availability of new sources suggests that it is timely to do this. The expected outcome of this workshop is updated regional estimates of southern right whale catches, which can be used to conduct regional assessments of southern right whale past exploitation and develop population trajectories to measure past abundance and current recovery levels.

RP25 INTERSESSIONAL MEETING OF THE TASK TEAM ON SOUTH ASIAN RIVER DOLPHINS
The South Asian river dolphin*, Platanista gangetica*, is listed as an endangered cetacean species by the IUCN Red List assessment. Across its range, in the countries of India, Pakistan, Nepal, and Bangladesh, the species remains highly threatened by a range of anthropogenic activities at multiple scales. These range from localised threats caused by hunting, fisheries bycatch, or local disturbances as well as from large-scale alterations of the rivers by dams, barrages, waterways and river-linking schemes. In particular, large-scale and rapidly accelerating water development in the Indo-Ganges-Brahmaputra floodplains make the outlook for the South Asian river dolphin conservation grim. In recognition of this situation, the Scientific Committee has established a Task Team for the species and the team of experts will meet in person and discuss how to go forward.

RP26 GUIANA DOLPHIN PRE-ASSESSMENT (*SOTALIA GUIANENSIS*)
An intersessional workshop will assess the geographic extent of Guiana dolphin threats and conservation measures needed in both national and international contexts. The outcomes of the workshop shall include: (1) a Comprehensive Assessment of the status of Guiana dolphins; (2) recommendations to potentially improve management actions and the monitoring efforts associated with the current conservation plans of actions; and (3) a consolidated report to be presented to the SC at next year's meeting for review.

RP27 MODELLING WHALE WATCHING IMPACTS (MAWI)
There is little research on the potential mid- and long-term impacts of whale watching on cetacean populations. This is due to the complexity of the required modelling approaches, lack of clarity regarding the data needed to inform them, and the need to identify locations suitable for data collection. Without addressing these issues understanding the potential mid- and long-term impacts of whale watching is not possible. The workshop will bring together modellers and field researchers to achieve the following outcomes: (1) identify existing modelling approaches that could be used to understand the potential mid- and long-term impacts of whale watching, and determine whether new approaches are required; (2) determine which data currently being collected are suitable for answering questions regarding the mid- and long-term impacts of whale watching, and what new data are required; and (3) determine the feasibility of data collection, and identify locations where this has already been done or could be achieved.

27.1.3 Modelling/computing

RP20 ASSESSMENT MODELING FOR AN IN-DEPTH ASSESSMENT-NORTH PACIFIC SEI WHALES
The IA sub-committee is currently conducting a Comprehensive Assessment for North Pacific sei whales. This involves evaluating the status of a population using a population dynamics model that is specific to the biological parameters and movement behaviour of that particular population and is fitted to monitoring data. During the intersessional periods after the 2018 SC meeting and possibly also after 2019 SC meeting, it is expected that population dynamics models will be finalised and run using the existing data. This will result in an assessment of the status of the population.

RP22 DEVELOP AN AGE-STRUCTURED EMULATOR FOR THE INDIVIDUAL-BASED ENERGETICS MODEL (IBEM)
An IBEM provides an alternative population dynamics model to the usual cohort models, particularly because density dependence in births, growth and age-specific mortality are emergent properties of a species in a given environment (which can be stochastic). The IBEM is computationally infeasible for conducting *IST*s; the proposal is to develop a computationally efficient cohort model (emulator) which uses demographic parameters and their covariances generated using the IBEM.

RP23 ESSENTIAL COMPUTING SUPPORT TO THE SECRETARIAT
Regular *Implementation Reviews* are required under the RMP and AWMP. Computing support is alos required for Comprehensive and in-depth assessments. The Committee is currently about to undertake an *Implementation Review* for the North Pacific common minke whales, and more will follow. The Committee has developed a complex trials structure for *Implementation Reviews*. A key task in this process is to develop and validate the code for the simulation trials that are the core component of this process. Experience has shown that the Secretariat staff alone cannot handle this complete process themselves, so computing support is needed.

RP36 SIMULATING LINE TRANSECT DATA TO INVESTIGATE ROBUSTNESS OF NOVEL ANALYSIS METHODS
The IWC SC has already invested time and money in developing simulated line transect data to evaluate the robustness of the Norwegian minke whale and Antarctic minke whale survey data. This project will update the old code for the simulator to make it more user-friendly so that

Table 31

List of the funding allocations by project recommended by the IWC-SORP Assessment Panel.

ID	Chief Investigator	Title	Requested amount (£)	Recommended amount (£)	Level of funding (Partial/Full)
1	Baker and Steel	Is migratory connectivity of humpback whales in the Central and Eastern South Pacific changing? A decadal comparison by DNA profiling	27,598	26,375 (deducted in house instrument expenses)	P
2	Charrassin	Application of satellite telemetry data to better understand the breeding strategies of humpback whales in the Southern Hemisphere	21,200	21,200	F
3	Branch	Modelling somatic growth and sex ratios to predict population-level impacts of whaling on Antarctic blue whales	32,594	32,594	F
4	Friedlaender and Constantine	Pregnancy rates in Southern Ocean humpback whales: implications for population recovery and health across multiple populations	29,334	19,984 (equipment deducted and some analytical costs)	P
5	Herr	Recovery status and ecology of Southern Hemisphere fin whales (*Balaenoptera physalus*)	82,300	81,900 (equipment deducted)	P
6	Friedlaender and Constantine	A circumpolar analysis of foraging behaviour of baleen whales in Antarctica: Using state-space models to quantify the influence of oceanographic regimes on behaviour and movement patterns	34,711	34,711	F
7	Buchan and Miller	A standardised analytical framework for robustly detecting trends in passive acoustic data: A long-term, circumpolar comparison of call-densities of Antarctic blue and fin whales	43,369	41,369 (publication costs)	P
8	Lang and Archer	Inferring the demographic history of blue and fin whales in the Antarctic using mitogenomic sequences generated from historical baleen	22,710	22,710	F
9	Zerbini and Clapham	Assessing blubber thickness to inform satellite tag development and deployment on Southern Ocean whales	22,646	22,426 (supply costs deducted)	P
10	Širović and Stafford	Acoustic ecology of foraging Antarctic blue whales in the vicinity of Antarctic krill studied during AAD interdisciplinary voyage aboard the *RV Investigator*	34,183	30,107 (airfares deducted)	P
12	Kelly and Maire	Development of statistical and technical methods to support the use of long-range UAVs to assess and monitor cetacean populations in the Southern Ocean	30,576	30,576	F
13	Reisinger and de Bruyn	An integrative assessment of the ecology and connectivity of killer whale populations in the southern Atlantic and Indian Oceans	33,650	33,650	F
14	Bengston Nash	Implementation of humpback whales for Antarctic sea-ice ecosystem monitoring; Inter-program methodology transfer for effective circumpolar surveillance	91,202	51,555 (equipment costs deducted)	P
17	Carroll, Torres, Graham	Circumpolar foraging ecology of southern right whales: past and present	21,290	21,290	F
18	Iñíguez Bessega	Habitat use, seasonality and population structure of baleen and toothed whales in the Scotia sea and the western Antarctic Peninsula using visual and passive acoustic methods and genetics	26,579	23,097 (equipment costs reduced, communication and network costs deducted)	P
		TOTAL	**693,195**	**493,544**	

it can be made available to all SC members and to produce some standard data sets in accordance to the specifications of the ASI sub-committee.

27.1.4 Databases/catalogues

RP01 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. This is one of the most important international collaborations undertaken by the IWC and the cost to the IWC is minimal given the generous contribution of a vessel by Japan and acoustic equipment by the USA . Committee 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 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 2020 Annual Meeting.

RP11 ABUNDANCE ESTIMATES OF THE FRANCISCANA DOLPHIN IN BUENOS AIRES PROVINCE, ARGENTINA

Abundance estimates of franciscanas will be based on a series of aerial surveys along the coast of Buenos Aires Province, with the same survey design of surveys carried out in 2003 and 2004 (Crespo *et al*., 2010). The new estimate will allow comparing density values with those obtained in the previous surveys. This item represents only one third of the funds required for the project, with the remainder being provided by the Government of Argentina.

RP09 GULF OF PENAS, SOUTHERN RIGHT WHALES

Eastern South Pacific (ESP) Southern right whales (SRW) are classified as critically endangered as there are no more than 50 SRW in this population and there is no information on the ESP SRW breeding and feeding grounds. Gulf of Penas is one of the most remote and exposed areas in Chile, with limited access and wild weather that have prevented its exploration. The largest baleen whale mass mortality of almost 400 sei whales occurred in this area and almost remained unnoticed. Recently, a local living nearby the Gulf of Penas recorded the presence of SRWs, including several calves. The Gulf might be the unknown breeding ground of the ESP SRW. This area will be explored during the austral winter breeding season with a group of researchers

Table 32

Workshop proposals agreed during this meeting (TBD: to be decided).

Title	Relevance	Date	Venue
Western gray whale update of CMP and conservation issues within modelling framework	CMP		
Marine debris	E	December 2019	Barcelona, Spain
Noise pre-meeting	E	Pre-meeting 2020	TBD
Cetaceans and ecosystem functioning: a gap analysis*	EM	TBD	TBD
Joint IWC-IUCN workshop to evaluate how the data and process used to identify Important Marine Mammal Areas (IMMAs) can assist the IWC to identify areas of high risk for ship strike	HIM	April 2019	Greece
Comprehensive Assessment of North Pacific humpback whales	NH		
Comparative biology, health, status and future of NA right whales	NH	Late 2019	Boston, USA
Implementation Review: North Pacific minke whales	RMP		
Catch series: Southern right whales	SH	Pre-meeting 2020	TBD
Intersessional workshop of the task team on South Asian river dolphins	SM	Feb 2019	TBD
Guiana dolphin pre-assessment	SM	October 2019	Curitiba, Brazil
Modelling whale watching impacts (MAWI)	WW	December 2019	
POWER planning meeting	ASI	Oct 2018	Tokyo, Japan
Wildmeat workshop	SM	Late 2019/early 2020	Africa
Tagging best practices	ASI	Jun 2018	Seattle, USA

*Japan referred to its statement on the adoption of the Agenda (see Annex Z) and considered that several of the items for the proposed Workshop see (Item 16.4.4) are outside the competence of IWC. Therefore, it cannot support the proposed Workshop or associated funding from the Committee's budget.

and government officers to confirm this finding and if so, start immediately working towards the protection and management of the species and the area.

RP10 POPULATION DYNAMICS OF SOUTHERN RIGHT WHALES AT PENÍNSULA VALDÉS, ARGENTINA: THE INFLUENCE OF KELP GULL LESIONS ON THE HEALTH, CHANGES IN INCREASE AND MORTALITY RATES IN THE CONTEXT OF A DENSITY-DEPENDENT PROCESS

The recent mortality of southern right whales at Península Valdés, Argentina is the highest ever recorded for the species. Understanding the causes is critical to propose management and mitigation actions. Preliminary results from glucocorticoids in baleen from stranded calves show that stress from injuries due to Kelp Gull attacks negatively affects their physiological homeostasis, potentially leading to death. Also, aerial counts show an important reduction in population rate of increase as a whole (from 7% in the past to 0.5% at present), and changes in distribution (mainly of adults) and density along the Argentinian coast.

RP12 PASSIVE ACOUSTIC MONITORING OF THE EASTERN SOUTH PACIFIC SOUTHERN RIGHT WHALE

The Eastern South Pacific southern right whale population is Critically Endangered and in 2012 the IWC adopted a Conservation Management Plan (CMP). Over the years, few opportunistic sightings have been recorded and no breeding area has yet been identified. Until a breeding ground is found many CMP priority actions cannot be implemented. Thus, in 2016 the IWC Scientific Committee decided to support this passive acoustic monitoring (PAM) project to facilitate the identification of potential breeding areas along the coast of Chile and Peru. This project seeks to obtain temporal coverage over a complete annual cycle and spatial coverage depending on the number of sites. The PAM project is likely the most cost-effective way to investigate the seasonal and temporal distribution of southern right whales along the coast of Chile and Peru. The information will be crucial to identify aggregation areas and facilitate the implementation of CMP for this population.

RP13 SAMPLE THE HOLOTYPE SPECIMEN OF *MEGAPTERA INDICA* (GERVAIS, 1883) AT THE MUSÉUM NATIONAL D'HISTOIRE NATURELLE (PARIS)

Several lines of evidence suggest that humpback whales in the Arabian Sea/Northern Indian Ocean comprise a discrete, isolated and non-migratory population that merits a taxonomic revision. Genetic analyses of available samples are now underway in order to determine whether sub-species/species designation is merited. The resultant nomenclature will necessarily draw on a description of the type specimen of *Megaptera indica*, which is held at the Muséum National d'Histoire Naturelle in Paris. This work will develop an approach for examining and sampling this specimen so that the taxonomy of Arabian Sea humpback whales can be accurately defined, better informing regional conservation efforts, highly relevant to the IWC's stated interest in the establishment of a Conservation Management Plan for Arabian Sea humpback whales.

RP14 ASSESSING ISOLATION OF THE ARABIAN SEA HUMPBACK WHALE POPULATION AND CONTINUITY ACROSS THE ARABIAN SEA THROUGH GEOGRAPHIC VARIATION IN SONG

A study of geographic variation in humpback whale song indicates that the Arabian Sea song from Oman is distinct from the Southwest Indian Ocean (SWIO) song, and evidence from a small Indian sample suggesting continuity in song between the western and eastern Arabian Sea. This work will be followed up on with a detailed comparison of song across the Arabian Sea and continued assessment of song differences with the SWIO: The project will (1) assess the connectivity of Arabian Sea humpback whales from Oman to India by comparing existing samples of song between the two regions from several different years; and (2) assess and re-examine the differences in song exhibited between Oman and the SWIO with more recent data, particularly in light of evidence that SWIO singers were found off Oman during the Boreal summer of 2012.

RP15 A QUANTITATIVE ASSESSMENT OF THREATS TO ARABIAN SEA HUMPBACK WHALES USING EXISTING PHOTOGRAPHIC AND UAV DATA

The research will assess the prevalence of anthropogenic and natural threats to Arabian Sea humpback whales through a robust and quantitative assessment of available photographic data. These data include the entire Oman photo-ID catalogue, imagery recently acquired using UAVs (drones) and images provided by third parties. The latter include several images from elsewhere in the populations range. The project will provide an assessment of the relative prevalence of a suite of indices typically associated with major threats (fisheries entanglements, ship-strikes, other scars) as well as scars

Table 33

Summary of budget requests for the 2019-20 period. For explanation and details of each project see text.

RP no.	Title	Sub-committee/ working group	2019 (£)	2020 (£)
Invited Participants				
	Invited Participants - SC/68a and SC/68b	SC	85,000	65,000
Meeting/Workshop				
RP16	Western gray whale update of CMP and conservation issues within modelling framework	CMP	10,500	0
RP06	Marine debris	E	0	20,000[1]
RP05	Noise pre-meeting	E	0	12,000
RP08	Cetaceans and ecosystem functioning: a gap analysis	EM	0[2]	0
RP17	Joint IWC-IUCN workshop to evaluate how the data and process used to identify Important Marine Mammal Areas (IMMAs) can assist the IWC to identify areas of high risk for ship strike	HIM	10,000	0
RP19	Comprehensive Assessment of North Pacific humpback whales	NH	1000[3]	0
RP37	Comparative biology, health, status and future of NA right whales	NH		20,000
RP21	*Implementation Review*: North Pacific minke whales	RMP	13,000[4]	15,000
RP29	Catch series: Southern right whales	SH	0	15,800
RP25	Intersessional workshop of the task team on South Asian River dolphins	SM	7,000[5]	0
RP26	Guiana dolphin pre-assessment	SM	0	9,990
RP27	Modelling whale watching impacts (MAWI)	WW	0	17,000[6]
Modelling/computing				
RP20	In Depth Assessment of North Pacific sei whales	ASI	5,000	0
RP22	Develop an age-structured emulator for the individual-based energetics model (IBEM)	RMP	7,000	0
RP23	Essential computing support	RMP	11,500	11,500
RP36	Simulating line transect data to investigate robustness of novel analysis methods	ASI	6,000	0
Research				
RP01	IWC-POWER cruise	ASI	22,500[7]	22,500[8]
RP11	Abundance estimates of the franciscana dolphin in Buenos Aires province, Argentina	CMP	7,100	0
RP09	Gulf of Penas, Southern right whales	CMP	0	0[9]
RP10	Population dynamics of southern right whales at Península Valdés, Argentina	CMP	19,130	0
RP12	ES Pacific Southern right whales acoustic monitoring	CMP	13,700	16,800
RP13	Sample holotype specimen of *Megaptera indica* at the Muséum National d'Histoire Naturelle (Paris)	CMP	0	1,975
RP14	Assessing isolation of Arabian Sea humpback whales and continuity across the Arabian Sea through geographic variation in song	CMP	16,400	0
RP15	Quantitative assessment of threats to Arabian Sea humpback whales using existing photographic and UAV data	CMP	9,500	0
RP24	Collaborative analysis of WNP minke whale stock structure	SD-DNA	6,247	0
RP28	Updated catch series and assessments of four pygmy blue whale populations	SH	0[10]	12,865
RP30	Multi-ocean analysis of southern right whale demographic parameters and environmental correlates	SH	13,600	13,600
RP31	Southern Hemisphere fin whale song	SH	0	12,000
RP34	Photo-Identification information placards for naturalists and citizen scientists	SH	1000	0
RP07	IWC strandings initiative – emergency response and investigations	E	4,500	4,500
Databases				
RP18	Ship strikes database coordinator	HIM	7,000[11]	7,000[12]
RP33	Antarctic Blue Whale Catalogue: comparison of new photographs from 2014-20	SH	3,000	800
RP32	Southern Hemisphere blue whale photo catalogue	SH	16,810	3,000[13]
RP38	Secretariat database management	SC	3,000	3,000
Reports				
RP03	Mercury in cetaceans	E	0[14]	0
RP04	State of the Cetacean Environment Report	E	3,000[15]	3,000[16]
RP02	Amendment of RMP Guidelines to incorporate spatial modelling approaches to estimate abundance	RMP	3,000	0
General items				
	Implementation: resolutions and instructions from Commission & follow up from previous years' recommendations	SC	10,313	28,470
Total request			**£315,800**	**£315,800**

Notes: [1]Budget was reduced from £22,200. [2]£20,300 was the expected financial need for 2019 but savings from 2018 allowed for the reduced budget of £0. [3]£11,400 was the expected financial need for 2019 but savings from 2018 allowed for the reduced budget of £1,000. [4]£15,000 was the expected financial need for 2019 but savings from 2018 allowed for the reduced budget of £13,000. [5]Budget was reduced from £8,958. [6]£20,000 was the expected financial need for 2020 but financial savings for 2018 allowed for the reduced budget of £17,000. [7]£32,500 was the expected need for 2019 but financial savings from 2017 allowed for the reduced budget of £22,500. [8]£32,500 was the expected need for 2020 but financial savings from 2018 allowed for the reduced budget of £22,500. [9]The requested budget was £15,000 but further information is required before funding can be considered. The project will be re-evaluated at the 2019 SC meeting. [10]£6,185 was the expected financial need for 2019 but financial savings from 2018 allowed for the reduced budget of £0. [11]Budget was reduced from £10,000. [12]Budget was reduced from £10,000. [13]Funding of approximately £7,280 may be requested for 2020 next year depending on progress. [14]£4,000 was the expected financial need for 2019 but savings from 2018 allowed for the reduced budget of £0. [15]Budget was reduced from £4,000. [16]Budget was reduced from £4,000.

associated with natural sources (barnacles, cyamids, Penella sp., killer whales). Project outcomes will include assessment of the risks posed by each threat, as well as the development of a set of metrics with which further changes can be monitored. Project results will be reported to the IWC SC in 2019 and will contribute to the development of a draft Conservation Management Plan for this population.

RP24 COLLABORATIVE ANALYSIS OF WNP MINKE WHALE STOCK STRUCTURE USING JAPANESE MICROSATELLITE DNA DATABASE AND SPATIALLY EXPLICIT POPULATION STRUCTURE ANALYSES.

This item will help address the recommended 'analysis 2' from the report of the workshop on Western North Pacific common minke whale stock structure (SC/67b/

Rep05) in support of the next intersessional meeting on WNP common minke whale stock structure. This specific aspect of the work will apply spatially explicit population structure analyses that provide greater power than the program STRUCTURE together with geographic context. The data will be analysed as a total dataset (not based on any assignment in STRUCTURE), but also include temporal subdivision to assess possible seasonal changes in patterns of connectivity. The latter aspect may be critical to understanding the true pattern of structure, but it will also be the most time-consuming, requiring extensive replication of the analyses. The results of these analyses will provide an assessment of structure in the context of biogeography using methods that have considerably more power than the program STRUCTURE and using an approach that will consider temporal patterns of movement.

RP28 UPDATED CATCH SERIES AND ASSESSMENTS OF FOUR PYGMY BLUE WHALE POPULATIONS

The SH sub-committee is conducting in-depth assessments of populations of Southern Hemisphere blue whales. Assessments have previously been conducted for two of the six populations (Antarctic blue whales, and Chilean blue whales), but not for the four pygmy blue whale populations addressed by this research. This project will provide crucial catch separation data and associated uncertainty needed to conduct stock assessments and provide the first stock assessments for each of the four populations. Such data are critical inputs for the assessments planned by the SC.

RP30 MULTI-OCEAN ANALYSIS OF SOUTHERN RIGHT WHALE DEMOGRAPHIC PARAMETERS AND ENVIRONMENTAL CORRELATES

This study aims to compare population demographics of southern right whales in Southern Hemisphere wintering grounds and investigate correlations between reproductive success and abundance trends, and environmental variables. This study is a component of the proposed SORP project - The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale.

RP 31 ANALYSIS OF FIN WHALE SONG VARIABILITY ACROSS SOUTHERN HEMISPHERE

Fin whale songs consist of short pulses repeated at regular interpulse intervals (IPIs). These songs have been suggested as a tool to distinguish populations. Features that have be used for fin whale song separation include: spectral structure of individual pulses; their patterning; the IPIs; and presence of a higher frequency component of the pulses. Based on this higher frequency component, there appear to be two fin whale song types in the Southern Ocean. We propose to use a combination of song feature measurements to identify whether fin whale songs in the Southern Hemisphere could be indicative of population structure. Data to be used include recorders deployed in the Western Antarctic Peninsula, Weddell Sea, and Eastern Antarctica (Kerguelen and Casey) from 2014-16. Additional SH lower-latitude recordings are available in southeastern Pacific and South Indian Ocean. Overall, the analysis will enable a comprehensive review of fin whale song variability across the SH.

RP34 PHOTO-IDENTIFICATION INFORMATION PLACARDS FOR NATURALISTS AND CITIZEN SCIENTISTS

Pre-cruise training and reference placards describing examples of photo-identification subjects (large whales) will be developed for distribution to the tourist vessel industry in the South Georgia and Antarctic Peninsula region. Information will include primary ID features used for seven species likely to be encountered; right, blue, sei, fin, humpback, sperm and killer whales (key species). A Powerpoint presentation will be developed for distribution to naturalists working on tourist vessels, to orient them and their clients to the basics of whale identification photography. Minimal training is required for a considerable improvement to the quality of identification photographs that are collected by naturalists and citizen scientists and ultimately provided to the established photo-ID catalogues from the region. A formal collaboration with the global photo-ID platform, HappyWhale will be established.

RP07 IWC STRANDINGS INITIATIVE – EMERGENCY RESPONSE AND INVESTIGATIONS

Over the next two years, the Emergency Response and Investigations fund will support response, collection of data to determine the cause(s) or contributing factors for the event and/or to fill critical data gaps identified by the SC or Commission. The Initiative will be evaluated annually and policies and procedures adapted according to feedback from responses and through Steering Group/Expert Panel advice.

27.1.5 Databases and catalogues

RP18 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.

RP33 ANTARCTIC BLUE WHALE CATALOGUE: COMPARISON OF NEW PHOTOGRAPHS FROM 2014-2020

In year one (2019) this project will compare the identification photographs of an estimated 45 individual Antarctic blue whales collected during ICR cruises 2014-17, to the Antarctic Blue Whale Catalogue. These identifications would increase the size of the catalogue (458 individuals) by almost 10%. In year two (2020) additional photos representing approximately 12 IDs are expected from collaborating scientists and citizen scientists that will be compared to the catalogue. The expected outcome is an expanded dataset that may improve estimates of population abundance and reveal new information on movement patterns.

RP32 SOUTHERN HEMISPHERE BLUE WHALE PHOTO CATALOGUE

The Southern Hemisphere Blue Whale Catalogue (SHBWC) is an international collaborative effort to facilitate cross-regional comparison of blue whale photo-identifications catalogues. To date more than 1,500 individual blue whales have been contributed to the SHBWC from researchers groups working on areas off Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific, Australia, Timor Leste, New Zealand, Madagascar and Sri Lanka. Therefore, the SHBWC has become the largest repository of Southern Hemisphere blue whale photo-identifications. Results of comparisons among different regions will improve the understanding of basic questions relating to blue whale populations in the Southern Hemisphere such as defining population boundaries, migratory routes, visual health assessments, and to model abundance estimates.

The results will contribute primarily to the IWC Southern Hemisphere blue whale assessments.

RP38 DATABASE MANAGEMENT
The IWC Secretariat hosts several databases for the SC. These have annual service costs associated with them including, web/database servers, storage, backups, software licences and other associated infrastructure or costs.

27.1.6 Reports

RP03 MERCURY IN CETACEANS: BIOGEOCHEMICAL CYCLING, TOXICOLOGICAL IMPACTS
In response to the Commission resolution on mercury, the objective of the work is to comple the global review of mercury in cetaceans, resulting in the documentation and mapping of decadal trends. The Scientific Committee will also invite experts in mercury in the environment and its cycling and in mercury and selenium cetacean toxicology to participate to provide further detail and interpretation of the current status and potential impact of mercury on cetacean populations at an ocean basin scale.

RP04 PRODUCTION OF ANNUAL STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) FOR THE SCIENTIFIC COMMITTEE AND COMMISSION (2019 AND 2020)
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 Atlantic Ocean (2019) and the Pacific Ocean (2020). It will, in both years, also present key current global developments that are affecting the cetacean environment. It will also contain a glossary of technical terms used and species names. A 5-year compendium spanning all regions is also being produced.

RP02 AMENDMENT OF THE RMP GUIDELINES TO INCORPORATE SPATIAL MODELLING APPROACHES TO ESTIMATE ABUNDANCE
The ‘Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme’, referred to as the ‘RMP Guidelines’ (IWC, 2012) constitutes a document prepared by the Scientific Committee to state the requirements and to guide the collection and analysis of survey data to compute abundance estimates for use in the Revised Management Procedure (RMP). Currently this document provides detailed guidance for developing estimates using design-based line transect shipboard and aerial surveys. Amendments are required to consider other methods, for example, model-based analysis of survey data and mark-recapture models. This project will update the RMP Guidelines as required by the Scientific Committee. This update will be completed in consultation with the project’s steering committee and presented for consideration of the SC by SC68b. The expected outcome is a new, revised document of with the ‘RMP Guidelines’.

27.1.7 General items

***IMPLEMENTATION*: RESOLUTIONS AND INSTRUCTIONS FROM COMMISSION AND FOLLOW UP FROM PREVIOUS YEARS’ RECOMMENDATIONS**

This line is required to accommodate additional work requested by the Commission at IWC67 and work generated by meetings, workshops and projects funded and concluded in the first year (2019). This line can also accommodate new project proposals generated during the 2019 Scientific Committee meeting.

28. WORKING METHODS OF THE COMMITTEE

28.1 Rules of Procedure of the Scientific Committee

Attention: C, S

As per usual practice in the last biennium the Committee has been reviewing its working methods to improve transparency and align its processes with the biennial pace of the Commission. These changes and a number of changes that were made in previous years and approved by the Commission (i.e. SORP Voluntary Fund, new process to allocate and manage the Research Fund and the Small Cetacean Voluntary Fund Rules of Procedure) require a number of adjustments and additions to the Commission Rules of Procedure, Financial Regulations and Scientific Committee Rules of Procedure. The Committee ***agrees*** *to submit all proposed amendments to the Commission for its consideration (Annex W).*

The updated Rules also refer to the online ‘Scientific Committee Handbook’ that has been updated at this meeting. The Committee ***requests*** *the Secretariat to post the updated version online as soon as feasible. The Committee also* ***agrees*** *to that a pdf version of the Handbook be made available as a document for the Commission meeting.*

28.2 Biennial reporting and related matters

At its 2015 meeting, the Joint Conservation Committee and Scientific Committee Working Group (Joint CC/SC WG) agreed to undertake a collation and analysis of conservation-relevant recommendations from the Scientific Committee and organise these recommendations into key issues/ areas highlighting those that feature regularly, including the creation of a pilot database. Double, Convenor of the Global Databases and Repositories Steering Group (GDR), presented an update on the development of this database. The Scientific Committee is fully engaged in this process and, this year, a standing agenda item was added to all sub-committee agendas to ensure a regular, more formal review of progress in delivering recommendations than was the case in the past.

Attention: SC, CC

The Committee ***welcomes*** *the development of the IWC Database of Recommendations, noting that this tool will give recommendations more prominence and improve the ability to measure progress. The Committee* ***agrees*** *to:*

(1) continue to improve its standardised way to present recommendations to include core information[13] to facilitate input into the database; and
(2) to work closely with the Secretariat to assist with the overall process of data entry.

28.3 Additional proposals for revisions to ‘Annex P’

The Committee continued this year the work begun last year to update Annex P in response to Commission Resolution 2016-2 and recommendations by previous Expert Panels.

Attention: C-R, SC,

The Committee ***recommends*** *the revisions to the previous Annex P reported in Annex P in response to Resolution 2016-2 and recommendations made by Expert.*

[13]IWC/MAY18/CCSC/01

Table 34

Summary of requests under the Data Availability Agreement.

Date	Requested by	Objective/subject	Outcome
June 2015	De la Mare Australia) – Procedure B	(a) Consistent with recent advice of the Scientific Committee with particular respect to minke whale nutritive condition analyses, to develop a set of models that best capture the Committee's previous recommendations, taking into account the structure of the underlying processes giving rise to the data; and (b) to provide analyses relevant to the determination of sample sizes for detecting specified trends in the age at sexual maturity (ASM).	SC/66b/EM02, SC/67a/EM01, SC/67a/EM02, SC/67a/EM03, SC/67a/EM04, SC/67a/EM07, SC/67a/EM08, SC/67b/EM01rev1, SC/67b/EM02, SC/67b/EM03, SC/67b/EM08. See EM Annexes, 2016 to 2018. Differing results between research groups about changes in body condition of Antarctic minke whales .
January 2018	Baker (USA)	The intent of the request is to examine plausible stock hypotheses. Analyses will rely primarily on tests of Hardy-Weinberg expectations, exact tests of differentiation, randomised Chi-squared tests (contingency tables), Analyses of Molecular Variance (AMOVA), as well as mixed-stock analyses, clustering methods and kinship (parent offspring pairs), to investigate dispersal and differences in haplotype frequencies, genotypes and sex for various geographic and temporal strata.	On-going

28.4 Succession plan for key Scientific Committee experts

Last year, the Committee had identified the need to consider 'succession planning' for key participants, particularly in relation to the *Implementation Reviews* and assessment processes. Informal discussions continued informally during the intersessional period and invitations were issued to three modellers to evaluate their interest in becoming active members of the IWC Scientific Committee, but only one could attend. Concern regarding succession planning of these other key positions on the Committee still remains and an intersessional group has been re-established to look at this and report back to the Committee next year (Annex Y). The Committee also refers to its discussion related to a Deputy Head of Science in its review if the governance report (see Item 28.6.2).

28.5 Update on Data Availability requests

Suydam provided a summary of requests received under the Data Availability Agreement shown in Table 34.

28.6 Any other matters

28.6.1 Welfare Assessment Tool

Since our last discussion in 2015 on animal welfare related matters relevant to the Committee (IWC, 2016, p.86), Dr. Nicol (Professor of the Royal Veterinary College, London) developed a 'Welfare Assessment Tool' following the recommendations of the Workshop to 'Develop Practical Guidance for the Handling of Cetacean Stranding Events' (South Africa, 2016) on this matter. This year, the Committee received a report from Nicol on the latest phase of the development of such a tool, that is being developed to help assess non-hunting related threats in the context of the IWC's Welfare Action Plan and in a joint project between the RVC and Humane Society International, supported by the UK Department for Environment, Food and Rural Affairs (Defra). The approach is based on application of the 'five domains model' (Beausoleil and Mellor, 2015; Mellor *et al*., 2015) and two hypothetical case studies have been explored, one related to marine debris and the other to whale-watching.

Trial assessments were presented and the Scientific Committee was asked for assistance and advice in the development of real examples for consideration. The Committee welcomed the information provided and further discussions were held informally. The Tool was also considered by the Whale Watching Subcommittee (see Annex N) and will be presented for consideration by the Commission at the next meeting of the Working Group on Whale Killing Methods and Associated Welfare Issues.

28.6.2 Review of the IWC review report

The final report from the Governance Review was released on the 16th April 2018 (downloadable here: https://archive.iwc.int/?r=6890). The Independent Review Panel report represents the view of the three panellists, based on a survey, in-person interviews and analysis of documents. It represents only the first step of the Governance Review process. The Chair of the Operational Effectiveness Working Group of the Finance and Administration Committee asked the Scientific Committee to provide a voluntary feedback to the Commission on recommendations related to the Committee.

The Scientific Committee formed an *ad hoc* Working Group to develop an initial response, which was then discussed in Plenary. The initial WG membership was restricted to the Scientific Committee Chair and Vice Chair, all Heads of Delegations present at the meeting, sub-groups Convenors that are also delegates, and former Scientific Committee Chair present at the meeting. This subset represented the view of Committee members that, given their roles, had a strong knowledge on the current and past structure and procedures of the Committee. More delegates and invited participants joined the discussion in Plenary. The final version of this preliminary feedback, which has the support of all 32 delegations attending the meeting and additional members of the Scientific Committee is provided in Annex X.

The Scientific Committee organised its discussion and feedback on Review Panel's recommendations and comments around five mutually exclusive subject areas (pre-eminence of the Scientific Committee, IWC strategic planning, communication, Scientific Committee function in relation to Commission and other subsidiary bodies, Secretariat function in relation to the Scientific Committee). Within each subject area, those recommendations of perceived importance to the WG were identified. Where feasible, a timeline for developing a response was proposed.

Attention: C, SC

Given the fact that both the Chair of the Commission (Morishita) and the Chair of the F&A Working Group on Operational Effectiveness (Phelps) reminded the Committee that the Commission has not yet decided the fate of the 'IWC review report', nor has yet requested a full engagement by the Committee, the Committee ***agrees*** *to submit the preliminary* *feedback on the report (Annex X) for the Commission's consideration.*

In addition, given the productive exchange of opinions and ideas on several aspects of the Committee working methods that occurred in during its discussions, the Committee ***agrees*** *to establish an Intersessional Correspondence Group on 'Improving on-going working practices of the IWC Scientific Committee' under DeMaster (see Annex Y). The ICG will provide a written summary of its proposals to the Scientific Committee 60 days prior to the start of the annual meeting of the Scientific Committee in 2019. This ICG will also be in charge dealing with the preparation of a draft document for the follow-up on Governance Review, should the Commission instruct the Committee to do so at its next biennial meeting.*

28.6.3 Additional discussion on other issues related to the Committee working procedures

A number of suggestion for improving the ability to follow a topic during the Scientific Committee meeting were discussed by the Committee and the Convenors group. In order to facilitate the full participation of members of the Committee to various sub-groups and, especially, to the discussion of cross-cutting issues relevant to different groups, the Committee agrees that next years the Convenors should: (a) organise joint-sessions early in the meeting and release draft reports of those discussion, as soon as feasible; (b) adopt a simple coding system for 'hot topics' (e.g. North Pacific common minke whales: NPMW, Antarctic minke whales: AMW; biopsy sampling; etc.), which will be included in the daily timetable together or instead of the Agenda item. The Convenors group will carefully consider these issues intersessionally.

29. PUBLICATIONS

The Secretariat reported on the excellent progress made with the *Journal* this year, and in particular that the previously noted backlog has now been dealt with. This has been particularly assisted by the excellent work of the new Associate Editors including Fortuna, Leaper, New, Jackson, Punt, Tiedemann, Zerbini. The Committee **thanked** the Publications Team for its dedication and hard work and **reiterated** the importance of the *Journal* and *Supplements* to its work.

30. ELECTION OF OFFICERS

This was the final year of office for the Chair (Fortuna) and the Vice-Chair (Suydam). In accordance with its Rules of Procedure, the Vice-Chair becomes the new Chair for the next three years. The Committee elects Zerbini (Brazil) to be the new Vice-Chair by consensus. The outgoing Chair will provide the formal report to IWC67 in Florianopolis, Brazil of the SC Reports from the 67a and 67b SC meetings.

The Committee rose in appreciation to thank the outgoing Chair. It wished to formally record its immense gratitude for her excellent leadership over the past three years. Dr. Fortuna's scientific and organizational skills provided a lasting legacy to the Committee. She adeptly faced the many complex and challenging issues during her term and tremendous progress has been made for the benefit of the entire Commission in meeting its science and stewardship objectives. The Chair, Head of Science, and Executive Secretary of the Commission added their thanks and congratulations to the many participants expressing their appreciation to Dr. Fortuna.

The Committee also welcomed with enthusiasm the new team of Suydam and Zerbini and looked forward to working with them over the next three years.

31. ADOPTION OF REPORT

The Committee adopted the report at 17:45 hrs on 6 May 2018, apart from the final items discussed during the last session. As is customary, these items were agreed by the Chair, rapporteurs and convenors. The Chair thanked the participants for their scientific contributions as well as their constructive dialogue. Given the sensitivity of several agenda items, this positive approach helped ensure that all views could be presented and rigorously discussed for a productive outcome. The Chair especially thanked the convenors, rapporteurs, Head of Science, and Vice-Chair for their excellent assistance. Finally, she reiterated her thanks to the government of Slovenia and the hotel staff for the facilities and great service, which contributed greatly to the success of the meeting.

Fortuna concluded that it had been an honour to serve as the IWC Scientific Committee Chair over the past three years. She expressed her gratitude for all the support provided by so many as she led this effort. She voiced her thanks for the Secretariat, and in particular her deep appreciation for the guidance provided by the Head of Science (Donovan) without whom she could not have accomplished her work.

Suydam congratulated Fortuna for having expertly led the Scientific Committee as their Chair over the past three years. He noted that the praise and applause from the participants in the room were well very much deserved given her outstanding leadership. Suydam noted that it will be a particular challenge to follow the incredible example set by Fortuna and thanked her for her mentorship. The Executive Secretary (Lent) added to these words of gratitude and commendation on behalf of the Secretariat and wished her all the best. She also offered the full support of the Secretariat to the incoming SC Chair Suydam.

Echoing the sentiments raised under Item 30, participants thanked the Chair for her adept, fair and efficient handling of the meeting, her unflagging dedication and her great contribution to the effective working of the Committee.

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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

4. Cooperation with other organisations
   - 4.1 African States Bordering the Atlantic Ocean (ATLAFCO)
   - 4.2 Arctic Council
   - 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)
   - 4.6 Convention on International Trade in En-dangered 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 Organization (PICES)
   - 4.15 Protocol on Specially Protected Areas and Wildlife of the Cartagena Convention for the Wider Caribbean (SPAW)

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 $MSYR_{mat}$
   - 5.2 Implications of *IST*s for consideration of species' and populations' status
   - 5.3 General consideration of how to evaluate the effect of special permit catches on stocks
   - 5.4 Work plan 2019-20

6. RMP – *Implementation*-related matters
   - 6.1 Completion of the Implementation Review of western North Pacific Bryde's whales
   - 6.2 Start of the Implementation Review of western North Pacific common minke whales
   - 6.3 Work plan 2019-20

7. Aboriginal Subsistence Whaling Management Procedure (AWMP)
   - 7.1 *SLA* development for the Greenlandic hunts
     - 7.1.1 Fin whales
     - 7.1.2 Common minke whales
     - 7.1.3 Bowhead whales
   - 7.2 Aboriginal whaling management scheme
   - 7.3 Implementation Review
     - 7.3.1 B-C-B bowhead whales
     - 7.3.2 Review schedule for next six years
   - 7.4 Work plan 2019-20

8. Stocks subject to aboriginal subsistence whaling including management advice (AWMP)
   - 8.1 Eastern Canada and West Greenland bowhead whales
   - 8.2 North Pacific gray whales
   - 8.3 Bering-Chukchi-Beaufort Seas bowhead whale
   - 8.4 Common minke whale stocks off East Greenland
   - 8.5 Common minke whale stocks off West Greenland
   - 8.6 Fin whales off West Greenland
   - 8.7 Humpback whales off West Greenland
   - 8.8 Humpback whales off St Vincent and The Grenadines

9. Whale stocks not subject to directed takes
   - 9.1 In-depth Assessments (IA)
     - 9.1.1 Comprehensive assessment of North Pacific humpback whales
     - 9.1.2 In-Depth Assessment of North Pacific sei whale
     - 9.1.3 In-Depth Assessment of Indo-Pacific Antarctic minke whales
     - 9.1.4 Work plan 2019-20
   - 9.2 Evaluation for potential new In-Depth Assessments
     - 9.2.1 North Pacific blue whales
     - 9.2.2 Non-Antarctic Southern Hemisphere blue whales
     - 9.2.3 Antarctic blue whales (Areas III and IV)
     - 9.2.4 Southern Hemisphere fin whales
     - 9.2.5 North Atlantic sei whales
     - 9.2.6 North Atlantic right whales
     - 9.2.7 North Pacific right whales
     - 9.2.8 Work plan 2019-20
   - 9.3 New information and work plan for other Northern stocks
     - 9.3.1 North Pacific fin whales
     - 9.3.2 Omura's whale

9.3.3 North Atlantic Bryde's whales
9.3.4 North Atlantic blue whales
9.3.5 North Atlantic humpback whales
9.3.6 North Atlantic bowhead whales not subject to aboriginal subsistence whaling
9.3.7 North Pacific bowhead whales not subject to aboriginal subsistence whaling
9.3.8 North Pacific sperm whales
9.3.9 Other stocks- Northern Indian Ocean sperm whales
9.3.10 Work plan 2019-20
9.4 New information and work plan for other Southern stocks
9.4.1 Southern Hemisphere sei whales
9.4.2 Southern Hemisphere humpback whales
9.4.3 Southern Hemisphere right whales not the subject of CMPs
9.4.4 Antarctic minke whales
9.4.5 Dwarf minke whales
9.4.6 Southern Hemisphere Bryde's whales
9.4.7 Southern Hemisphere sperm whales
9.4.8 Work plan 2019-20

10. Stocks that are or have been suggested to be the subject of Conservation Management Plans (CMPs)
10.1 Stocks with existing CMPs
10.1.1 South East Pacific southern right whales
10.1.2 South West Atlantic southern right whales
10.1.3 North Pacific gray whales
10.1.4 Franciscana
10.2 Progress with identified priorities
10.2.1 Humpback whales in the northern Indian Ocean including the Arabian Sea
10.2.2 Other species/populations
10.3 Work plan 2019-20

11. Stock definition and DNA testing
11.1 DNA testing
11.1.1 Genetic methods for species, stock and individual identification
11.1.2 'Amendments' of sequences deposited in *GenBank*
11.1.3 Collection and archiving of tissue samples from catches and bycatches
11.1.4 Reference databases and standards for diagnostic DNA registries
11.2 Guidelines for DNA data quality and genetic analyses
11.2.1 Update DNA quality guidelines to include discussion of NGS data
11.3 New statistical and genetic issues concerning stock definition
11.3.1 Simulation tools for spatial structuring (e.g. TOSSM)
11.3.2 PCA, DAPC, and related methods
11.3.3 Terminology
11.3.4 Close-kin mark-recapture
11.3.5 Epigenetic ageing
11.4 Update on previous recommendations
11.5 Work plan 2019-20

12. Cetacean abundance estimates, stock status
12.1 Summary of abundance estimates and update of IWC consolidated table
12.2 Methodological issues
12.2.1 Model-based abundance estimates (and amendments to RMP Guidelines)
12.2.2 Review new survey techniques/equipment
12.3 Consideration of status of stocks
12.4 Update on previous recommendations
12.5 Work plan

13. Bycatch and entanglements
13.1 Review new estimates of entanglement rates, risks and mortality (large whales)
13.2 Reporting of entanglements and bycatch in National Progress Reports
13.3 Mitigation measures for preventing large whale entanglement
13.4 Review proposal for global entanglement database
13.5 Estimation of rates of bycatch, risks of, and mortality for small cetaceans
13.6 Scientific aspects of mitigation measures for small cetaceans
13.6.1 The IWC Bycatch Mitigation Initiative
13.6.2 Collaboration with FAO on bycatch related issues
13.6.3 Measures to mitigate bycatch of small cetaceans
13.7 New information on cetacean bycatch in the Western, Central and Northern Indian Ocean
13.8 Update on previous recommendations
13.9 Work plan 2019-20

14. Ship strikes
14.1 Review estimates of rates of ship strikes, risk of ship strikes and mortality
14.1.1 Review progress on ship strike database
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
14.2.2 Consideration of methods to identify 'high risk' areas
14.3 Co-operation with IMO Secretariat and relevant IMO committees
14.4 Update on previous recommendations
14.5 Work plan 2019-20

15. Environmental concerns
15.1 Pollution 2020
15.1.1 Review on intersessional progress on the pollution 2020 project
15.1.2 Report on mercury in cetaceans
15.1.3 Impact of heavy fuel oils on cetaceans
15.2 Cumulative impacts
15.3 Diseases of concern
15.4 Strandings amd mortality events
15.4.1 Update on the IWC Strandings Initiative
15.4.2 New information on unusual mortality events
15.5 Noise
15.6 State of the Cetacean Environment Report – SOCER
15.7 Update on other stranding topics
15.7.1 Marine Debris
15.7.2 Climate change
15.8 Update on previous recommendations
15.9 Work plan 2019-20

16. Ecosystem modelling
    - 16.1 Co-operation with CCAMLR on multispecies modelling
        - 16.1.1 Review ecosystem modelling in the Antarctic Ocean
        - 16.1.2 Update on cooperation with CCAMLR, including the plan for a joint SC-CAMLR-IWC SC workshop
    - 16.2 Applications of species distribution models (SDMS) and ensemble averaging
        - 16.2.1 Review progress of guideline for SDMs
        - 16.2.2 Review progress of work on SDMs and ensemble modelling
    - 16.3 Modelling of competition among whales
    - 16.4 Standing topics
        - 16.4.1 Effects of long-term environmental variability on whale populations
        - 16.4.2 Update on body condition analyses for the Antarctic minke whales
        - 16.4.3 Review the information on krill distribution and abundance by NEWREP-A
        - 16.4.4 Ecosystem services
    - 16.5 Update on previous recommendations
    - 16.8 Work plan 2019-20

17. Small cetaceans
    - 17.1 Review of small cetaceans in rivers and estuaries of South America
        - 17.1.1 Boto
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    - 17.2 Review on progress on *Tursiops* taxonomy
    - 17.3 Poorly documented hunts of small cetaceans for food, bait or cash and changing patterns of use
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    - 17.4 Small cetacean task team
        - 17.4.1 Progress on South Asian river dolphins Task Team
        - 17.4.2 How to address emerging issues within the sub-committee
    - 17.5 Review takes of small cetaceans
        - 17.5.1 New information on direct takes and live captures
    - 17.6 Update on previous recommendations
        - 17.6.1 Māui dolphin
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    - 17.7 Status of the voluntary fund for small cetacean conservation research
    - 17.8 Work plan 2019-20

18. Whale watching
    - 18.1 Assess the impacts of whalewatching and swim-with-whale operations on cetaceans
        - 18.1.1 Review report of the workshop on Modelling and Assessment of Whale Watching Impacts (MAWI)
        - 18.1.2 Studies on assessing impacts
        - 18.1.3 Potential case-studies: status of whale watching in east Africa and wider Indian Ocean
    - 18.2 Five-year strategic plan and joint work with Conservation Committee
        - 18.2.1 Recommendation on the Conservation Committee new five-year strategic plan for whale watching
        - 18.2.2 Recommendation on the online Whale Watching Handbook
        - 18.2.3 Revised Terms of Reference for the sub-committee on whale watching
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    - 18.3 Platform of opportunity data
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19. Special permits
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        - 19.2.1 Report on ongoing research
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        - 19.2.3 Committee conclusions and recommendations
    - 19.3 JARPN II
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20. Whale sanctuaries
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21. Satellite tagging development and best practices

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    - 23.1 Guidelines for IWC catalogues and photo-ID databases
    - 23.2 Progress with existing or proposed new catalogues
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        - 23.2.2 Southern Hemisphere and Indian Ocean humpback whales: catalogues
            - 23.2.2.1 Antarctic Humpback Whale Catalogue (AHWC)
            - 23.2.2.2 Arabian Sea Whale Network's Flukebook
        - 23.2.3 Southern Hemisphere Antarctic and pygmy blue whales: catalogues and databases
            - 23.2.3.1 Southern Hemisphere Blue Whale Catalogue (SHBWC)
            - 23.2.3.2 Antarctic Blue Whale Catalogue (ABWC)
        - 23.2.4 Southern Hemisphere fin whale photo catalogues

- 23.3 Progress with existing IWC databases
  - 23.3.1 IWC catch database
  - 23.3.2 National Progress Report database
- 23.4 Potential future IWC databases
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24. IWC multinational research programmes
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25. Scientific Committee budget for the current biennum
    - 25.1 Status of previously funded research, workshop proposals, data processing and computing needs
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26. Committee priorities and initial agenda for the biennum 2019-20

27. Scientific Committee budget for the biennium 2019-20
    - 27.1 Budget for the next biennium
      - 27.1.1 Invited participants
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28. Working methods of the Committee
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    - 28.2 Biennial reporting and related matters
    - 28.3 Additional proposals for revisions to 'Annex P'
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    - 28.5 Update on Data Availability requests
    - 28.6 Any other matters

29. Publications

30. Election of Officers

31. Adoption of Report

Annex C

List of Documents

SC/67b/ASI

01. Diallo, S.T. and Bamy, I.L. Report of the cetacean sighting survey in the north western Africa coastal waters of COMHAFAT zone (Guinea, Sierra Leone and Liberia). 23pp.
02. Cooke, J.G. AbUndance estimates for western North Pacific gray whales for use with stock structure hypotheses of the Range-wide Review of the Population Structure and Status of North Pacific gray whales. 15pp.
03. Palka, D., Cañadas, A., Donovan, G., De Freitas, L., Gunnlaugsson, T., Herr, H., Pike, G., Víkingsson, G., Weinrich, M. and Zerbini, A.N. Report of the intersessional correspondence group that reviewed the Icelandic humpback whale abundance estimates. 5pp.
04. Tyurneva, O.Y., Yakovlev, Y.M., Vertyankin, V.V., Van Der Wolf, P. and Scott, M.J. Long-term photo-identification studies of gray whales (*Eschrichtius robustus*) offshore northeast Sakhalin Island, Russia, 2002-2017. 16pp.
05. Cooke, J.G., Steel, D., Hamner, R.M., Constantine, R. and Baker, C.S. Population estimates and projections of Maui dolphin (*Cephalorhynchus hectori maui*) based on genotype capture-recapture, with implications for management of mortality risk. 16pp.
06. Hakamada, T., Matsuoka, K., Miyashita, T. and Pastene, L.A. Revised research plan for a dedicated cetacean sighting survey in 2018 and research plan for 2019 under the NEWREP-NP. 13pp.
07. Mogoe, T., Yamaguchi, F., Kawabe, S., Katsumata, T., Kasai, H., Sasaki, Y., Bando, T. and Matsuoka, K. Results of the NEWREP-A dedicated sighting survey during the 2017/18 austral summer season. 30pp.
08. Øien, N. Report of the Norwegian 2017 survey for minke whales within the Small Management Area EB - the Barents Sea. 10pp.
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10. Matsuoka, K., Hakamada, T., Ueda, Y., Kominami, T., Abe, N., Ohkoshi, C. and Miyashita, T. Result of the Japanese dedicated sighting survey in the western North Pacific in 2017. 11pp.
11. Hakamada, T., Matsuoka, K. and Pastene, L.A. Research plan for the NEWREP-A dedicated sighting survey in the Antarctic in 2018/19. 10pp.
12. Matsuoka, K., Taylor, J., Yoshimura, I., Crance, J. and Kasai, H. Cruise report of the 2017 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). 47pp.
13. Matsuoka, K., Miyashita, T., Murase, H., Kitakado, T. and Kato, H. (DRAFT) Proposal for the 2019 and 2020 IWC-Pacific Ocean Whale and Ecosystem Research (POWER). 11pp.

13.rev1. Matsuoka, K., Zharikov, K.A., Miyashita, T., Murase, H., Kitakado, T., Kato, H. and Donovan, G. Proposal for the 2019 and 2020 IWC-Pacific Ocean Whale and Ecosystem Research (POWER). 10pp. REVISED: paper finalised.

14. Allison, C., Butterworth, D.S., Canadas, A., Cooke, J.G., Donovan, G., Freitas, L., Herr, H., Kitakado, T., Matsuoka, K., Mckinlay, J.P., Palka, D., Punt, A.E., Gunnlaugsson, T. And Zerbini, A.N. Report of the intersessional email group on abundance estimates, status and international cruises (ASI). 6pp.
15. Hakamada, T., Matsuoka, K. And Miyashita, T. Updated g(0) estimate for western North Pacific Bryde's whales and its application to previous abundance estimates. 11pp.

15rev1. Hakamada, T., Matsuoka, K. And Miyashita, T. Updated g(0) estimate for western North Pacific Bryde's whales and its application to previous abundance estimates. 11pp. REVISED: editorial changes to Figure 1.

15rev2. Hakamada, T., Matsuoka, K. And Miyashita, T. Updated g(0) estimate for western North Pacific Bryde's whales and its application to previous abundance estimates. 11pp. REVISED: Table 7 has been revised.

16. Gushcherov, P.S., Tiupeleev, P.A., Samonov, V.I. And Miyashita, T. Research plan of the cetacean sighting survey in the north western Sea of Okhotsk in 2018. 6pp.
17. Gushcherov, P.S., Tiupeleev, P.A., Shkarupa, M.A., Makrak, S.V., Samonov, V.I. And Miyashita, T. Cruise report of the cetacean sighting survey in the eastern part of the Sea of Okhotsk in 2017. 26pp.

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01. Givens, G.H., Mocklin, J.A., Brattström, L.V., Tudor, B.J., Koski, W.R., Zeh, J.E., Suydam, R. And George, J.C. Survival rate and 2011 abundance of Bering-Chukchi-Beaufort Seas bowhead whales from photo-identification data over three decades. 24pp.

01rev1. Givens, G.H., Mocklin, J.A., Brattström, L.V., Tudor, B.J., Koski, W.R., Zeh, J.E., Suydam, R. And George, J.C. Adult survival rate and 2011 abundance of Bering-Chukchi-Beaufort Seas bowhead whales from photo-identification data over three decades. 25pp. REVISED: edited.

02. Willoughby, A.L., Clarke, J.T., Ferguson, M.C., Stimmelmayr, R. And Brower, A.B. Bowhead whale carcasses in the Eastern Chukchi and Western Beaufort Seas, 2009-2017. 11pp.
03. Clarke, J.T., Ferguson, M.C., Brower, A.B. And Willoughby, A.L. Bowhead whale calves in the Western Beaufort Sea, 2012-2017. 12pp.
04. Quakenbush, L., Citta, J., George, J.C., Heide-Jørgensen, M.P., Brower, H., Harwood, L., Adams, B., Pokiak, C., Pokiak, J. And Lea, E. Bering-Chukchi-Beaufort stock of bowhead whales: 2006-2017 satellite telemetry results with some observations on stock sub-structure. 26pp.
05. Suydam, R., George, J.C., Person, B., Stimmelmayr, R., Sformo, T., Pierce, L., Von Duyke, A., De Sousa, L. And Sheffield, G. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Natives during 2017. 9pp.
06. Suydam, R. And George, J.C. Subsistence harvest of bowhead whales (*Balaena mysticetus*) taken by Alaskan Natives, 1974 to 2016. 16pp.

07. George, J.C., Suydam, R., Givens, G., Horstmann, L., Stimmelmayr, R. And Sheffield, G. Length at sexual maturity and pregnancy rates of Bering-Chukchi-Beaufort Seas bowhead whales. 10pp.
08. Stimmelmayr, R., George, J.C., Willoughby, A.L., Brower, A.B., Clarke, J.T., Ferguson, M.C., Sheffield, G., Stafford, K., Von Duyke, A., Sformo, T., Person, B., Sousa, L. And Suydam, R. 2017 health report for the Bering-Chukchi-Beaufort Seas bowhead whales - preliminary findings. 26pp.
09. NO PAPER.
10. Reinhart, S. 2018 update to the International Whaling Commission (IWC): Canadian bowhead harvests since 2015. 2pp.
11. NO PAPER.
12. Suydam, R., George, J.C., Ferguson, M.C. And Givens, G. Update on plans for a population survey in 2019 of Bering-Chukchi-Beaufort bowhead whales. 4pp.
13. Witting, L. A candidate SLA for fin whales in West Greenland. 2pp.
13rev1. Witting, L. A candidate SLA for fin whales in West Greenland. 9pp. REVISED: paper completed.
14. Witting, L. A candidate SLA for the common minke whale in West Greenland. 2pp.
14rev1. Witting, L. A candidate SLA for the common minke whale in West Greenland. 9pp. REVISED: paper completed.
14rev2. Witting, L. A candidate SLA for the common minke whale in West Greenland. 15pp. REVISED: edited.
15. Brandão, A. Potential SLAs for West Greenland fin whales testing againts the agreed evaluation trials. 31pp.
16. Ferguson, M.C., Clarke, J.T., Angliss, R., Bengtson, J., Brower, A.B., Citta, J., Clapham, P., Conn, P., Forney, K., George, J.C. And Givens, G. Bering-Chukchi-Beaufort bowhead whale abundance estimation survey workshop report, 4-5 April 2018, Marine Mammal Laboratory, AFSC, NOAA. 24pp.
17. Ilyashenko, V.Y. Needs of Chukotka indigenous people in gray whale harvest products and rationale for updates to the Paragraph 13(b)(2) of the Schedule (the gray whale catch limit). 5pp.
18. Witting, L. On evaluation trials for West Greenland minke whales. 8pp.
19. Denmark/Greenland. Request for advice on Greenlandic hunts. 2pp.
20. Zagrebelnyy, S.V. Whaling in Chukotka from 2013 till 2017. 8pp.
20rev1. Zagrebelnyy, S.V. Whaling in Chukotka from 2013 till 2017. 8pp. REVISE: edited.
21. Givens, G.H., Allison, C., Donovan, G., George, J.C., Scordino, J., Stachowitsch, M., Suydam, R., Tiedemann, R. And Witting, L. Report of the Intersessional Correspondence Group on Drafting an Aboriginal Whaling Scheme. 10pp.
22. Zharikov, K. Aboriginal subsistence whaling in the Russian Federation in 2017. 3pp. WORKING PAPER UPGRADED AFTER MEETING.

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01. Arias, M., Coscarella, M.A., Romero, M.A., Sueyro, N., Svendsen, G.M., Crespo, E.A. And Gonzalez, R.A. Southern Right Whale *Eubalaena australis* recolonizes Golfo San Matías (Patagonia, Argentina). 24pp.
02. Sueyro, N., Crespo, E.A., Arias, M. And Coscarella, M.A. Density-dependent changes in the distribution of southern right whales (*Eubalaena australis*) in the breeding ground Peninsula Valdés. 14pp.
03. Marón, C.F., Di Martino, M., Chirife, A., Beltramino, L., Alzugaray, L., Adler, F.R., Seger, J., Sironi, M., Rowntree, V.J., Lábaque, M.C. And Uhart, M. No evidence of malnutrition in dead southern right whale calves off Argentina as inferred from blubber thickness measurements and lipid content analyses. 12pp.
04. Fernández Ajó, A.A., Hunt, K.E., Uhart, M., Rowntree, V., Sironi, M., Marón, C.F., Di Martino, M. And Buck, C.L. Lifetime glucocorticoid profiles in baleen of right whale calves: potential relationships to chronic stress of repeated wounding by Kelp Gulls. 16pp.
05. Crespo, E.A. And Coscarella, M.A. The Southwestern Atlantic Southern Right Whale, *Eubalaena australis*, population is growing but at a decelerated rate. 17pp.
06. Sironi, M., Rowntree, V.J., Di Martino, M., Alzugaray, L., Rago, V., Maron, C.F. And Uhart, M. Southern right whale mortalities at Península Valdés, Argentina: updated information for 2016-2017. 9pp.
07. Burdin, A.M., Sychenko, O. And Mamaev, M. Gray whale research off northeastern Sakhalin Island and Eastern Kamchatka, Russia, in 2017. 11pp.
08. Jacobs, E., Duffy, M., Magolan, J., Galletti Vernazzani, B., Cabrera, E., Landea, R., Buchan, S. And Sayigh, L. First acoustic recordings of critically endangered eastern South Pacific southern right whales (*Eubalaena australis*). 15pp.
09. Urbán R, J., Swartz, S.L., Martinez, A., Viloria, G. And Gomez-Gallardo, A. 2018 gray whale abundance in Laguna San Ignacio and Bahia Magdalena, Mexico. 21pp.
10. Minton, G. and Antonopoulou, M. The Arabian Sea Whale Network: a brief progress report. 5pp.
10rev1. Minton, G. And Antonopoulou, M. The Arabian Sea Whale Network: a brief progress report. 5pp. REVISED: this revision includes the correct references/document numbers for other papers submitted to this meeting relating to Arabian Sea humpback whales. These document numbers (which were not yet available at the time of the original submission of this document), will make it easier for readers to cross-reference relevant reports.
11. Kim, H.Y., Sohn, H. And Imai, Y. Possible occurrence of a gray whale off Korea in 2015. 6pp.
11rev1. Kim, H.Y., Sohn, H. And Imai, Y. Possible occurrence of a gray whale off Korea in 2015. 6pp. REVISED: edited.
12. Nakamura, G., Yoshida, H., Morita, H., Konishi, K., Mogoe, T., Miyashita, T., Kamizawa, Y. And Kato, H. Status report of conservation and researches on the Western North Pacific gray whales in Japan, May 2017-April 2018. 9pp.
13. Willson, A., Baldwin, R., Cerchio, S., Childerhouse, S., Collins, T., Findlay, K., Genov, T., Godley, B.J., Al-Harthi, S., Leslie, M., Macdonald, D., Minton, G., Zerbini, A.N. And Witt, M.J. Update on satellite telemetry studies and first unmanned aerial vehicle assisted health assessment studies of Arabian Sea humpback whales off the coast of Oman. 11pp.
13rev1. Willson, A., Leslie, M., Baldwin, R., Cerchio, S., Childerhouse, S., Collins, T., Findlay, K., Genov, T., Godley, B.j., Al-Harthi, S., Macdonald, D., Minton, G., Zerbini, A.N. And Witt, M.J. Update on satellite telemetry studies and first unoccupied aerial

vehicle assisted health assessment studies of Arabian Sea humpback whales off the coast of Oman. 15pp. REVISED: insertion of missing text on UAV method and results. Insertion of figures including; survey sightings, satellite telemetry tracks, UAV morphology and skin disease assessments.

14. Iñíguez Bessega, M. Southern right whale of the SW Atlantic: An update on the CMP actions in Argentina (2017-2018). 13pp.
15. Sutaria, D. Baleen whale reports from the eastern Arabian Sea based on interview surveys and stranding reports - update from India. 5pp.
16. Iñiguez Bessega, M. Report of the Conservation Management Plan for franciscana (*Pontoporia blainvillei*). 11pp.

16rev1. Iñiguez Bessega, M. Report of the Conservation Management Plan for franciscana (*Pontoporia blainvillei*). 13pp. REVISED: edited.

17. Zerbini, A.N., Ajo, A.F., Andriolo, A., Clapham, P.J., Crespo, E.A., Gonzalez, R.A., Harris, G., Mendez, M., Rosenbaum, H., Sironi, M., Sucunza, F. And Uhart, M. Satellite tracking of southern right whales (*Eubalaena australis*) from Golfo San Matias, Rio Negro Province, Argentina. 10pp.
18. Vernazzani, B.G., Balcazar-Cabrera, N., Buchan, S., Brownell, J., R.L., Cholewiak, D., Goya, E. And Moore, S. Progress Report on Passive Acoustic Monitoring of the Eastern South Pacific Southern Right Whale, a Key to Improve Conservation Management Plan Outputs: May 2017-April 2018. 7pp.
19. Cerchio, S., Willson, A., Muirhead, C., Al Hathi, S., Baldwin, R., Bonato, M., Collins, T., Di Clemente, J., Dulau, V., Estrade, V., Latha, G., Minton, G. And Willson, M.S. Geographic variation in song indicates both isolation of Arabian Sea humpback whales and presence of Southern Hemisphere whales off Oman. 31pp.
20. Vernazzani, B.G. IWC Eastern South Pacific Right Whale Conservation Management Plan - progress report April 2018. 8pp.
21. Zuazquita, E., Belgrano, J., Sarandon, R. And Zerbini, A.n. Seasonal occurrence of southern right whales (*Eubalaena australis*) in Miramar (Buenos Aires Province, Argentina). 5pp.

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01. Stachowitsch, M., Rose, N.A. And Parsons, E.C.M. State of the Cetacean Environment Report (SOCER) 2018. 19pp.
02. Bukina, L.A., Skurihin, L.E., Lobovikov, S.V. And Litovka, D.I. The occurrence of Trichinellosis in gray whales (*Eschrichtius robustus*) and Pacific walruses (*Odobenus rosmarus divergens*) off Chukotka, Russian Federation. 5pp.
03. Litovka, D.I., Simokon, M.V., Kovekovdova, L.T., Blokhin, S.A., Krasnova, V.V., Belikov, R.A., Prasolova, E.A., Ryabov, A.A. And Chikilev, V.G. Overview of monitoring, populational and toxicology researches of gray whales in the Mechigmensky Bay and beluga whales in the Anadyr Liman (western Bering Sea, Russia), 2013-2017. 5pp.

03rev1. Litovka, D.I., Simokon, M.V., Kovekovdova, L.T., Blokhin, S.A., Krasnova, V.V., Belikov, R.A., Prasolova, E.A., Ryabov, A.A. And Chikilev, V.G. Overview of monitoring, populational and toxicology researches of gray whales in the Mechigmensky Bay and beluga whales in the Anadyr Liman (western Bering Sea, Russia), 2013-2017. 5pp. REVISED: edited.

04. Naidenko, S.V., Klyuchnikova, P.S. And Litovka, D.I. Assessment of cortisol concentration in baleens of gray whales harvested in Chukotka, 2003-2017. 6pp.
05. Hayden, M., Klein, D., Subbiah, S., Wittmaack, C., Lesage, V., Morin, Y., Urbán R, J., Montalvo, C.L., Bickham, J. And Godard-Codding, C. Reproductive and stress steroid hormone analysis in cetacean blubber by liquid chromatography - tandem mass spectrometry. 20pp.
06. Mosquera-Guerra, F., Trujillo, F., Parks, D., Oliveira-Da-Costa, M., Usma, S., Willems, D., Maldonado, R., Amorocho, D., Berg, K., Armenteras-Pascual, D., Van Damme, P.A., Sainz, L., Franco, N., Mantilla-Meluk, H., Carvajal-Castro, J.D., Cambell, E., Cordova, L., Echeverria, A., Caballero, S. And Marmontel, M. Presence of mercury in river dolphins (*Inia* and *Sotalia*) in the Amazon and Orinoco basins: evidence of a growing threat for these species. 30pp.
07. Frisch-Nwakanma, H. CMS Family guidelines on environmental impact assessments for marine noise-generating activities developed by the Convention on Migratory Species (CMS). 3pp.

07rev1. Frisch-Nwakanma, H. And Prideaux, G. CMS Family guidelines on environmental impact assessments for marine noise-generating activities developed by the Convention on Migratory Species (CMS). 3pp. REVISED: author name added.

08. Hall, A.J. Mercury in cetaceans. 16pp.
09. Angel-Romero, P.A., Barragán-Barrera, D.C., Botero-Acosta, N., Riet-Sapriza, F.G., Caballero, S. And Luna-Acosta, A. Mercury concentrations in wild humpback whales (*Megaptera novaeangliae*) sampled in the Colombian Pacific and the Antarctic Peninsula. 15pp.
10. Pierantonio, N., Simmonds, M. And Eisfeld-Pierantonio, S. Relevant debris to be targeted for cetaceans: a review of available information. 50pp.
11. Burkhardt-Holm, P. And N'Guyen, A. Microplastics in the food web of cetaceans - a review. 14pp.
12. NO PAPER.
13. Anon. Joint ACCOBAMS/ASCOBANS/SPA-RAC Workshop on Marine Debris and Cetacean Stranding. 15pp.
14. Cunha, H.A., Santos Nero, E.B., Carvalho, R.R., Ikeda, J., Groch, K.R., Diaz-Delgado, J., Flach, L., Bisi, T.L., Catodias, J.L., Azevedo, A.F. And Brito, J.L. First outbreak of cetacean morbillivirus in the South Atlantic: epidemiological context. 14pp.
15. Pierantonio, N. And Simmonds, M.P. Consideration of data collection related to marine debris and cetaceans. 16pp.
16. Cholewiak, D., Burkhardt, E., Frey, S., Leaper, R., Moore, S. And Williams, R. Updates on progress related to international noise strategies. 5pp. UPGRADED WP.

SC/67b/EM

01. Mckinlay, J.P., De La Mare, W.K. And Welsh, A.H. Issues Cunen, Walløe and Hjort should consider in relation to their analyses of Antarctic minke whale body condition. 10pp.

01rev1. Mckinlay, J.P., De La Mare, W.K. And Welsh, A.H. Issues Cunen, Walløe and Hjort should consider in relation to their analyses of Antarctic minke whale body condition. 13pp. REVISED: this revision provides our review, in an addendum, of EM/02 submitted by Cunen, Walloe, Konishi and Hjort. The revision involves no new analyses of the data.

02. Cunen, C., Walløe, L., Konishi, K. And Hjort, N.L. Supplementary notes and material, with some refined analyses, compared to our IWC/SC/67A/EM04 May 2017 report. 14pp.

03. Mckinlay, J.P., De La Mare, W.K. And Welsh, A.H. No substantial change in Antarctic minke whale condition during the JARPA years. 133pp.

04. De La Mare, W.K. The contribution of prey spatial distribution to baleen whale functional responses. 5pp.

05. Wada, A., Mogoe, T., Banjo, S., Kasai, H., Sasaki, Y. And Tamura, T. Results of the krill and oceanographic survey under the NEWREP-A in the Antarctic in 2017/18. 13pp.

06. Miller, E.J., Potts, J., Cox, M.J., Miller, B.S., O'driscoll, R., Kelly, N. And Double, M.C. The characteristics of krill swarms in relation to aggregating Antarctic blue whales. 12pp.

06rev1. Miller, E.J., Potts, J., Cox, M.J., Miller, B.S., O'driscoll, R., Kelly, N. And Double, M.C. The characteristics of krill swarms in relation to aggregating Antarctic blue whales. 12pp. REVISED: numerical amendments to Figure 2 and Table 2. Amendment to acknowledgements.

07. De La Mare, W. Further development of individual base energetic models including the effects of feeding during migration. 18pp.

08. Cunen, C., Walløe, L. And Hjort, N.L. Reactions and answers to two papers by McKinlay, De La Mare and Welsh. 17pp.

SC/67b/HIM

01. Van Waerebeek, K., Apaza, M., Reyes, J.C., Alfaro-Shigueto, J., Santillán, L., Barreda, E., Altamirano-Sierra, A., Astohuaman-Uribe, J., Ortiz-Alvarez, C. And Mangel, J. Beach-cast small cetaceans bear evidence of continued catches and utilisation in coastal Peru, 2000-2017. 15pp.

02. De Jager, M., Hengeveld, G., Mooij, W. And Slooten, E. Modelling the spatial dynamics of Maui dolphins using individual based models. 57pp.

03. Siciliano, S., Cardoso, J. And Francisco, A. Humpback whale (*Megaptera novaeangliae*) feeding behaviour and gillnet entanglements off south-eastern Brazil: 2016-2017. 8pp.

04. Jacob, T., Leslie, A. And Ody, D. Protecting large cetaceans from ship strikes in the Pelagos Sanctuary. 14pp.

05. Peltier, H., Czeck, R., Dabin, W., Daniel, P., Deaville, R., Haelters, J., Ijsseldijk, L.L., Jensen, L.F., Jepson, P.D., Keijl, G., Olsen., M.T., Siebert, U., Van Canneyt, O. And Ridoux, V. Small cetacean mortality as derived from stranding schemes: the harbour porpoise case in the northeast Atlantic. 38pp.

06. Anon. Towards understanding the overlap of selected threats and important marine mammal areas (IMMAs) across the Mediterranean Sea. 9pp.

07. Kiszka, J.J., Talwar, B., Minton, G., Collins, T. And Reeves, R.R. Cetacean bycatch in Indian Ocean tuna fisheries: recent updates and perspectives from the 13th Meeting of the Working Party on Ecosystems and Bycatch of the Indian Ocean Tuna Commission. 11pp.

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09. Brownell, J., R.L. And Mallette, S.D. Global baleen whale bycatch: the most threatened population. 12pp.

09rev1. Brownell, J., R.L. And Mallette, S.D. Global baleen whale bycatch: the most threatened populations. 18pp. REVISED: edited.

10. Fruet, P.F., Prado, J.H., Genoves, R.C., Di Tullio, J.C. And Secchi, E.R. Preliminary evidences suggest that the establishment of a bottlenose dolphin protection area in southern Brazil is failing against the reduction of bycatch. 14pp.

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12. Tarzia, M. IWC Bycatch Mitigation Initiative - strategic assessment of potential work on bycatch [draft]. 20pp.

SC/67b/IA

01. Punt, A.E. Updated progress report: A multi-stock model for North Pacific sei whales, with preliminary results. 21pp.

02. Mizroch, S.A., Balcomb, K.C. And Rice, D.W. Historical winter and summer distribution of large whales along the eastern North Pacific coast based on data from the US whale marking program, 1962-1969. 29pp.

03. Clapham, P.J., Baker, C.S., Calambokidis, J., Donovan, G., Ivashchenko, Y., Kitakado, T., Matsuoka, K., Palka, D., Punt, A.E., Urbán R, J., Wade, P., Yoshida, H. And Zerbini, A.N. Report of the intersessional working group on the Comprehensive Assessment of North Pacific humpback whales. 8pp.

03rev1. Clapham, P.J., Baker, C.S., Calambokidis, J., Donovan, G., Ivashchenko, Y., Kato, H., Kitakado, T., Matsuoka, K., Palka, D., Punt, A.E., Urbán R, J., Wade, P., Yoshida, H. And Zerbini, A.N. Report of the intersessional working group on the Comprehensive Assessment of North Pacific humpback whales. 8pp. REVISED: name added to participants list.

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SC/67b/NH

01. No Paper.

02. Pastene, L.A., Taguchi, M., Lang, A.R., Goto, M. And Matsuoka, K. Population genetic structure and historical demography of North Pacific right whales. 18pp.

03. Branch, T.A., Brownell, J., R.L., Donovan, G., Ivashchenko, Y., Kato, H., Lang, A.R., Matsuoka, K., Mizroch, S., Rosenbaum, H., Širovič, A. And Suydam,

R. Data available for an assessment of North Pacific blue whales. 24pp.

04. Inai, K., Matsuoka, K. And Kitakado, T. Preliminary report of abundance estimation for the North Pacific humpback whales using IWC-POWER data. 14pp.
05. Corkeron, P.J. And Pace, R.M., III. Status of North Atlantic right whales: an update on the events of 2017. 4pp.
06. Tajima, Y., Matsuda, A., Shiozaki, A., Mori, K., Kurihara, N., Nishimaniwa, K. And Yamada, T.K. A yearling right whale calf entangled in a set net off Ito, central Japan. 13pp.
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07. Cholewiak, D., Palka, D., Chavez-Rosales, S., Davis, G., Josephson, E., Van Parijs, S. And Weiss, S. Updates on sei whale (*Balaenoptera borealis*) distribution, abundance estimates, and acoustic occurrence in the western North Atlantic. 16pp.
08. Ivashchenko, Y.V. And Clapham, P.J. Preserving the past: digitization of Soviet whale catches and sightings from the North Pacific. 9pp.
09. Cerchio, S., Andriantenaina, B., Zerbini, A.N., Pendleton, D., Rasoloarijao, T. And Cholewiak, D. Residency, feeding ecology, local movements and potential isolation of the Madagascar Omura's whale (*Balaenoptera omurai*) population. 26pp.
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01. Olson, P.A. And Jones, C.D. Photo-identification of Antarctic fin whales. 8pp.
02. Olson, P.A., de Boer, M., Kennedy, A., Double, M.C., Matsuoka, K., Pastene, L.A. and Findlay, K. Photo-identification of Antarctic blue whales: new data from 1998 and 2015-2018. 6pp.
03. Blount, D., Holmberg, J. and Minton, G. Flukebook - a tool for cetacean photo identification, data archiving and automated fluke matching. 10pp.
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SC/67b/RMP

01. De La Mare, W. Update on incorporating an individual based energetics model into the RMP trials software. 9pp.
02. Kitakado, T. And Goto, M. A plausible range of MSYR(1+) and relative plausibility of stock structure hypotheses for the WNP common minke whales investigated by bycatch data: Updated responses to requests by the Scientific Committee for more detailed explanation for Section 4 of SC/67a/SCSP/13. 9pp.
03. Kitakado, T. Evaluation of management procedures with CLA modified by recruitment information: specifications of trials to evaluate CLA variants for Antarctic minke whales which utilize ageing information. 14pp.

SC/67b/SAN

01. De La Mare, W., Dearie, T., Anderson, H., Mckinlay, J.P., Bell, E.M. And Double, M.C. Draft Southern Ocean Sanctuary Management Plan. 14pp.

SC/67b/SCP

01. Convenors' Group. Draft amendments to SC Rules of Procedure - working document for SC/67b. 7pp.
02. SC Chair, SC Vice-Chair and Head of Science. Scientific Committee Handbook - Working Methods of the IWC's Scientific Committee. 27pp.
02rev1. SC Chair, SC Vice-Chair and Head of Science. Scientific Committee Handbook - Working Methods of the IWC's Scientific Committee. 26pp. REVISED: updated information.

SC/67b/SCSP

01. De La Mare, W.K. And Mckinlay, J.P. Newrep-A sample size calculations needs to be completed. 4pp.
02. Isoda, T., Yasunaga, G., Yoshida, H., Mogoe, T., Ito, N., Shimatani, K., Nakamura, G., Maeda, H., Inoue, S., Kumagai, S., Goto, M., Nishimura, F., Kim, Y., Asano, Y., Akagi, M., Nakajo, K., Yamamoto, R., Watanabe, H., Sonobe, N., Shibata, C., Agari, T., Katsumata, T., Sazawa, R., Hatanaka, T., Takahashi, T., Hatsuse, A., Inoue, T., Kobata, M., Takeuchi, A., Matsumoto, S., Miyoshi, M., Seko, H., Monguchi, Y. And Kato, H. Cruise Report of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in 2017 - Pacific coastal component off Hachinohe and Kushiro. 15pp.
03. Konishi, K., Isoda, T., Bando, T., Minamikawa, S. And Kleivane, L. Results of satellite monitored tagging experiments on North Pacific sei whales conducted during the 2017 NEWREP-NP offshore survey 8pp.
04. Yasunaga, G., Konishi, K., Isoda, T. And Tamura, T. Results of the feasibility study on biopsy sampling and satellite tagging of Antarctic minke whales under NEWREP-A. 9pp.
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06. Konishi, K., Isoda, T., Nakai, K., Oikawa, H., Kanbayashi, J., Uchida, M., Tsunekawa, M., Ueda, Y., Kominami, T., Kawabe, S., Eguchi, H. And Tamura, T. Results of the first cruise of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in the 2017 summer season - offshore component. 14pp.
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09. Uchida, M., Suzuki, I., Tamura, T., Bando, T., Konishi, K. And Mitani, Y. Preliminary results in stable isotope analysis along edge of baleen plates in the Antarctic minke whales to estimate duration of time on feeding grounds. 11pp.

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SC/67b/SDDNA

01. Baird, A.B., Givens, G.H., George, J.C., Suydam, R.S. And Bickham, J.W. Stock structure of bowhead whales inferred from mtDNA and SNP DNA. 21pp.

02. Brüniche-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*) historical population attributes from whole-genome sequences. 29pp.

03. Brüniche-Olsen, A., Urbán R, J., Vertyankin, V.V., Godard-Codding, C., Bickham, J.W. And Dewoody, J.A. Genetic data reveal mixed-stock assemblages of gray whales in both Eastern and Western Pacific Ocean. 21pp.

04. Goto, M., Kitakado, T., Taguchi, M. And Pastene, L.A. Feasibility of the DNA methylation technique for age determination in the Antarctic minke whale. 9pp.

05. José Pérez-Álvarez, M.J., Olavarría, C., Kraft, S., Moraga, R., Sepúlveda, M., Santos-Carvallo, M., Pavez, G. And Poulin, E. Genetic diversity of South East Pacific fin whales and lack of genetic differentiation between Southern Hemisphere stocks. 10pp. NOTE: this is the wrong paper.

05rev1. José Pérez-Álvarez, M.J., Rodriguez, F., Kraft, S., Olavarría, C., Naretto, C. And Poulin, E. Historical and contemporary population structure and the impact of whaling on sei whales. 7pp. REVISED: original uploaded was the wrong file.

06. Taguchi, M. Results of the genetic analyses recommended by the 'Workshop on Western North Pacific common minke whale stock structure in preparation for the start of the Implementation Review in April 2018. 10pp.

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01. Vermeulen, E., Wilkinson, C., Thornton, M., Peters, I.T. And Findlay, K. Report on the Mammal Research Institute Whale Unit southern right whale survey - 2017. 24pp.

02. Sremba, A.L., Lang, A.R., Saremi, N., Shapiro, B., Pitman, R., Wilson, P., Martin, A.R. And Baker, C.S. Loss of maternal lineages in Antarctic blue whales described from whole mitochondrial genomes of historical and contemporary samples. 7pp.

03. Pastene, L.A., Acevedo, J. And Branch, T.A. Morphometric analysis of Chilean blue whales and implications for their taxonomy. 17pp.

04. Torres, L.G., Barlow, D.R. And Klinck, H. New Zealand blue whale distribution and response to disturbance analysis underway to inform management decisions. 4pp.

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07. Double, M.C., Westwood, K., Bell, E.M., Kelly, N., Miller, B.S., De La Mare, W., Andrews-Goff, V.A., Cox, M.J., Kawaguchi, S., King, R., Melbourne-Thomas, J., Davidson, A., Nicol, S., Williams, G., Laverock, B., Ratnarajah, L., Seymour, J., Friedlaender, A., Herr, H., Findlay, K., Iñiguez Bessega, M. And Miller, E.J. Cruise plan for the 2019 IWC-SORP research voyage 'The availability of Antarctic krill to large predators and their role in biogeochemical recycling in the Southern Ocean'. 11pp.

08. Olson, P.A., Kinzey, D., Double, M.C., Matsuoka, K., Pastene, L.A. And Findlay, K. Capture-recapture estimates of abundance of Antarctic blue whales. 11pp.

08rev1. Olson, P.A., Kinzey, D., Double, M.C., Matsuoka, K., Pastene, L.A. And Findlay, K. Capture-recapture estimates of abundance of Antarctic blue whales. 11pp. REVISED: updated two figures to show a more complete range of confidence intervals.

08rev2. Olson, P.A., Kinzey, D., Double, M.C., Matsuoka, K., Pastene, L.A. And Findlay, K. Capture-recapture estimates of abundance of Antarctic blue whales. 11pp. REVISED: growth rate value needed correction.

09. Goetz, K., Childerhouse, S., Paton, D., Ogle, M., Hupman, K., Constantine, R., Double, M.C., Andrews-Goff, V., Zerbini, A.N. And Olson, P.A. Satellite tracking of blue whales in New Zealand waters, 2018 voyage report. 13pp.

09rev1. Goetz, K., Childerhouse, S., Paton, D., Ogle, M., Hupman, K., Constantine, R., Double, M.C., Andrews-Goff, V., Zerbini, A.N. And Olson, P.A. Satellite tracking of blue whales in New Zealand waters, 2018 voyage report. 12pp. REVISED: small errors corrected in the number of photo-identifications and typos.

09rev2. Goetz, K., Childerhouse, S., Paton, D., Ogle, M., Hupman, K., Constantine, R., Double, M.C., Andrews-Goff, V., Zerbini, A.N. And Olson, P.A. Satellite tracking of blue whales in New Zealand waters, 2018 voyage report. 12pp. REVISED: fixed dates and sightings table and error to photo-ID data. Also fixed legends on three figures.

10. San Martin, A.A., Paso Viola, M.N., Dellabianca, N.A., Riccialdelli, L., Torres, M.A. And Massone, A.R. The first report of a necropsy in fin whale (*Balaenoptera physalus*) stranded in Tierra del Fuego in 2016. 12pp.

11. Širovič, A., Branch, T.A., Brownell, J., R.L., Cerchio, S., Lang, A.R., Buchan, S., Findlay, K., Miller, B.S., Olson, P.A., Rogers, T., Samaran, F. And Suydam, R. Blue whale song occurrence in the Southern Hemisphere. 13pp.

11rev1. Širovič, A., Branch, T.A., Brownell, J., R.L., Cerchio, S., Lang, A.R., Buchan, S., Findlay, K., Miller, B.S., Olson, P.A., Rogers, T., Samaran, F. And Suydam, R. Blue whale song occurrence in the Southern Hemisphere. 13pp. REVISED: added data from paper SC/67b/SH/14/Rev1 (updated Figures 1, 2, Table 1, and references).

12. Širovič, A. Progress report on the development of a permanent blue whale song reference library. 5pp.

13. Pérez-Álvarez, M.J., Olavarria, C., Kraft, S., Moraga, R., Sepúlveda, M., Santos-Carvallo, M., Pavez, G. And Poulin, E. Genetic diversity of south east Pacific fin whales and lack of genetic differentiation between Southern Hemisphere stocks. 10pp.
14. Cerchio, S., Rasoloarijao, T. And Cholewiak, D. Progress report: acoustic monitoring of blue whales (*Balaenoptera musculus*) and other baleen whales in the Mozambique Channel off the northwest coast of Madagascar. 14pp.

14rev1. Cerchio, S., Rasoloarijao, T. And Cholewiak, D. Progress report: acoustic monitoring of blue whales (*Balaenoptera musculus*) and other baleen whales in the Mozambique Channel off the northwest coast of Madagascar. 14pp. REVISED: brief additional details added. Corrections to some presented data and general clean up edits.

15. Jackson, J.A., Sremba, A.L., Zerbini, A.N., Reyes Reyes, V., Herr, H., Archer, F.I., Širovič, A., Baker, C.S., Olson, P.A., Torres-Florez, J.P., Lang, A.R., Rogers, T.L., Samaran, F., Fretwell, P., De La Mare, W., Aguilar, A., Kelly, N., Bell, E.M., Miller, B.S., Cerchio, S. And Leslie, M.S. Southern Hemisphere fin whale stock structure: a summary of published information to date. 10pp.
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17. Garrigue, C., Derville, S. And Bonneville, C. Searching for humpback whales two centuries post-whaling: what is left in the Chesterfield-Bellona archipelago? 17pp.
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19. Herr, H. Southern Hemisphere fin whales: update on available data sets. 12pp.

19rev1. Herr, H. Southern Hemisphere fin whales: update on available data sets. 14pp. REVISED: new tables added.

20. Jackson, J.A., Carroll, E.L., Kennedy, A., Leaper, R., Calderan, S., Leslie, M.S., Andriolo, A., Stepien, E., Zerbini, A.N., Miller, B.S., Kelly, N., Stowasser, G., Cheeseman, T. And Moore, M. Sightings and acoustic records of right whales collected in South Georgia (Islas Georgias del Sur) waters January-February 2018. 13pp.
21. Bell, E.M. Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2017/18. 108pp.
22. Brandão, A., Vermeulen, E., Ross-Gillespie, A., Findlay, K. And Butterworth, D.S. Updated application of a photo-identification based assessment model to southern right whales in South African waters, focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. 19pp.
23. Branch, T.A., Monnahan, C.C. And Širovič, A. Separating pygmy blue whale catches by population. 24pp.
24. Cerchio, S., Willson, A., Muirhead, C., Al Harthi, S., Baldwin, R., Cholewiak, D., Collins, T., Minton, G., Rasoloarijao, T. And Willson, M.S. A new baleen whale song type described for the West Indian Ocean off Oman and northwest Madagascar. 8pp. UPGRADED WORKING PAPER.

24rev1. Cerchio, S., Willson, A., Muirhead, C., Al Harthi, S., Baldwin, R., Cholewiak, D., Collins, T., Minton, G., Rasoloarijao, T. And Willson, M.S. A new baleen whale song type described for the West Indian Ocean off Oman and northwest Madagascar. 8pp. REVISED: new version of Figure 3.

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01. Report of the Tenth Meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA). 67pp.

01rev1. Report of the Tenth Meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA). 67pp. REVISED: correction to a figure.

02. Cosentino, M. And Souviron-Priego, L. The Aquatic Wild Meat Database: a useful tool for monitoring small cetaceans illegally exploited for food and other purposes. 8pp.
03. Marcondes, M.C.C., Angeli, M., Fontes, F., Palazzo, J.T., Campos, R., Dapper, C. And Cremer, M. Report on franciscana fisheries interaction in FMA 1a, Brazil. 17pp.
04. Alfaro-Shigueto, J., Campbell, E. And Mangel, J.C. Hydrovias: an emerging threat to river dolphins in Peru. 7pp.
05. Siciliano, S., Tavares, D.C., De Moura, J.F. And Di Beneditto, A.P.M. Final Report Project: Assessment of the fisheries characteristics in southeastern Brazil: Moving towards a monitoring program to assess Franciscana bycatch in FMA 1b – northern Rio de Janeiro. 24pp.
06. Castro, C., Cárdenas, D., Kaufman, G. And Van Waerebeek, K. Marine mammals used as bait with improvised Fish Aggregating Devices in Ecuador. 10pp.
07. Mei, Z., Hao, Y., Wang, K., Wang, Z., Zheng, J., Han, Y., Xiong, X., Chen, M. And Wang, D. A range wide survey of the Yangtze finless porpoise (*Neophocaena asiaeorientalis*). 4pp.
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09. Costa, M.O., Marmontel, M., Xavier Da Rosa, D.S., Coelho, A., Wich, S., Mosquera-Guerra, F. And Trujillo, F. Effectiveness of unmanned aerial vehicles for population estimates of Amazon river dolphins. 16pp.
10. Frisch-Nwakanma, H. Guidelines on national legislation regarding live capture of cetaceans for commercial purposes developed by the Convention on Migratory Species (CMS). 2pp.
11. No Paper.
12. Ingram, D.J. And Avila, I.C. Improving our understanding of aquatic wild meat: database requirements and research agenda. 13pp.
13. Emin-Lima, R., Siciliano, S., Moreira, R.H.M., JR., Pereira, T.S., Amaral, T.M.M.M. And Silva De Paula, W. Unrecognized and so many threats: case studies in conservation of the Araguaian boto (*Inia araguaiaensis*). 8pp.
14. Mosquera-Guerra, F., Trujillo, F., Oliveira-Da-Costa, M., Marmontel, M., Armenteras-Pascual, D., Usma, S., Willems, D., Carvajal-Castro, J.D., Mantilla-Meluk, H., Franco, N., Amorocho, D.,

Maldonado, R., Berg, K., Sainz, L. And Van Damme, P.A. Movements and habitat use of river dolphins (*Cetartiodactyla: Iniiidae*) in the Amazon and Orinoco river basins, determined from satellite tagging. 27pp.
15. Brownell, J., R.L., Mallette, S.D. And Rebolledo, R. Illegal totoaba fishing in San Felipe, Mexico in January 2018. 7pp.
16. Mosquera-Guerra, F., Trujillo, F., Parks, D., Oliveira-Da-Costa, M., Marmontel, M., Armenteras-Pascual, D., Usma, S., Willems, D., Carvajal-Castro, J.D., Mantilla-Meluk, H., Franco, N., Amorocho, D., Maldonado, R., Berg, K., Sainz, L., Van Damme, P.A. And Cambell, E. Analysis of distribution of river dolphins (*Inia* and *Sotalia*) in protected and transformed areas in the Amazon and Orinoco basins. 24pp.
17. No Paper.
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18rev1. No Paper.
19. Fruet, P.F., Daura-Jorge, F., Genoves, R.C., Bezamat, C., Di Tullio, J.C., Simoes-Lopes, P.C. And Secchi, E.R. A review on the life history parameters and threats to bottlenose dolphins in two estuaries of southern Brazil. 15pp.

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01. Rose, N.A., Frisch-Nwakanma, H., Smith, C., Smith, S. And Ferriss, S. Update on swim-with-whales intersessional group. 2pp.
02. Wulff, R. Whale Watching Strategic Plan (2018-2024) - draft. 6pp.
03. Notarbartolo Di Sciara, G. And Frisch-Nwakanma, H. Work on recreational in-water interactions with aquatic mammals under the Convention on Migratory Species (CMS). 2pp.
04. Vilches, F.O., Rowntree, V.J., Sironi, M. And Moreda, C.M. Incorporating whale-watch photographs into a 47-year aerial photoidentification catalog for a better assessment of the population dynamics of southern right whales off Argentina. 6pp.
05. Clark, A., Anderson, H. And Heaton, S. Indian Ocean Rim Association (IORA) Sustainable Whale and Dolphin Watching Tourism Network. 10pp.
06. Nunny, L. And Simmonds, M. Solitary sociable dolphins: a preliminary update. 12pp.
07. Parsons, E.C.M. And Smith, C.E. Recent advances in whale watching research 2017-2018. 22pp.
08. Minton, G., Ferriss, S. And Wulff, R. Report on the development of the online IWC Whale Watching Handbook. 12pp.
09. New, L. Update on the Modelling and Assessment of Whale Watching Impacts (MAWI) Steering Group. 4pp.

PLENARY PAPERS

SC/67b/Plenary
01. IWC Secretariat. Financial position of the Research Fund. 12pp.
01rev1. IWC Secretariat. Financial position of the Research Fund. 12pp. REVISED.

COMMISSION DOCUMENTS

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01. Cooperation with other organisations. 12pp.
01rev1. Cooperation with other organisations. 13pp.
01rev2. Cooperation with other organisations. 14pp.

PROGRESS REPORT SUMMARIES

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01. Croatia. 4pp.
02. Netherlands. 4pp.
03. New Zealand. 7pp.
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05. Argentina. 6pp.
06. Iceland. 3pp.
07. United States of America. 10pp.
08. Spain. 28pp.
08rev1. Spain. 28pp.
08rev2. Spain. 28pp.
09. Mexico. 4pp.
10. Italy. 8pp.
11. Republic of Korea. 4pp.
12. Denmark. 4pp.
13. Norway. 3pp.
14. Brazil. 5pp.
15. France. 7pp.
16. UK. 4pp.
17. Australia. 18pp.
18. Germany. 3pp.
19. Panama. 4pp.

REPORTS FROM INTERSESSIONAL WORKSHOPS

SC/67b/Rep
01. Report of the Workshop on the Poorly Documented Takes of Small Cetaceans in South America: including in-depth review of the hunting of the hunting of the Amazon River dolphin (*Inia geoffrensis*) for the piracatinga (*Calophysus macropterus*) fishery, 19th - 21st March 2018, City of Santos, Brazil. 68pp.
02. Report of the Second Implementation Review Workshop on Western North Pacific Bryde's Whales, 14-16 February 2018, Tokyo, Japan. 23pp.
03. Report of the Workshop on Identifying Key Research Questions for the Modelling and Assessment of Whale Watching Impacts (MAWI), 5-6 April 2018, La Spezia, Italy. 17pp.
03.rev1 Report of the Workshop on Identifying Key Research Questions for the Modelling and Assessment of Whale Watching Impacts (MAWI), 5-6 April 2018, La Spezia, Italy. 16pp. REVISED: edited.
04. Report of the Planning Meeting for the 2018 and 2019 IWC-POWER Cruise in the North Pacific, 15-17 September 2017, Tokyo, Japan. 27pp.
05. Report of the Workshop on Western North Pacific Common Minke Whale Stock Structure in Preparation for the Start of the Implementation Review in April 2018, 12-13 February 2018, Tokyo, Japan. 11pp.
06. Report of the 2017 AWMP Workshops on the Development of SLAs for the Greenlandic Hunts, 18-21 October 2017, Copenhagen, Denmark. 25pp.
07. Report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales, 28-31 March 2018, Big Sur, California, USA. 21pp.
07rev1. Report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales, 28-31 March 2018, Big Sur, California, USA. 43pp. REVISED: appendices added.
08. NO PAPER.
09. Report of the SM/SD Joint Intersessional Workshop: Resolving Tursiops Taxonomy Worldwide, 12-14 January 2018, La Jolla, CA, USA. 47pp.

Annex D

Report of the Sub-Committee on the Revised Management Procedure

Members: Robbins (Convenor), Allison, Aoki, Baba, Bell, Bjørge, Brandão, Brierley, Brownell, Burkhardt, Butterworth, Cipriano, Cooke, de la Mare, de Moor, DeWoody, Di Tullio, Doniol-Valcroze, Donovan, Double, Fortuna, Goto, Gunnlaugsson, Haug, Hoelzel, Hubbell, Iñíguez, Inoue, Jaramillo-Legorreta, Johnson, Kim, E.M., Kitakado, Lang, Lundquist, Maeda, Mallette, McKinlay, Miyashita, Morishita, Morita, Moronuki, Nelson, Øien, Palka, Panigada, Pastene, Punt, Reeves, Simmonds, Skaug, Slugina, Solvang, Strasser, Sampaio, Suydam, Taguchi, Tamura, Taylor, Terai, Tiedemann, Víkingsson, Wade, Walløe, Walters, Wambiji, Wilberg, Williams, Witting, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Robbins welcomed the participants and passed along the best wishes of the co-Convenor, John Bannister, who was unable to attend the meeting due to ill health.

1.2 Election of Chair
Robbins was elected Chair.

1.3 Appointment of rapporteurs
Punt acted as the rapporteur.

1.4 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

1.5 Available documents
The documents considered by the sub-committee were SC/67b/RMP01-03, SC/67b/Rep02, SC/67b/Rep05, SC/67b/ASI15, SC/67b/SDDNA06 and SC/67b/EM07.

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

2.1 Evaluate the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
SC/67b/EM07 outlined enhancements to the individual-based energetics model (IBEM) developed since last meeting. One of these changes enabled feeding on migration to be explicitly modelled. Results presented for 'minke like' whales showed that carrying capacity and the parameters of the yield curve in terms of MSYR and MSYL were sensitive to the level of migration food, with a threefold difference in MSYR arising from a 30% reduction in migration food. Although based on a small number of scenarios, the ratios of $MSYR_{1+}$ to $MSYR_{mat}$ were similar to earlier results for 'minke like' populations from the previous version of the model.

The sub-committee thanked de la Mare for his efforts to continue to develop the IBEM. This model has the potential to inform the work of the Committee in several ways. Specifically, the IBEM and previous age-aggregated population dynamics models have shown that MSYL depends on the extent of stochasticity in the population dynamics, emphasising the importance of accounting for such stochastically in the work of the RMP sub-committee. The IBEM also provides a way to better understand the relationship between biological processes and MSYR, for example, with species that require food in winter having lower values for MSYR, all things being equal. The possibility was raised of inferring MSYR for species based on the values for parameters in the IBEM by calibrating the rates of increase for stocks for which these rates are known with values for these parameters in the IBEM. However, it was recognised that the IBEM has many parameters so that conducting such an analysis would be very difficult. Another potential use of the IBEM is to examine the impact of forage fisheries on growth rates for migrating species.

SC/67b/RMP01 reported on trials using the IBEM within the standard RMP testing framework. The trials covered three scenarios relating to the 'development' (D), 'sustain' (S) and 'recovery' (R) trials using one of the models presented in SC/67b/EM07, which had $MSYR_{mat}$=1.8%. The results were consistent with the behaviour of the RMP *CLA* observed from less complex population models. The author of SC/67b/RMP01 stated that, apart from confirming that the *CLA* did not exhibit unusual behaviour under this different scenario model, the results would provide a point of comparison for the emulator model for the IBEM currently under development.

The sub-committee noted that the trends in population numbers and catches from the IBEM-based D1, R1, and S1 trials match the patterns observed from deterministic operating models, although the outcomes were, as expected, more variable. Direct quantitative comparisons between the performance statistics in SC/67b/RMP01 and those for the single-stock trials was not possible owing to differences in MSYR. The sub-committee had previously agreed that an emulator model could form the basis for future *Implementation Simulation Trials* once it is fully developed. The sub-committee again identified priorities for the next steps for this work as:

(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 IBEM 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.

Attention: SC

The Committee ***agrees*** *that work continue to develop an emulator model; assess whether it is possible to represent the trajectories from the IBEM using an emulator model; compare the yield curves from the IBEM 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.*

2.2 Implications of ISTs for consideration of species' and populations' status
At SC/67a, it was concluded that the results of a set of *Implementation Simulation Trials* should be summarised using three statistics to provide information on status (IWC, 2018a).

Intersessional computing work was recommended to allow these values to be reported, but that work was not completed due to computing demands for other RMP and AWMP activities. The sub-committee **agreed** that the Donovan should draft updates to the Guidelines for *Implementations* and *Implementation Reviews* to reflect decisions on evaluation status of stocks, and that Allison should modify the control programs used for *Implementation Simulation Trials* to report the three measures of status agreed last year (IWC, 2018a). The sub-committee, in conjunction with the ASI sub-committee, will review outcomes of the analyses at SC/68a.

Attention: SC

The Committee ***agrees*** *that Allison should modify the control programs used for Implementation Simulation Trials to report the three measures of status agreed last year (IWC, 2018a). The RMP sub-committee, in conjunction with the Working Group on ASI, will review outcomes of the analyses at SC/68a. Punt and Donovan will develop draft updates to the Guidelines for Implementations and Implementation Reviews to reflect decisions on evaluation status of stocks for consideration at SC/68a.*

2.3 General consideration of how to evaluate the effect of special permit catches on stocks and levels of information needed to show improved management performance

2.3.1 General issues

Last year, the Committee received a paper (Punt and Donovan, 2017) that outlined a potential approach based on *Implementation Simulation Trials* to inform the quantification of the management-related benefits of research programs. The sub-committee agreed that it would be useful for both proponents and reviewers if there was general guidance on the level of information to be provided to show quantitatively that any proposed research will have management benefits. The sub-committee agreed last year 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 also recognised that what constitutes 'sufficient' information would be a difficult task. The sub-committee therefore recommended last year that discussion documents be prepared intersessionally for discussion at SC/67b.

Appendix 2 lists some general guidelines to assist proponents in writing proposals which will in turn assist in the review process (e.g. minimising requests by the Expert Panel for additional information to be provided). It is stressed that these are guidelines not requirements. In particular, appointment and use of an Advisory Committee is not mandatory[1], but would be advisable for nations that have not previously developed proposals or that may be lacking analysts familiar with the modelling approaches commonly applied at the IWC.

Attention: SC

The Committee ***agrees*** *that the general guidelines on the levels of information needed to show improved management improvement, for proposals that identify this as an objective (Appendix 2), should be included as an Appendix to the Scientific Committee handbook.*

2.3.2 Specific issues

A paper presented to SC/66b (Government of Japan, 2016) had outlined RMP/*IST*-like simulations to evaluate whether or not a modified *CLA* that includes age data in the control rule will: (a) result in improved performance; and (b) if so, by how much. A small group reviewed the analyses and agreed that the approach was conceptually appropriate but recognised that further work was needed to specify an appropriate trial structure (IWC, 2017). An Advisory Group (Bannister (Chair), Butterworth, Cooke, de la Mare, Donovan, Fortuna, McKinlay, Kitakado, Morishita, Punt and Walløe) was appointed to assist in the process to facilitate the Committee to review and agree trial specifications. It was recognised that the process would be iterative. Members of the Advisory Group provided advice to Kitakado during the intersessional period.

SC/67b/RMP03 provided draft specifications for an RMP/*IST* type simulation exercise to evaluate management procedures based on modified *CLA*s (MCLAs) that use information on recruitment inferred from age data from Antarctic minke whales. This work arose from discussions regarding NEWREP-A, in which the extent of improvement in RMP-related performance (e.g. through catch and risk indicators) that might be obtained by incorporating information on age of caught animals formed part of the justification for the sample size for NEWREP-A (Recommendation 1 of Panel Review for NEWREP-A). During SC/66b, to respond to this recommendation, (Government of Japan, 2016) introduced preliminary work on minke whale population models that would be a part of the operating models to be used in simulation trials, and presented a quantitative evaluation of NEWREP-A in terms of improvements in the performance of alternative RMPs. SC/67b/RMP03 is separate and independent from NEWREP-A, and introduces a more general framework of trials for Antarctic minke whales to evaluate MCLAs, with a focus on conditioning and the generation of future observations.

It will be necessary to both refine the MCLA and how it is tested using a more extensive set of trials. The author of SC/67b/RMP03 plans to pursue this work further, potentially seeking advice from the Advisory Group established in 2016. The sub-committee noted that SC/67b/RMP03 was necessarily a work-in-progress, and that several features of the operating models would need to be modified before final conclusions could be drawn. In particular, there is need for the simulations to account for future stochasticity in the same variables as the statistical catch-at-age method on which the operating model is based (i.e. selectivity, carrying capacity, and growth), although there would be value in conducting projections in which these variables are time-invariant as an initial way to explore the feasibility of a MCLA outperforming the *CLA*. Future work should also consider alternative assumptions about mixing of the I- and P- stock. Other matters that might be included in trials would be density-dependence in both natural mortality and recruitment simultaneously and stochasticity. The set of trials should consider a broad range of assumptions regarding changes in recruitment rate, including a longer duration for the pulse in SC/67b/RMP03, pulse up and stay up, pulse down and stay down, linear changes over pulses. In addition, variations in recruitment rate seen in the past should be replicated into the future. The sub-committee noted that the specifications should be clear that the pulses pertain to recruitment rate (calves per mature female).

The performance statistics used to report the results of trials should include the standard sets of *CLA*/RMP performance statistics. Use of performance statistics that scale population size to the population size when there was no harvest have eased interpretation of trials with time-varying parameters such as carrying capacity, and included in the standard set of statistics.

[1]The decision to appoint an Advisory Committee and its membership shall be at the sole discretion of the proponents.

2.4 Work plan 2019-20 – general issues

Work plan for RMP (general issues)

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Item 2.1: Conduct work to evaluate the energetics-based model and hence the relationship between MSYR1+ and MSYRmat	(a) Continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model (de la Mare); (b) Compare the yield curves from the IBEM with those from the emulator model (de la Mare); and (c) 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 (de la Mare).	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$	Conduct follow-up analyses	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
Item 2.2: Implications of ISTs, for consideration of status	(a) Draft updates to 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 the results of the projections		
Item 2.3: levels of information needed to show improved management performance		Review progress implementing the suggested changes to the specifications of SC/67b/RMP03 and any results.		

3. RMP – *IMPLEMENTATION*-RELATED MATTERS

3.1 Completion of the *Implementation Review* of western North Pacific Bryde's whales

3.1.1 Report of the intersessional Workshop

Donovan summarised the report of the intersessional Workshop (SC/67b/Rep02) held in Tokyo from 14-16 February 2018. The objective of the second Workshop was to facilitate completion of the *Implementation Review*, and in particular to resolve any outstanding issues and complete the conditioning of the trials so that the final results could be developed during the intersessional period.

Much of the work therefore focussed on completing the final trial specifications and in particular: (a) confirming the mixing matrices; and (b) updating the abundance estimates for the new sub-areas (including consideration of $g(0)$ and additional variance (but see Item 3.1.3 below) as well as confirming future sighting survey plans and whaling options. The Workshop reviewed preliminary conditioning results for almost all trials and agreed that they were satisfactory. It developed a work plan to try to ensure completion of the *Implementation Review* at SC/67b.

The sub-committee noted that the intersessional Workshop led to considerable progress towards completing the *Implementation Review* and that the Workshop had been conducted in an excellent spirit of co-operation among the participants. It thanked Donovan for chairing the meeting, the Government of Japan for providing excellent facilities and all the participants for their contributions to the development of trial specifications and work plan.

Attention: SC

The Committee ***agrees*** *the updated trial specifications for the Implementation Review of western North Pacific Bryde's whales. These specifications are provided in Appendix 3.*

3.1.2 Progress since the intersessional Workshop

Following the intersessional Workshop, the code was modified to allow for the two future survey plans and the two future survey areas requested by Japan and agreed at the Workshop. The two future survey areas include a 'large' area with a southern boundary of 10°N in sub-areas 1W and 1E, and a 'small' area with a southern boundary of 20°N in sub-areas 1W and 1E.

3.1.3 Final trial specifications

Revised $g(0)$-corrected abundance estimates and CVs from the past surveys were adopted by the ASI sub-committee (Annex Q, item 3.1.1.6). Abundance estimates and CVs corresponding to the proposed small and large areas (Appendix 3, Table 2) were included in the conditioning. The estimates of additional variance (required for forecasts and not conditioning) for the case in which sub-area 1W is surveyed over three years were updated, and the trial specifications updated accordingly.

The sub-committee **agreed** the updated trial specifications (Appendix 3).

3.1.4 Conditioning of trials

Appendix 4 lists examples of the plots used to evaluate whether conditioning has been achieved satisfactorily. The sub-committee noted that trials 3 and 4, which involve alternative catch series, had yet to be conditioned but that conditioning for the remaining trials was satisfactory.

3.1.5 Conclusions and recommendations

There was insufficient time during the meeting to complete all of the required projections and to check the associated calculations. The sub-committee therefore **agreed** that the calculations would be completed intersessionally and reviewed and summarised by a Steering Group (Donovan (Convenor), Allison, Butterworth, deMoor, Kitakado, Palka, Pastene, Punt, Tiedemann). This would occur well prior to SC/68a so that Japan has sufficient time to consider the results, prior to final conclusions (e.g. with regard to preferred survey options) being drawn. The sub-committee expects that this work can be completed before the end of 2018, but if complications arise conducting the projections, an extra day should be added to the First Intersessional

Workshop for the western North Pacific minke whales to address outstanding issues.

Attention: SC

The Committee ***agrees*** *that the Implementation Review of western North Pacific Bryde's whales will be completed in SC/68a. Outstanding tasks would be completed intersessionally and the results reviewed and summarized by a Steering Group convened by Donovan. This would occur well prior to SC/68a, but if complications arise then an extra day should be added to the First Intersessional Workshop for the western North Pacific minke whales to address those issues.*

3.2 Start of the *Implementation Review* of western North Pacific common minke whales

Last year, 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, the sub-committee considered it was likely that resolving how to handle stock structure uncertainty in the next *Implementation Review* will again be challenging. It therefore recommended that a preparatory meeting be held prior to SC67b focused on stock structure for western North Pacific minke whales.

3.2.1 Report of the intersessional Workshop

Donovan summarised the report of the preparatory Workshop for the Western North Pacific common minke whale *Implementation Review* (SC/67b/Rep05). The Workshop was held at the Crew House (*Senin Tsumesho*) of the Fisheries Agency of Japan, Tokyo from 12-13 February 2018. The objective of the Workshop was to provide a preliminary opportunity to review work undertaken since the last *Implementation Review* and to develop, if necessary and possible, consensus advice on further analyses that will assist in the forthcoming *Implementation Review.*

Three stock structure hypotheses were used in the previous *Implementation Review* (IWC, 2012, p.103).

- Hypothesis A: a single J stock distributed in the Yellow Sea, Sea of Japan, and Pacific coast of Japan, and a single 'O' stock in sub-areas 7, 8 and 9 (Fig. 1). The O stock migrates in summer mainly to the Okhotsk Sea (sub-areas 12SW and 12NE). Both J and O stocks overlap temporally along the Pacific coast (subareas 7CS and 7CN) and the southern part of the Okhotsk Sea (sub-areas 11 and 12SW).
- Hypothesis B: as for hypothesis A, but a different stock (Y stock) which resides in the Yellow Sea and overlaps with J stock in the southern part of sub-area 6; and
- Hypothesis C: five stocks, referred to Y, JW, JE, OW, and OE, two of which (Y and JW) occur in the Sea of Japan, and three of which (JE, OW and OE) are found to the east of Japan.

There was no agreement within the Committee at the time regarding the plausibility category for these hypotheses, and so all were treated as 'medium' plausibility for the purposes of the *Implementation Review.* Stock structure hypothesis is perhaps the major factor in determining the acceptability of management variants.

The focus of the Workshop was to identify and conduct additional analyses to assist the discussion of stock structure during the upcoming *Implementation Review*. The results of these deliberations are reported in SC/67b/Rep05.

The Workshop was provided with an update to SC/67a/SCSP13 that used information on the trend over time in the J:O stock ratio for common minke whale bycatches around Japan to draw various inferences, in particular about the value of the MSYR. The Workshop agreed that J:O stock ratios in bycatch will require attention when formulating stock distribution assumptions for the process of conditioning *IST*s in the coming *Implementation Review* and made some recommendations for refinement of the analyses (see Item 3.2.2).

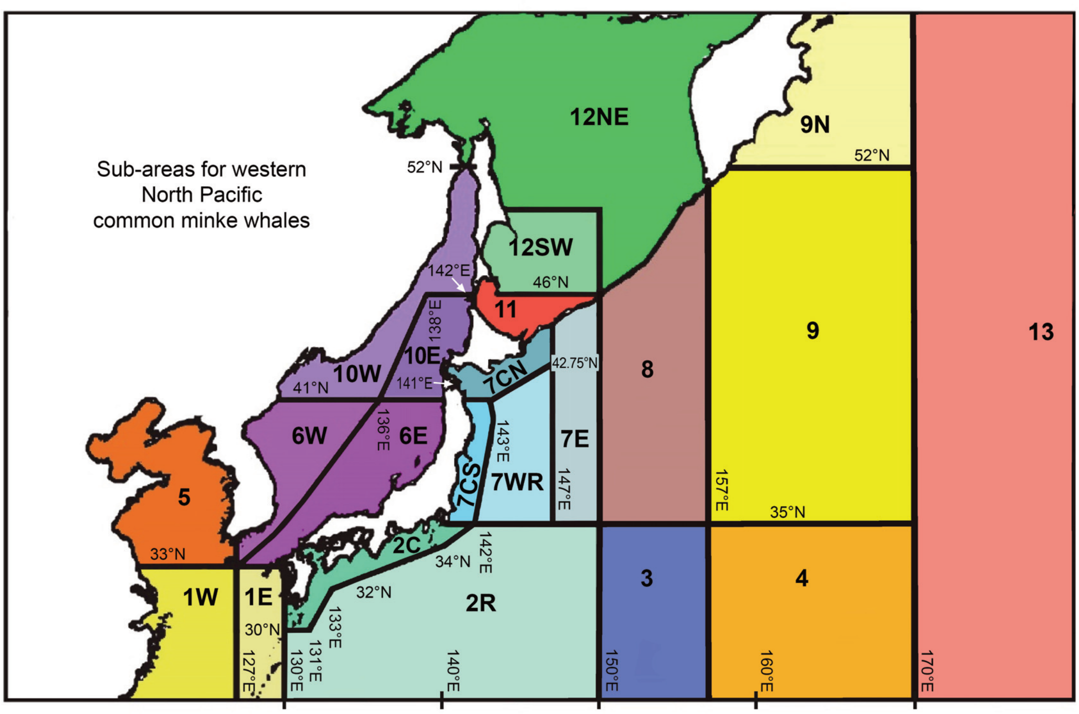

Fig. 1. Sub-areas used for the western North Pacific common minke whales.

The intersessional Workshop was held in an excellent spirit of co-operational among the participants and led to identification of additional data sets and analyses that should be taken forward. Some analyses based on the Workshop recommendations were presented at SC/67b. The sub-committee thanked Donovan for chairing the meeting, the Government of Japan for providing excellent facilities and all the participants for their contributions to progress the *Implementation Review*.

3.2.2 Progress since the intersessional Workshop
SC/67b/RMP02 aimed at suggesting a plausible range for $MSYR_{1+}$ for the western North Pacific common minke whales, and the relative plausibility of stock structure Hypotheses A and C. MSYR is a difficult parameter to estimate, while Hypotheses A and C, were assigned equal plausibility in the last *Implementation Review*. An estimated time trend of the proportion of J-stock animals in the Japanese bycatch were analysed using a set of formula identified by the Committee. The resulting trend was compared to that estimated in the RMP/IST trials under different assumptions for stock structure (Hypotheses A and C) and $MSYR_{1+}$. Only for an $MSYR_{1+}$ value of 2% or more under Hypothesis A were the model predictions consistent with the bycatch data. This conclusion was robust to the error structure for the time trend estimate from the bycatch data. Also, the results were not sensitive to how unassigned J/O animals were handled. There are discrepancies between the bycatch data and the model predictions at a sub-area level, which highlights the need to revise the mixing matrices for the RMP/IST trials. SC/67b/RMP02 also proposed a possible mechanism/function in the RMP/IST to assess plausibility over various assumptions regarding $MSYR_{1+}$ and stock structures hypotheses.

The sub-committee thanked Kitakado for the updated analysis, which implements some of the recommendations from the intersessional Workshop. It **agreed** that:

(1) it was necessary to update the mixing matrices in the trial specifications to be more consistent with observed bycatch data;
(2) whether it is possible to use the bycatch data to assign plausibility ranks to $MSYR_{1+}$ values and stock structure hypotheses depends on assumptions regarding trends in effort spatially and temporally; and
(3) trials would need to consider different assumptions regarding the use of J:O bycatch ratios, including that these data do not provide information on $MSYR_{1+}$ and the plausibility of stock structure hypotheses because of possible differential distributional changes by stock.

Therefore, it **recommended** that scientists from Japan and Korea provide data on the amount, location and timing (seasonal and annual) of effort and bycatch to the First Intersessional Workshop (see Item 3.2.3).

Analysis of genetic data since the intersessional workshop as well as a workplan are discussed in Annex I, item 4.5.

Attention: SC

The Committee ***agrees*** *that:*

(a) it is necessary to update the mixing matrices in the trial specifications to be more consistent with observed genetic and bycatch data, also taking into account sensitivity to alternative methods of genetic assignment to stock;
(b) whether it is possible to use the bycatch data to assign plausibility ranks to $MSYR_{1+}$ *values and stock structure hypotheses depends on assumptions regarding trends in fishing effort spatially and temporally; and*
(c) trials would need to consider different assumptions regarding the use of J:O bycatch ratios, including that these data do not provide information on $MSYR_{1+}$ *and the plausibility of stock structure hypotheses because of possible differential distributional changes by stock.*

The Committee therefore ***agrees*** *that scientists from Japan and Korea provide data on the amount, location and timing (seasonal and annual) of fishing effort and bycatch to the First Intersessional Workshop (see item 6.2.3).*

3.2.3 Preparation for the First Intersessional Workshop
The primary objectives of the First Intersessional Workshop are:

(1) review the plausible hypotheses and eliminate any hypotheses that are inconsistent with the data) – this will take into account the probable management implications of such hypotheses to try to avoid unnecessary work in the precise specifications of hypotheses for which these are very similar;
(2) examine more detailed information in expected operations, including whether coastal, pelagic, on migration, on feeding, on breeding or combinations of these. When providing such information, users and scientists may provide options or suggest modifications to the pattern of operations;
(3) review the small geographical areas ('sub-areas') that will be used in specifying the stock structure hypotheses and operational pattern; and
(4) specify the data and methods for conditioning the trials that will be carried out before the next annual meeting.

The sub-committee re-established the Steering Group (Donovan (Chair), Allison, Butterworth, Kitakado, Palka, Pastene, Punt, Tiedeman, Kim) to organise the Workshop. Appendix 5 provides an initial agenda for the Workshop, highlighting the associated data and analysis requirements.

3.3 Work plan 2019-20 – *Implementation*- related matters
[See Table below]

Work plan for RMP (*Implementation*-related matters).

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Item 3.1: Western North Pacific Bryde's whales	Finalise the projections and the application of the criteria for evaluating which RMP variants are acceptable, borderline, and unacceptable	Complete the *Implementation Review*		
Item 3.2: Western North Pacific minke whales	(a) conduct the First Intersessional Workshop; (b) code the resulting trials and condition the trials	Conduct the work required for the First Annual Meeting	Conduct the Second Intersessional Workshop	Conduct the work required for the Second Annual Meeting

4. BUDGETARY ITEMS 2019-20

(1) An intersessional Workshop (in early 2019) to conduct the First Intersessional Workshop for the *Implementation Review* for North Pacific common minke whales, with the possibility of an extra day to complete outstanding work to finalise the calculations for the *Implementation Review* for the Western North Bryde's whales (£15,000; Item 3.2).
(2) An intersessional Workshop (in early 2020) to conduct the Second Intersessional Workshop for the *Implementation Review* for North Pacific common minke (£15,000; Item 3.2).
(3) Essential computing support to the Secretariat for RMP (£23,000 over two years; Items 3.1 and 3.2).
(4) Development of an age-structured emulator for the individual-based energetics model (IBEM) (£7,000; Item 2.1).

The sub-committee gave high priority to the proposed Workshops and the essential computing support, 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*. Secondary priority was given to support for the development of an age-structured emulator for the individual-based energetics model. Volunteers from the sub-committee were asked to use the draft criteria in the proforma template to score the IBEM proposal to facilitate budgetary decisions across the Committee.

5. ADOPTION OF REPORT

The Report was adopted at 12:09 on 1 May 2018. The sub-committee acknowledged the considerable work undertaken by Allison, de Moor and Punt during the intersessional period and at this meeting. The sub-committee expressed its appreciation to Robbins for her chairing of the sub-committee.

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Appendix 1

AGENDA

1. Introductory items
    1.1 Convenor's opening remarks
    1.2 Election of Chair
    1.3 Appointment of rapporteur
    1.4 Adoption of Agenda
    1.5 Documents available
2. General assessment issues with a focus on those related to the revised management procedure
    2.1 Evaluate the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
    2.2 Implications of *IST*s for consideration of species' and populations' status
    2.3 General consideration of how to evaluate the effect of special permit catches on stocks and levels of information needed to show improved management performance
    2.4 Work plan 2019-20
3. RMP – *Implementation*-related matters
    3.1 Completion of the *Implementation Review* of western North Pacific Bryde's whales
        3.1.1 Report of the intersessional Workshop
            3.1.1.1 Progress since the intersessional Workshop
        3.1.2 Final trial specifications
        3.1.3 Conditioning of trials
        3.1.4 Conclusions and recommendations
    3.2 Start of the *Implementation Review* of western North Pacific common minke whales
        3.2.1 Report of the intersessional Workshop
        3.2.2 Progress since the intersessional Workshop
        3.2.3 Preparation for the First Intersessional Workshop
    3.3 Workplan 2019-20
4. Budgetary items 2019-20
5. Adoption of report

Appendix 2

GENERAL GUIDELINES FOR EVALUATING RESEARCH PROPOSALS WITH OBJECTIVES THAT INCLUDE IMPROVED MANAGEMENT

The following guidelines are designed to assist proponents as they develop their research proposals as well as the reviewers of such proposals. These guidelines relate only to those aspects of proposals that are aimed at improving management; proposals may often also include objectives unrelated to management. Proponents will normally provide an evaluation of:

(a) the potential benefits to management (and whether there is already evidence that such benefits exist or whether this is still unclear); and
(b) the likelihood that the research (including data collection and analysis within the timeline of the research) will be able to achieve the benefits within its stated timeline.

Proponents may also wish to provide a cost-benefit evaluation of alternative methods of obtaining and analysing data obtained using different techniques (e.g. lethal versus non-lethal) in the context of the levels of improved management expected.

It is noted that prior to long-term research proposals, proponents may include feasibility components intended to feed into the types of information/analyses envisaged below.

Proposals aimed at improved management would normally:

(1) include at least one objective of the research that can be expressed in a quantitative manner where the probability of success can in principle be evaluated, at least in a qualitative manner as outlined below (e.g. high, medium, low);
(2) express improved management as providing a greater level of catch without increasing risk to the stock(s) concerned, either by:
   - directly identify an improved management procedure given the current range of uncertainties; or
   - showing that additional research can, with reasonable probability, reduce the range of plausible hypotheses and thus uncertainty (i.e. a value of information approach).
(3) use a simulation test framework to demonstrate likely success and to provide some associated quantification unless some compelling reasons to the contrary can be offered (success of the approach proposed in other applications is a valuable but not sufficient basis for demonstration); and
(4) ensure that the test framework relates closely to the stock to which the proposal refers, taking into account the properties of existing data for the stock as well as future data planned to be collected.

Proponents might contact the Scientific Committee to form an Advisory Committee who would provide (technical) guidance on aspects of the analyses.

The guidance from an Advisory Committee would be non-binding on the proponents and following the guidance would not mean that the members of the Advisory Committee will automatically agree that the methodology is sufficient.

Establishment of an Advisory Committee could be especially beneficial for nations who lack the technical expertise and experience with the types of analyses outlined in (3)-(4), such as developing countries.

Appendix 3

THE SPECIFICATIONS FOR THE *IMPLEMENTATION SIMULATION TRIALS* FOR WESTERN NORTH PACIFIC BRYDE'S WHALES

C. Allison and C.L. de Moor

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 and the area of overlap (if any).

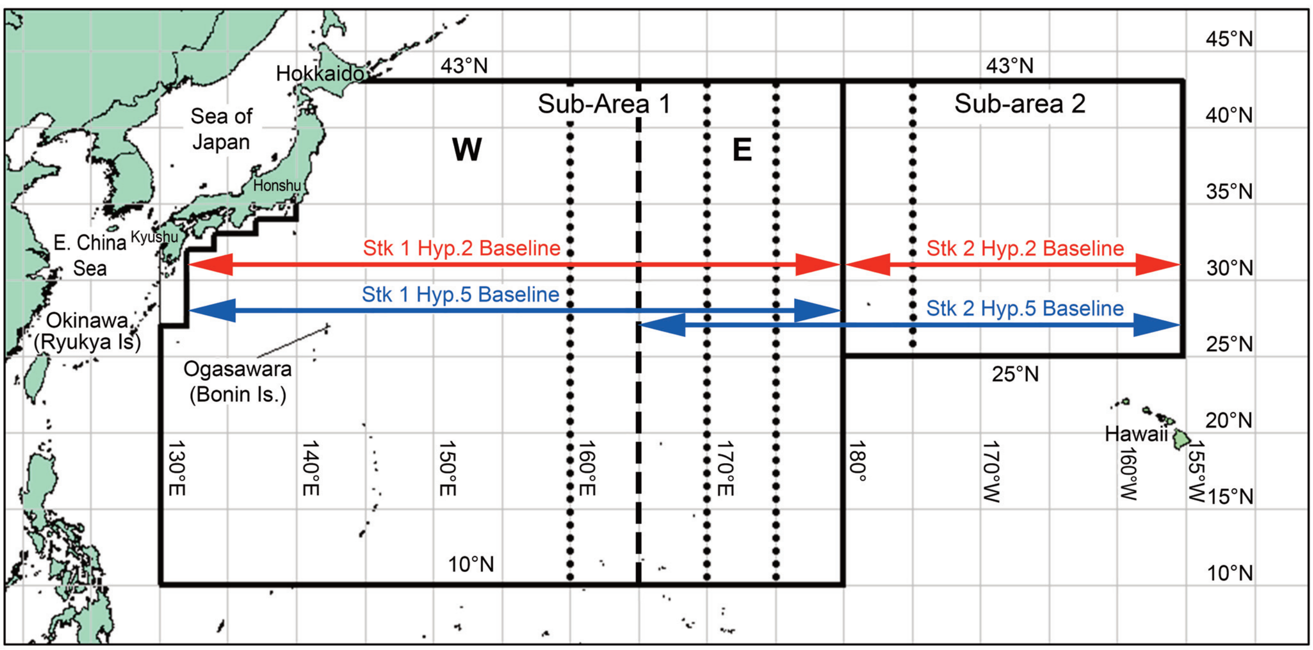

Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales. The ranges of the stocks for Hypotheses 2 and 5 (baselines) are also shown. The boundary between the sub-areas 1W and 1E at 165°E, indicated by a dashed line, is a management boundary (used by the RMP). The dotted lines at 160°E, 170°E, 175°E and 175°W denote the boundaries between the '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 are included in these trials.

The sub-areas are further divided into smaller 'Component-areas' (see Fig. 1 and Table 1) to enable these alternatives to be tested.

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.

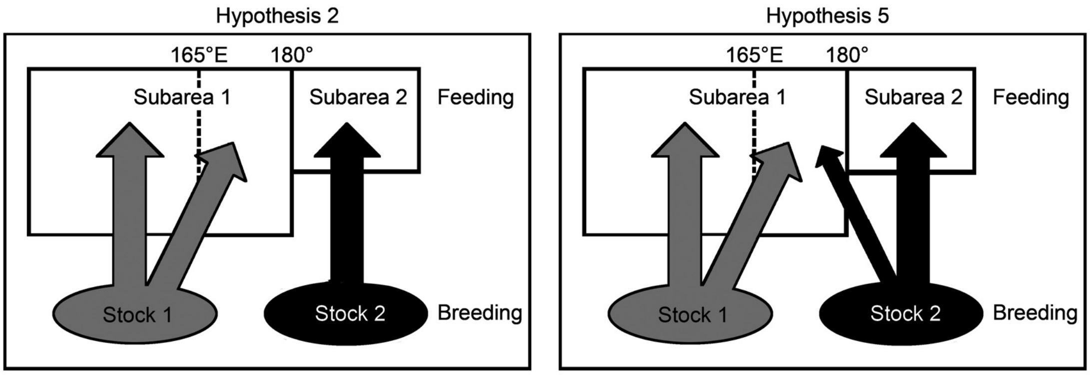

Fig. 2. The two hypotheses considered in the *Implementation Simulation Trials.*

B. Basic dynamics

The dynamics of the animals in stock j are governed by equation B.1:

$$N^{g,j}_{t+1,a} = \begin{cases} 0.5b^j_{t+1} & \text{if } a=0 \\ (N^{g,j}_{t,a-1} - C^{g,j}_{t,a-1})\tilde{S}^j_{t,a-1} & \text{if } 1 \le a < x \\ (N^{g,j}_{t,x} - C^{g,j}_{t,x})\tilde{S}^j_{t,x} + (N^{g,j}_{t,x-1} - C^{g,j}_{t,x-1})\tilde{S}^j_{t,x-1} & \text{if } a = x \end{cases} \tag{B.1}$$

where $N^{g,j}_{t,a}$ is the number of animals of gender g and age a in Stock j at the start of year t;
$C^{g,j}_{t,a}$ 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^j_t is the number of calves born to females from Stock j at the start of year t;
$\tilde{S}^j_{t,a}$ is the survival rate = $e^{-M^j_{t,a}}$ where $M^j_{t,a}$ is the instantaneous rate of natural mortality for animals of age a in Stock j during year t (assumed to be independent of gender); and
x is the maximum age (treated 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 be a function of the 1+ component of the population[2].

$$b^j_t = B^j N^{f,j}_t \{1 + A^j(1 - (N^{D,j}_t / K^{D,j})^{z^j})\} \tag{C.1}$$

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;
$N^{f,j}_t$ is the number of 'mature' females in Stock j at the start of year t

$$N^{f,j}_t = \sum_{a=a_m}^{x} N^{f,j}_{t,a} \tag{C.2}$$

a_m is the age-at-first-parturition (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);
$N^{D,j}_t$ is the number of whales in the density-dependent component of Stock j at the start of year t. In these trials:

$$N^{D,j}_t = \sum_{a=1}^{x} \left(N^{f,j}_{t,a} + N^{m,j}_{t,a} \right) \tag{C.3}$$

and

$K^{D,j}$ is the number of whales in the density dependent component of Stock j in the pristine (pre-exploitation written as t=–∞) population.

[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.
[2]This was changed at the February 2018 Workshop. In earlier RMP trials, density-dependence was assumed to be a function of the mature female component of the population. The control program retains the option to act on the mature female component.

$$K^{\mathrm{D},j} = \sum_{a=1}^{x}\left(N^{\mathrm{f},j}_{-\infty,a} + N^{m,j}_{-\infty,a}\right) \tag{C.4}$$

The values of the parameters and for each stock are calculated from the values for and (Punt, 1999). Their calculation assumes harvesting equal proportions of males and females.

D. Natural mortality

Natural mortality is assumed to be density-dependent in trials Br9 and Br10, i.e.:

$$M^j_{t,a} = M_a X^j_t \tag{D.1}$$

where M_a is the rate of natural mortality for an animal of age a in the pristine population;
X^j_t is the density-dependence term for natural mortality (Johnson and Punt, 2015):

$$X^j_t \frac{1 + A^{\mathrm{M},j}(N^{\mathrm{D},j}_t / K^{\mathrm{D},j}_t)^{z^{\mathrm{M},j}}}{1 + A^{\mathrm{M},j}} \tag{D.2}$$

$A^{\mathrm{M},j}$ is the resilience parameter for Stock j; and
$z^{\mathrm{M},j}$ is the degree of compensation for Stock j.

In these trials the number of calves born becomes:

$$b^j_t = B^j N^{f,j}_t \tag{D.3}$$

E. 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.:

$$C^{g,j}_{t,a} = \sum_k F^{g,k}_t V^{j,k} S^k_{t,a} N^{g,j}_{t,a} \tag{E.1}$$

$$F^{g,k}_t = \frac{C^{g,k}_t}{\sum_{j'} V^{j',k} \sum_{a'} S^k_{t,a} N^{g,j'}_{t,a}} \tag{E.2}$$

where $F^{g,k}_t$ is the exploitation rate in Component-area k on recruited animals of gender g during year t;
$S^k_{t,a}$ is the selectivity on animals of age a in Component-area k during year t;
$C^{g,k}_t$ 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 Adjunct 1); 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.

F1. 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 Br6	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 Br7	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 Br8	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

- The 4:1 ratios used in sub-area 1W are calculated from the ratio of the areas of sub-area 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=33/18.
- For Hypothesis 2, the ratio of the number of Stock 1 whales in sub-area 1W to that in 1E is estimated during conditioning using the relative abundance in the two sub-areas. In trials Br6, 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.

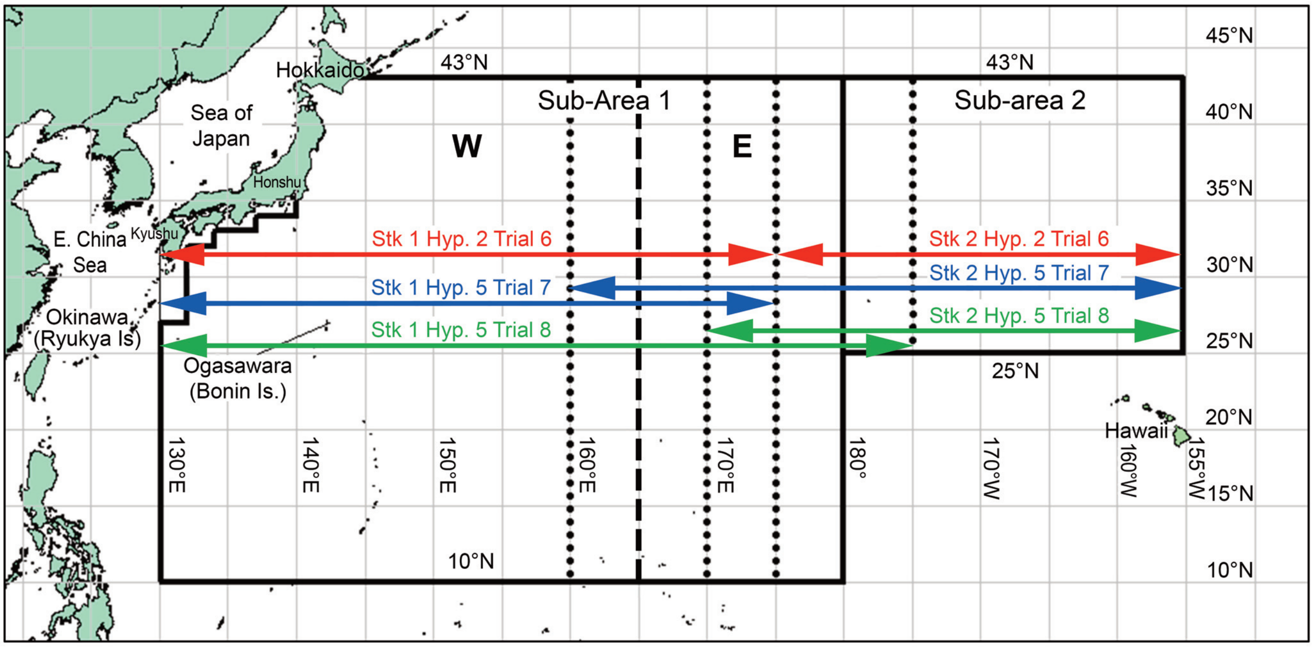

Fig. 3. The ranges of the stocks tested in trials 6, 7 and 8.

F2. Boundary

The management boundaries (i.e. the boundaries used by the RMP) are fixed at 165°E and 180° for all trials. In the baseline trials, the boundary between sub-areas 1W and 1E and that between 1E and 2 used when modelling the true population dynamics is the same as that used when applying the RMP, i.e. at 165°E and 180° respectively. However, a different boundary is used for some of the trials. Trials Br6 assume the boundary between Stocks 1 and 2 is at 175˚E. Stock structure hypothesis 5 assumes mixing between Stocks 1 and 2 in an intermediate area. This intermediate area corresponds to sub-area 1E for the baseline version of hypothesis 5. In trials Br7 the intermediate area is 5° further west than for the baseline trial, while in trials Br8 the intermediate area is 5° further east (Fig. 3).

G. Generation of data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the RMP are listed in Table 2. Four ways of generating future survey data are considered. This allows for two alternative survey plans (Table 3) and two alternative southern survey boundaries in sub-areas 1W and 1E (at 10°N and 20°N). When future surveys are assumed to be conducted to 10˚N in sub-areas 1W and 1E, future surveys are assumed to cover each of sub-areas 1W, 1E and 2 in their entirety. This may be a simplification of reality for future survey option 2 (Table 3). The trials assume that it takes two years for the results of a sighting survey to become available to be used by the RMP, 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:

$$\hat{P} = P\, Y\, w\, /\, \mu = P^{*} \beta^{2}\, Y\, w \tag{G.1}$$

where Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim \mathrm{N}(0;\sigma_{\varepsilon}^{2})$ and $\sigma_{\varepsilon}^{2} = \ell\mathrm{n}(\alpha^{2}+1)$;

P is the current total (1+) population size in survey area E:

$$P = P_{t}^{E} = \sum_{k \in E} \sum_{j} V_{t}^{j,k} \sum_{g} \sum_{a \geq 1} N_{t,a}^{g,j} \tag{G.2}$$

w is a Poisson random variable with $E(w) = \mathrm{var}(w) = \mu = (P\, /\, P^{*})/\beta^{2}$, Y and w are independent; 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 $CV^{2}(\hat{P}) \cong \alpha^{2}+\alpha^{2}P^{*}\, /\, P$.

For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; 1994, pp.85-6) the ratio $\alpha^{2} : \beta^{2} = 0.12 : 0.025$, so that:

$$\mathrm{CV}^{2}(\hat{P}) = \tau(0.12+0.025P^{*}\, /\, P) \tag{G.3}$$

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 $\bar{P}$ is the average value of the total (1+) population sizes in area E in the years of these surveys, then:

$$\tau = \overline{CV^{2}}\, /\, (0.12+0.025P^{*}\, /\, \bar{P}) \tag{G.4}$$

Note therefore that:

$$\alpha^{2} = 0.12\tau \qquad \beta^{2} = 0.025\tau \tag{G.5}$$

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:

$$\sigma_\varepsilon^2 = \ell n(1+\alpha^2+CV_{add}^2) \tag{G.6}$$

CV_{add} = 0.335 in the baseline trials (Hakamada *et al.*, 2017), while for trials Br5, CV_{add} = 0.737 [see item 3.2.3 of SC/67b/Rep02]. An estimate of the CV is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV(\hat{P})_{est}^2 = \sigma^2\chi^2 / n \tag{G.7}$$

where $\sigma^2 = \ell n(1+\alpha^2+\beta^2 P^* / \hat{P})$, and

χ^2 is a random number from a Chi-square distribution with n degrees of freedom (where n=1 (IWC, 2007) 0 as used for the North Pacific minke whale (*Implementation Simulation Trials*; IWC, 2004).

Table 2

The estimates of abundance and their sampling errors. These estimates of abundance correspond to an western boundary of 130°E for sub-area 1W and a southern boundary of 10°N for sub-areas 1W and 1E. Additional estimates corresponding to the smaller area with a southern boundary of 20°N are also provided for sub-areas 1W and 1E. The methods used to derive these values from the original abundance estimates in cases where the survey area differed from the area used here, were agreed in Feb2018 report. The estimates of abundance in sub-areas 1E and 2 exclude the portion of the sub-area north of 40˚N (see Annex F, Feb2018 report), with the corresponding assumption that a negligible number of whales are found in this area. Survey-specific g(0) values are used (SC67b/ASI/15rev1) with an assumed constant $g(0)$ CV = 0.25.

			Southern boundary of 10˚N in sub-areas 1W and 1E				Southern boundary of 20˚N in sub-areas 1W and 1E			
		Survey-specific g(0)	g(0) = 1		Survey-specific g(0)		g(0) = 1		Survey-specific g(0)	
Sub-area	Year		Estimate	Sampling CV	Estimate	Sampling CV	Estimate	Sampling CV	Estimate	Sampling CV
1W	1995[4]	0.671	8,152	0.329	12,149	0.413	5,110	0.192	7,604	0.315
	2000	0.719	4,957	0.398	6,894	0.470	4,222	0.317	5,872	0.404
	2011	0.613	24,536[1]	0.313	40,026	0.401	20,386[2]	0.274	33,256	0.371
1E	1995[4]	0.689	10,814	0.342	15,695	0.424	7,246	0.479	10,517	0.540
	2000	0.584	11,213	0.498	19,200	0.557	9,251	0.295	15,841	0.387
	2011	0.721	6,914[3]	0.211	9,589	0.327	6,716	0.216	9,315	0.330
2	1995[4]	0.659	2,860	0.372	4,340	0.448				
	2000	0.712	4,331	0.553	6,083	0.607				
	2014	0.641	4,161	0.264	6,491	0.364				

[1] This estimate was revised from15,422 [CV=0.289] to account for unsurveyed areas between 130-140°E and 10-20°N (Adjunct 2).
[2] This estimate was revised from 15,422 [CV=0.289] to account for unsurveyed areas between 10-20°N (Adjunct 2).
[3] This estimate was revised from 6,716 [CV=0.216] to account for unsurveyed areas between 10-20°N (Adjunct).
[4] The 1995 estimates are only used in conditioning and in the calculation of x_{1W} and x_{1E}, and not passed to the RMP.

Table 3

Sighting survey plan. All surveys are conducted in Jul-Aug.

Season	Option 1			Option 2				
	130°-165°E	165°E-180°	180°-160°W	130°-140°E	140°-152.5°E	152.5°-165°E	165°E-180°	180°-160°W
Sub-Area	1W	1E	2	1W	1W	1W	1E	2
2017								
2018								
2019								
2020	Yes[1]			Yes				
2021					Yes[2]			
2022		Yes				Yes		
2023							Yes	
2024			Yes					Yes
2025				Yes				
2026	Yes[1]				Yes[2]			
2027						Yes		
2028		Yes					Yes	
2029								Yes
2030			Yes	Yes				
2031					Yes[2]			
2032	Yes[1]					Yes		
and so on in this pattern								

[1] The survey effort in 1W will be double that of the past and thus $CV^2(\hat{P}) = \tau(0.12 + 0.025\,P^*/P)$ in equation (G,3) is replaced by $CV^2(\hat{P}) = \tau(0.12 + 0.025\,P^*/P)/\sqrt{2}$, prior to CV_{add} being incorporated in equation (G.7).
[2] Future surveys of sub-area 1W will be modelled to occur in a single year, although in practice it will take 3 years to survey the whole sub-area. Assuming the whales are distributed equally throughout the three part-areas of sub-area 1W surveyed, the variance from each of these annual surveys would be $(P/3 * SE)^2 = (P^2/9)(CV^2 + CV_{add}^2)$. The variance for 1W will thus be 3 times this, giving an effective CV of $\sqrt{(CV^2 + CV_{add}^2)/3}$, and equation (G.6) is replaced by $\sigma_\varepsilon^2 = ln[1 + (\alpha^2 + CV_{add}^2)/3]$. For this future survey plan, the additional CV increases to $CV_{add} = 0.767$ for sub-area 1W and for Trials Br05 to $CV_{add} = 1.516$ (Adjunct 3).

Future surveys covering smaller areas than historical surveys
When future surveys are assumed to be conducted south to 20˚N in sub-areas 1W and 1E, the future survey estimates of abundance in these sub-areas is given by $\hat{P}_{k'} = x_k\hat{P}_k$, where $\hat{P}_k$ is provided by equation (G.1) for sub-area k, and the proportions are generated from normal distributions x_{1W}~$Beta(0.77, 0.12^2)$ and x_{1E}~$Beta(0.82, 0.15^2)$. These normal distributions are given the mean and standard deviations of the proportions of the three historical survey estimates of abundance in these sub-areas that was north of 20°N.

H. 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 E.1 and E.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:

$$P_t^E = O_t^E \exp[\mu_t^E - (\sigma_t^E)^2 / 2]; \; \mu_t^E \sim \mathrm{N}[0;(\sigma_t^E)^2] \tag{H.1}$$

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 2, 10°N southern boundary); and
σ_t^E is the CV of O_t^E (Table 2).

(b) The 'targets' for the mixing proportion in the mixing area trials based on stock structure hypothesis 5 are generated from normal distributions (mean and SD given in Table 5), truncated at 0 and 1.

Table 4

The values for the biological and technological parameters that are fixed.

Parameter	Value
Plus group age, x	15 yrs
Natural mortality, M_a	0.08yr^{-1}
Age-at-first-parturition, a_m	9 years (See Annex I of SC/67a/Rep07: calculated as 8.6)
Selectivity (historical)	
Sub-area 1W:	Knife-edged at age 5 (IWC, 2000, 2005)
Sub-areas 1E & 2:	Knife-edged at age 9 (IWC, 2000, 2005)
Selectivity (future)	Knife-edged at age 5 (IWC, 2007 p415)
Maximum Sustainable Yield Level, $MSYL$	0.6 in terms of the1+ component of the population

Table 5

Estimates and asymptotic standard errors for the mixing proportions between Stocks 1 and 2 in Hypothesis 5 trials (Punt 2018).

Area	Average proportion of Stock 1 between 2004-2014 (from JARPNII/POWER samples)	Standard Error	Proportion of Stock 1 in 1979 (from commercial samples)	Standard Error
Baseline: 165°E-180°	1.000	0.114	0.851	0.132
Trial Br7: 160°E-175°E	0.900	0.065	0.933	0.057
Trial Br8: 170°E-175°W	0.644	0.144	1.000	0.467

I. Calculation of the Likelihood
The likelihood function consists of two components. Equations H.2 and H.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

$$L_1 = 0.5\sum_n \frac{1}{(\sigma_n)^2}\ell n(P_n / \hat{P}_n)^2 \tag{H.2}$$

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 $\hat{P}_n$ (the target abundances).

Mixing proportions

$$L_2 = 0.5\frac{1}{\sigma_{79}^2}(p_{79} - \hat{p}_{79})^2 + 0.5\frac{1}{\sigma_{04}^2}(p_{04} - \hat{p}_{04})^2 \tag{H.3}$$

where $\hat{P}_{79}$ is the model estimate of the proportion of Stock 1 animals in the mixing area[3] in 1979,
$\hat{P}_{04}$ is the average of the model estimate of the proportion of Stock 1 animals in the mixing area[3] over 2004 to 2014, and
$\hat{P}_{79}$ and $\hat{P}_{04}$ are the 'target' mixing proportions from commercial samples in 1979 and JARPNII/POWER survey samples between 2004-2014, respectively, given in Table 5.

J. 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)=0.672. Table 7 lists the factors used in the trials. These trials will be run under the following four future survey options:

(i) Future survey option 1 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 10˚N
(ii) Future survey option 1 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 20˚N
(iii) Future survey option 2 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 10˚N
(iv) Future survey option 2 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 20˚N

Table 6

The *Implementation Simulation Trials* for the Western North Pacific Bryde's whales.

Trial	Stock structure hypothesis	MSYR[1]	Additional variance	Catch series	Western boundary of Stock 2	Eastern boundary of Stock 1	Comment
Br1-1	2	1	Baseline	Best	180°	180°	Baseline stock structure hypothesis 2
Br1-4	2	4	Baseline	Best	180°	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	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
Br6-4	2	4	Baseline	Best	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
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	2	1	Baseline	Best	180°	180°	Density-dependent *M*
Br9-4	2	4	Baseline	Best	180°	180°	Density-dependent *M*
Br10-1	5	1	Baseline	Best	165°	180°	Density-dependent *M*
Br10-4	5	4	Baseline	Best	165°	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

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	$\boldsymbol{MSYR_{1+} = 1\%; MSYR_{mat} = 4\%}$
Catch series	Low, **Best**, High
Additional variance	**Baseline = 0.335**, Upper 5%ile = 0.737
Western boundary of Stock 2	160°E, **165°E**, **180°**, 170°E
Eastern boundary of Stock 1	175°E, **180°**, 175°W

K. 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.

All future catches from sub-area 1W will be simulated to only be taken in component area 1Wa (closest to the coast of Japan).

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 Adjunct 1).

[3]The mixing area is sub-area 1E (165˚E-180˚E) for the baseline trials, but changes to 160°E-175°E for trials Br7, and 170°E-175°W for trials Br8.

L. 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 (2005).

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Adjunct 1. The Catch Series used in the Trials

Year	1Wa M	1Wa F	1Wb M	1Wb F	1Ea M	1Ea F	1Eb M	1Eb F	1Ec M	1Ec F	2a M	2a F	2b M	2b F
1906	6	7	0	0	0	0	0	0	0	0	0	0	0	0
1907	17	18	0	0	0	0	0	0	0	0	0	0	0	0
1908	39	42	0	0	0	0	0	0	0	0	0	0	0	0
1909	23	24	0	0	0	0	0	0	0	0	0	0	0	0
1910	26	29	0	0	0	0	0	0	0	0	0	0	0	0
1911	75	81	0	0	0	0	0	0	0	0	0	0	0	0
1912	38	43	0	0	0	0	0	0	0	0	0	0	0	0
1913	58	66	0	0	0	0	0	0	0	0	0	0	0	0
1914	24	32	0	0	0	0	0	0	0	0	0	0	0	0
1915	72	97	0	0	0	0	0	0	0	0	0	0	0	0
1916	45	60	0	0	0	0	0	0	0	0	0	0	0	0
1917	88	93	0	0	0	0	0	0	0	0	0	0	0	0
1918	69	79	0	0	0	0	0	0	0	0	0	0	0	0
1919	77	84	0	0	0	0	0	0	0	0	0	0	0	0
1920	41	51	0	0	0	0	0	0	0	0	0	0	0	0
1921	40	49	0	0	0	0	0	0	0	0	0	0	0	0
1922	37	44	0	0	0	0	0	0	0	0	0	0	0	0
1923	32	43	0	0	0	0	0	0	0	0	0	0	0	0
1924	48	63	0	0	0	0	0	0	0	0	0	0	0	0
1925	55	63	0	0	0	0	0	0	0	0	0	0	0	0
1926	60	74	0	0	0	0	0	0	0	0	0	0	0	0
1927	53	65	0	0	0	0	0	0	0	0	0	0	0	0
1928	36	44	0	0	0	0	0	0	0	0	0	0	0	0
1929	29	34	0	0	0	0	0	0	0	0	0	0	0	0
1930	27	35	0	0	0	0	0	0	0	0	0	0	0	0
1931	64	71	0	0	0	0	0	0	0	0	0	0	0	0
1932	51	53	0	0	0	0	0	0	0	0	0	0	0	0
1933	39	49	0	0	0	0	0	0	0	0	0	0	0	0
1934	48	51	0	0	0	0	0	0	0	0	0	0	0	0
1935	48	48	0	0	0	0	0	0	0	0	0	0	0	0

Year	1Wa M	1Wa F	1Wb M	1Wb F	1Ea M	1Ea F	1Eb M	1Eb F	1Ec M	1Ec F	2a M	2a F	2b M	2b F
1936	40	48	0	0	0	0	0	0	0	0	0	0	0	0
1937	60	66	0	0	0	0	0	0	0	0	0	0	0	0
1938	76	83	0	0	0	0	0	0	0	0	0	0	0	0
1939	88	105	0	0	0	0	0	0	0	0	0	0	0	0
1940	48	57	0	0	0	0	0	0	0	0	0	0	0	0
1941	64	81	0	0	0	0	0	0	0	0	0	0	0	0
1942	9	12	0	0	0	0	0	0	0	0	0	0	0	0
1943	17	13	0	0	0	0	0	0	0	0	0	0	0	0
1944	37	37	0	0	0	0	0	0	0	0	0	0	0	0
1945	5	7	0	0	0	0	0	0	0	0	0	0	0	0
1946	52	74	0	0	0	0	0	0	0	0	0	0	0	0
1947	51	60	0	0	0	0	0	0	0	0	0	0	0	0
1948	57	76	0	0	0	0	0	0	0	0	0	0	0	0
1949	101	97	0	0	0	0	0	0	0	0	0	0	0	0
1950	117	156	0	0	0	0	0	0	0	0	0	0	0	0
1951	166	141	0	0	0	0	0	0	0	0	0	0	0	0
1952	303	188	0	0	0	0	0	0	0	0	0	0	0	0
1953	25	36	0	0	0	0	0	0	0	0	0	0	0	0
1954	31	44	0	0	0	0	0	0	0	0	0	0	0	0
1955	34	60	0	0	0	0	0	0	0	0	0	0	0	0
1956	12	12	0	0	0	0	0	0	0	0	0	0	0	0
1957	12	27	0	0	0	0	0	0	0	0	0	0	0	0
1958	113	141	0	0	0	0	0	0	0	0	0	0	0	0
1959	153	110	0	0	0	0	0	0	0	0	0	0	0	0
1960	188	216	0	0	0	0	0	0	0	0	0	0	0	0
1961	83	84	0	0	0	0	0	0	0	0	0	0	0	0
1962	209	295	0	0	0	0	0	0	0	0	0	0	0	0
1963	100	110	0	0	0	0	0	0	0	0	0	0	0	0
1964	25	43	0	0	0	0	0	0	0	0	0	0	0	0
1965	1	7	0	0	0	0	0	0	1	1	2	2	0	0
1966	19	36	0	0	0	0	0	0	1	2	2	3	0	0
1967	17	28	0	0	0	0	0	0	0	0	0	0	0	0
1968	70	101	0	0	0	0	0	0	1	2	4	5	0	0
1969	34	55	0	0	0	0	0	0	6	10	16	22	0	0
1970	36	37	0	0	0	0	0	0	4	7	11	15	0	0
1971	96	121	0	0	37	54	19	19	62	93	48	70	23	29
1972	38	46	0	0	2	4	0	0	20	37	4	6	0	3
1973	185	391	5	11	6	6	7	12	7	13	4	11	16	25
1974	282	418	5	4	13	9	12	30	95	147	67	84	80	76
1975	349	331	9	12	17	37	72	76	40	54	89	119	138	89
1976	379	446	11	15	106	62	183	95	81	50	14	5	11	1
1977	182	192	234	179	66	49	10	14	2	9	0	3	2	4
1978	252	203	22	13	102	48	51	57	14	21	7	4	1	1
1981	249	236	0	0	0	0	0	0	0	0	0	0	0	0
1982	275	207	0	0	0	0	0	0	0	0	0	0	0	0
1983	403	142	0	0	0	0	0	0	0	0	0	0	0	0
1984	353	175	0	0	0	0	0	0	0	0	0	0	0	0
1985	249	108	0	0	0	0	0	0	0	0	0	0	0	0
1986	217	100	0	0	0	0	0	0	0	0	0	0	0	0
1987	256	61	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	20	23	0	0	0	0	0	0	0	0	0	0	0	0
2001	17	33	0	0	0	0	0	0	0	0	0	0	0	0
2002	25	25	0	0	0	0	0	0	0	0	0	0	0	0
2003	18	28	1	3	0	0	0	0	0	0	0	0	0	0
2004	14	23	5	2	1	6	0	0	0	0	0	0	0	0
2005	21	26	0	3	0	0	0	0	0	0	0	0	0	0
2006	12	7	6	13	3	10	0	0	0	0	0	0	0	0
2007	23	25	0	0	0	2	0	0	0	0	0	0	0	0
2008	30	20	0	0	0	0	0	0	0	0	0	0	0	0
2009	15	18	1	1	2	13	0	0	0	0	0	0	0	0
2010	3	5	17	11	5	9	0	0	0	0	0	0	0	0
2011	17	24	1	4	2	2	0	0	0	0	0	0	0	0
2012	10	17	1	3	0	3	0	0	0	0	0	0	0	0
2013	12	13	1	2	0	0	0	0	0	0	0	0	0	0
2014	6	19	0	0	0	0	0	0	0	0	0	0	0	0
2015	14	11	0	0	0	0	0	0	0	0	0	0	0	0
2016	7	14	4	1	0	0	0	0	0	0	0	0	0	0

Adjunct 2. A Strategy to Estimate Abundance for Conditioning

D. Palka

For conditioning, abundance estimates for the entire area for the entire historical time series are required. The entire area is defined as the sub-areas 1W, 1E and 2, less the hatched region between 165°E and 165°W in the northeast (Fig. 1). The abundance time series consists of three sets of abundance surveys where the abundance estimates are centred on, and therefore time stamped 1995 (1988-1996; Shimada *et al.*, 2008; Figs 2-3), 2000 (1998-2002; Kitakado *et al.*, 2008; Fig. 4) and 2011 (2008-2015; Fig 5).

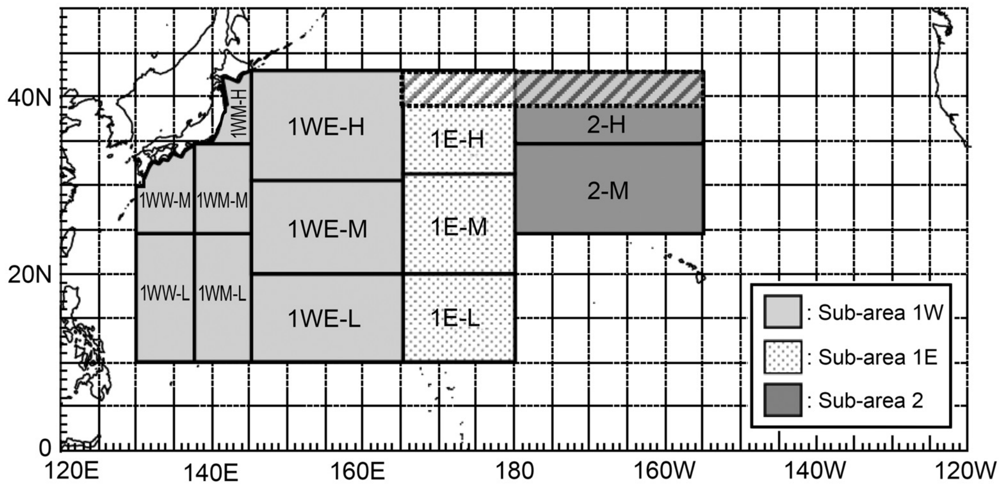


Fig. 1. Sub-areas and blocks used for the abundance estimation. H, M and L mean high, middle and low latitudes. The northern parts (shaded) in the two blocks, 1E-H and 2-H, were excluded from the estimation of abundances, which means any detections and effort in those parts were not included in the analyses, and the abundance estimates in those blocks were calculated for the southern parts of 1E-H and 2-H. A more detailed explanation is given in Shimada *et al*. (2008).

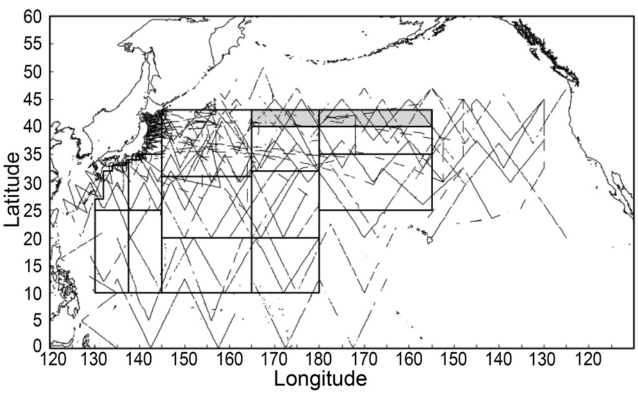


Fig. 2. Pre-determined cruise track lines on effort during the past sightings surveys in August and September, 1988-1996 (time stamp 1995). The northern part (north of 39˚ N) of 1E-H and 2-H block excluded this abundance estimation to keep consistency of estimation in the recent surveys that were not covered enough, shown as grey colour.

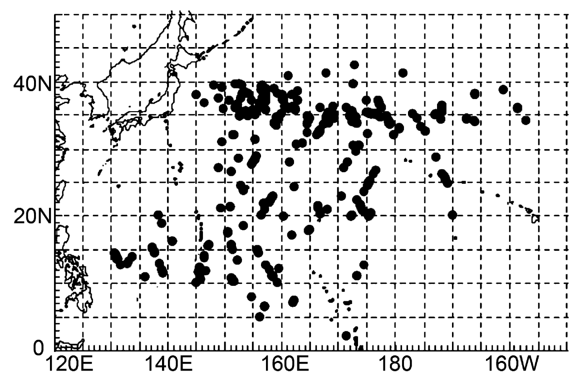


Fig. 3. Primary sighting positions of Bryde's whale during the past sighting surveys in August and September, 1988-1996 (time stamp 1995)

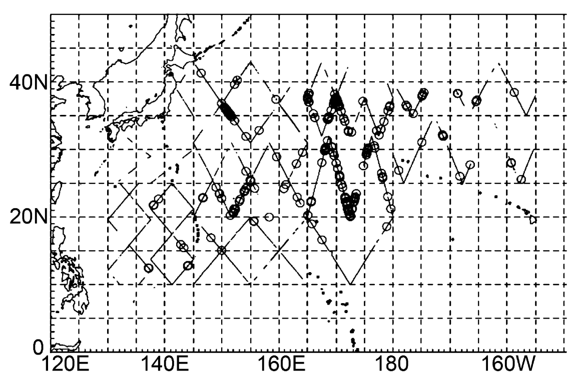


Fig. 4. Primary sighting positions of Bryde's whale and track lines on effort for surveys in August and September, 1998-2002 (time stamp 2000)

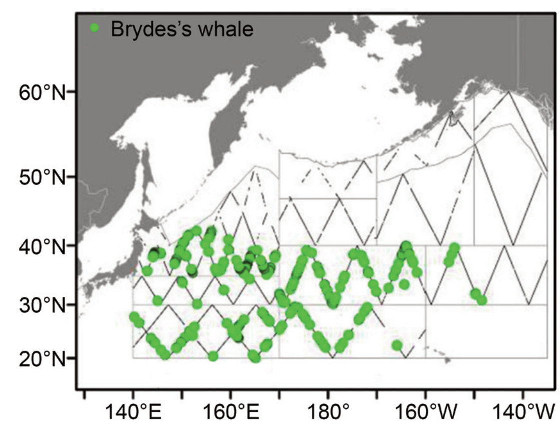


Fig. 5. Plot of primary sightings for Bryde's whales (green circles) and tracklines actually surveyed during 2008-2015 (time stamp 2011).

The abundance for the entire area has already been estimated (and agreed by the Committee) for the first two sets of surveys that were time stamped 1995 and 2000. However, the set of surveys time stamped 2011 did not cover the whole of the 1W sub-area. Thus the previously reported abundance estimates for 1W and 1E for the 2011 set of surveys represents only a partial estimates for the 1W and 1E sub-areas, respectively. Therefore, to make the 1W and 1E abundance estimates from the 2011 set of surveys comparable to the earlier two sets of surveys, the partial 1W and 1E abundance estimates from the 2011 set of surveys must be expanded by adding an approximate estimate of the abundance in the unsurveyed areas.

The best abundance estimate for an unsurveyed sub-areas for the 2011 set of surveys was derived from the abundance estimates for these sub-areas as calculated from the 1995 and 2000 previous sets of surveys. It was assumed that for each set of surveys, the ratio of the abundance in the 2011 unsurveyed areas to the abundance in the 2011 surveyed areas were similar. Since there are two sets of previous surveys, the average ratio of unsurveyed to surveyed abundance estimates from the two previous sets of surveys was assumed to be the most representative number to use to expand the 2011 partial abundance estimates using:

$$N_{tot2011} = N_{part2011} + \left(N_{part2011} \cdot Average\left[\frac{N_{unsurv.i}}{N_{surv.i}} \right] \right) \qquad \text{(eq. 1)}$$

where $N_{unsurv.i}$ is the abundance in the 2011 unsurveyed sub-areas from the ith set of surveys
$N_{surv.i}$ is the abundance in the 2011 surveyed sub-areas from the ith set of surveys
i is the set of surveys time stamped either 1995 or 2000.

The CV of $N_{tot2011}$ was estimated using the delta method.

The best estimates used to represent the 2000 set of surveys are the abundance estimates derived from a combination of the surveys conducted during 1998-2002, as reported in Kitakado *et al.* (2008), Table 3. Because combined abundances for each sub-sub-area was not available for the 1995 set of surveys, the most represent set of sub-sub-area abundance estimates was from the single year 1993 as reported in Shimada *et al.* (2008), Table 8a.

Results

1W sub-area: The partial abundance estimate for the surveyed regions from the 2011 set of surveys in 1W is $N_{1W\text{-}part2011}$=15,422 CV=0.289. The 1W sub-sub-areas not surveyed during the 2011 set of surveys and where there were Bryde's whales are between 130°-140°E (sub-sub-areas 1WW-M, 1WW-L and 1WM-L) and between 10°-20°N (sub-sub-area 1WE-L). Sub-sub-areas 1WM-M and 1WM-H were also not surveyed in 2011, but there were no Bryde's whales detected in the earlier two set of surveys (Figs 3 and 4), so it is assumed that there were no Bryde's whales in these sub-sub-areas during the 2011 set of surveys.

Using equation 1, the expanded 2011 abundance estimate for the entire 1W sub-area, $N_{1W\text{-}tot2011}$ (including 130°-140°E and 10°-20°N) was estimated to be 24,536 (CV=0.313; Table 1A). The expanded 2011 partial abundance estimate that represents the 1W sub-area that includes 130°-140°E, but no 10°-20°N is 20,386 (CV=0.274; Table 1B).

1E sub-area: The partial abundance estimate for the surveyed regions from the 2011 set of surveys in 1E is $N_{1E\text{-}part2011}$=6,716 CV=0.216. The 1E sub-sub-area not surveyed during the 2011 set of surveys is between 10°-20°N (sub-sub-area 1E-L).

Using equation 1, the expanded abundance estimate for the entire 1E sub-area, $N_{1E\text{-}tot2011}$ was estimated to be 6,914 (CV=0.211; Table 2).

Table 1

Estimate of abundance for the entire 1W sub-area for the 2011 set of surveys ($N_{tot2011}$). Estimates representing the 1995 set of surveys were taken from the 1993 single year's estimates from the base case in Shimada et al. 2008 (SC60/PFI2; Table 8a). Estimates from the 2000 set of surveys were taken from run 1, Model 4 in Kitakado *et al.* 2008 (SC60/PFI3; Table 3).

		Unsurveyed sub-areas in 2011 set of surveys				Surveyed sub-areas in 2011 set of surveys									
		130°-140°E			10°-20°N										
Timestamp year		1WW-M	1WW-L	1WM-L	1WE-L	1WE-H	1WE-M	$N_{surv.i}$	$N_{unsurv.i}$	total	unsurveyed/ surveyed	average extra bit	1W $N_{part2011}$	2011 unsurveyed sub-areas	**1W $N_{tot2011}$**
A. Adding in unsurveyed regions between 130°-140°E and 10°-20°N															
1993	Abun	110	2132	792	3002	3531	3450	6981	6036	13017	0.8646	0.59095	15422	9113.6	**24535.6**
	CV	0.6682	0.5812	0.5627	0.7114	1.2805	0.5348	0.6995	0.4158	0.4218	0.8138	0.6225	0.289	0.6863	**0.3130**
2000	Abun	0	348	439	407	1238	2525	3763	1194	4957	0.3173				
	CV	0	1.0632	0.784	0.7379	0.6371	0.6149	0.4628	0.4923	0.3708	0.6757				
B. Adding in unsurveyed regions between 130°-140°E															
1993	Abun	110	2132	792	0	3531	3450	6981	3034	1001	0.4346	0.3218	15422	4963.6	**20385.6**
	CV	0.6682	0.5812	0.5627	0	1.2805	0.5348	0.6995	0.4347	0.5051	0.8236	0.6125	0.289	0.6773	**0.2738**
2000	Abun	0	348	439	0	1238	2525	3763	787	4550	0.2091				
	CV	0	1.0632	0.784	0	0.6371	0.6149	0.4628	0.6421	0.3985	0.7915				

Table 2.

Estimate of abundance for the entire 1E sub-area for the 2011 set of surveys ($N_{tot2011}$). Estimates representing the 1995 set of surveys were taken from the 1993 single year's estimates from the base case in Shimada et al. 2008 (SC60/PFI2; Table 8a). Estimates from the 2000 set of surveys were taken from run 1, Model 4 in Kitakado *et al.* 2008 (SC60/PFI3; Table 3).

Timestamp year		Unsurveyed in 2011 (10°-20°N) 1E-L	Surveyed sub-areas in 2011 set of surveys 1E-H	total	Unsurveyed/ surveyed	Average extra bit	1E $N_{part2011}$	2011 Unsurveyed sub-areas	**1E $N_{tot2011}$**
1993	Abun	622	13634	21388	0.03	0.02945	6716	197.8	**6913.8**
	CV	0.7428	0.7427	0.6442	0.9958	0.675	0.216	0.7087	**0.2108**
2000	Abun	315	3480	11213	0.0289				
	CV	0.7646	0.5967	0.4765	0.908				

REFERENCES

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].

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].

Adjunct 3. Future Sighting Survey Plan for North Pacific Bryde's Whale – Additional CV for Three Longitudinal Blocks in Sub-area 1W

T. Hakamada and T. Miyashita

One of the options in Japan's future sighting survey plan for North Pacific Bryde's whale is sub-area 1W divided into three longitudinal blocks: (1) 130°E-140°E; (2) 140°E-152°30'E; and (3) 152°30'E-165°E (Fig. 1). This is because the whole sub-area 1W is too large to be covered within one year survey. Estimates of additional variance for the three blocks is required.

Table 1 shows the abundance estimates and CV for estimating additional variance. In the period 2008-15, there was no abundance estimate for 1W_1 blocks. Abundance for 1988-96 was re-allocated from the value in 1993 when the surveys covered all blocks once a year in Shimada *et al.* (2008) (Table 8a in SC/60/PFI1). Abundance for 1998-2002 was re-allocated from

Table 1

Abundance estimates in the three longitudinal blocks of sub-area 1W for estimating additional variance.

	1W_1(130E-140E, 10N-43N)				1W_2 (140E-152.5E, 10N-43N)				1W_3 (152.5E-165E, 10N-43N)			
	Year	P	CV(P)	Areal coverage (%)	Year	P	CV(P)	Areal coverage (%)	Year	P	CV(P)	Areal coverage (%)
1988-1996	1993	2,506	0.506	90.9	1995	4,271	0.769	96.2	1995	6,239	0.675	76.1
1998-2002	2000	535	0.744	74.3	2000	2,579	0.393	89.8	2000	1,642	0.448	80.6
2008-2015					2011	7,097	0.308	63.4	2011	8,168	0.251	66.9

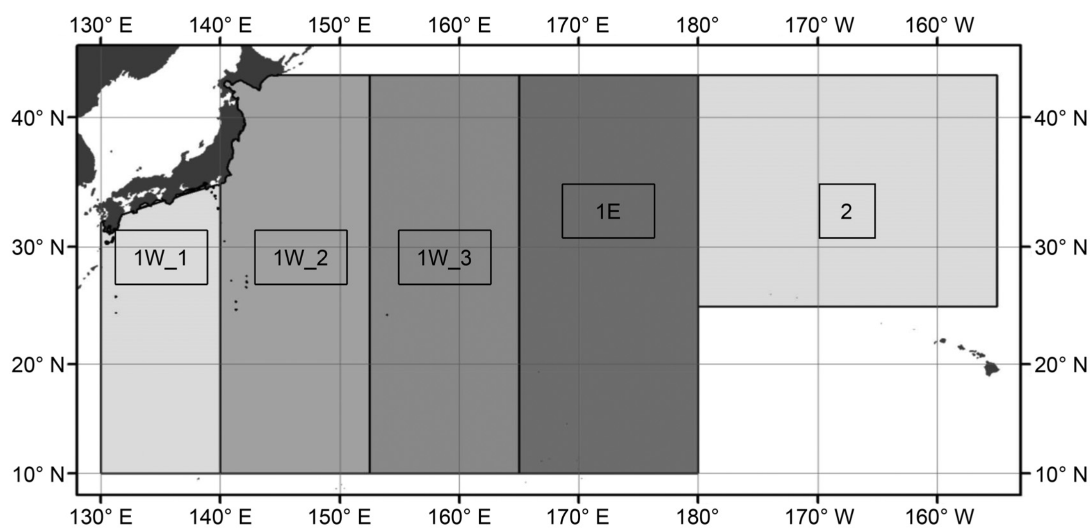


Fig. 1. Three blocks (1W_1, 1W_2 and 1W_3) in sub-area 1W and sub-areas 1E and 2.

those of run 1, Model 4 in Kitakado *et al.* (2008) (Table 3 in SC/60/PFI3). The value 2008-2015 was estimated from the original sighting data by Hakamada. The total abundance is re-allocated in proportional with (Area/Effort) for each block in the cases of 1988-96 and 1998-2002.

Since the covariances are very small (because for the abundance estimates the variance from sighting rate dominates those from the common factors of mean school size and effective search half-width), they have been neglected below in the estimation of additional variance.

Using the abundance estimate in Table 1, additional CV was estimated as 0.7670 and its upper 5th-percentile is 1.516.

REFERENCE

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].

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].

Appendix 4

RESULTS OF CONDITIONING THE *IMPLEMENTATION SIMULATION TRIALS* FOR NORTH PACIFIC BRYDES WHALES

C.L. de Moor

The following results are plotted.

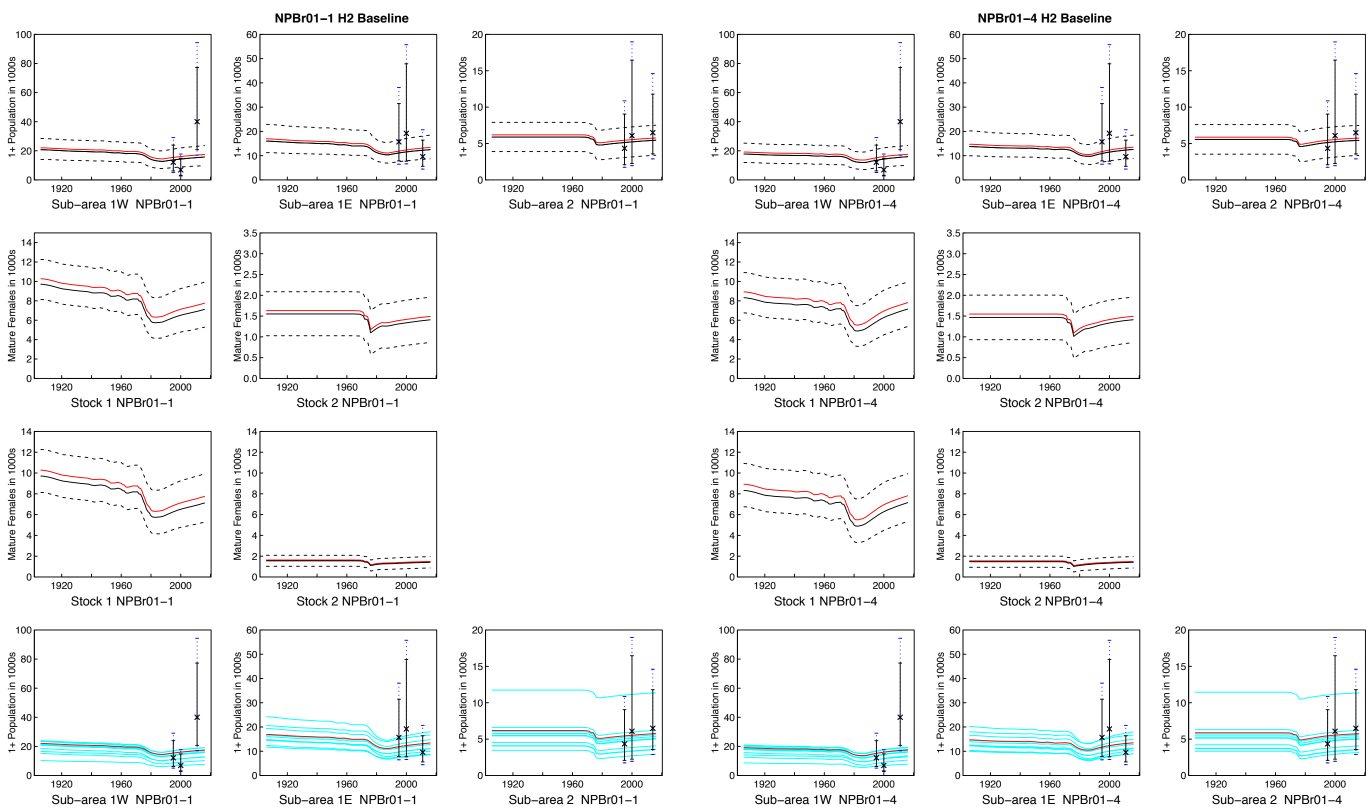
(1) Deterministic (red line), median and 90% confidence intervals for the 1+ population. The abundance estimates are shown (x) together with 90% confidence intervals. The extended blue dashed line indicated the additional variance about the abundance estimates not used during conditioning but taken into account when generating future abundance estimates for each sub-area.

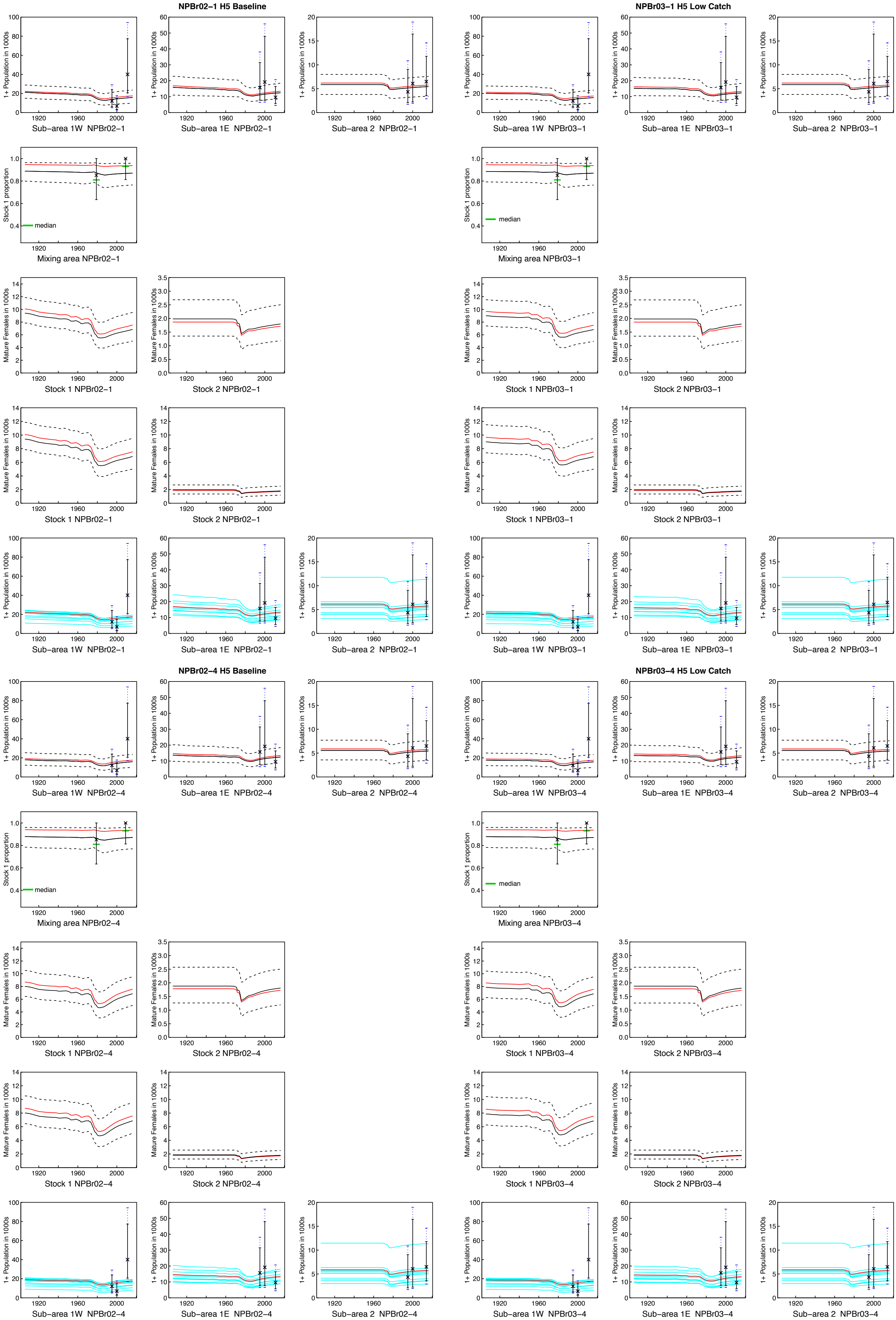
(2) Deterministic (red line), median and 90% confidence intervals for the proportion of stock 1 in the mixing area. The proportions estimated from commercial (1979) and survey (2004-14) samples are shown (x) together with 90% confidence intervals based on the sampling standard error. As target proportions are generated from truncated normal distributions, the median of the sampled targets is indicated by the green dash. Only shown for Hypothesis 5 trials.

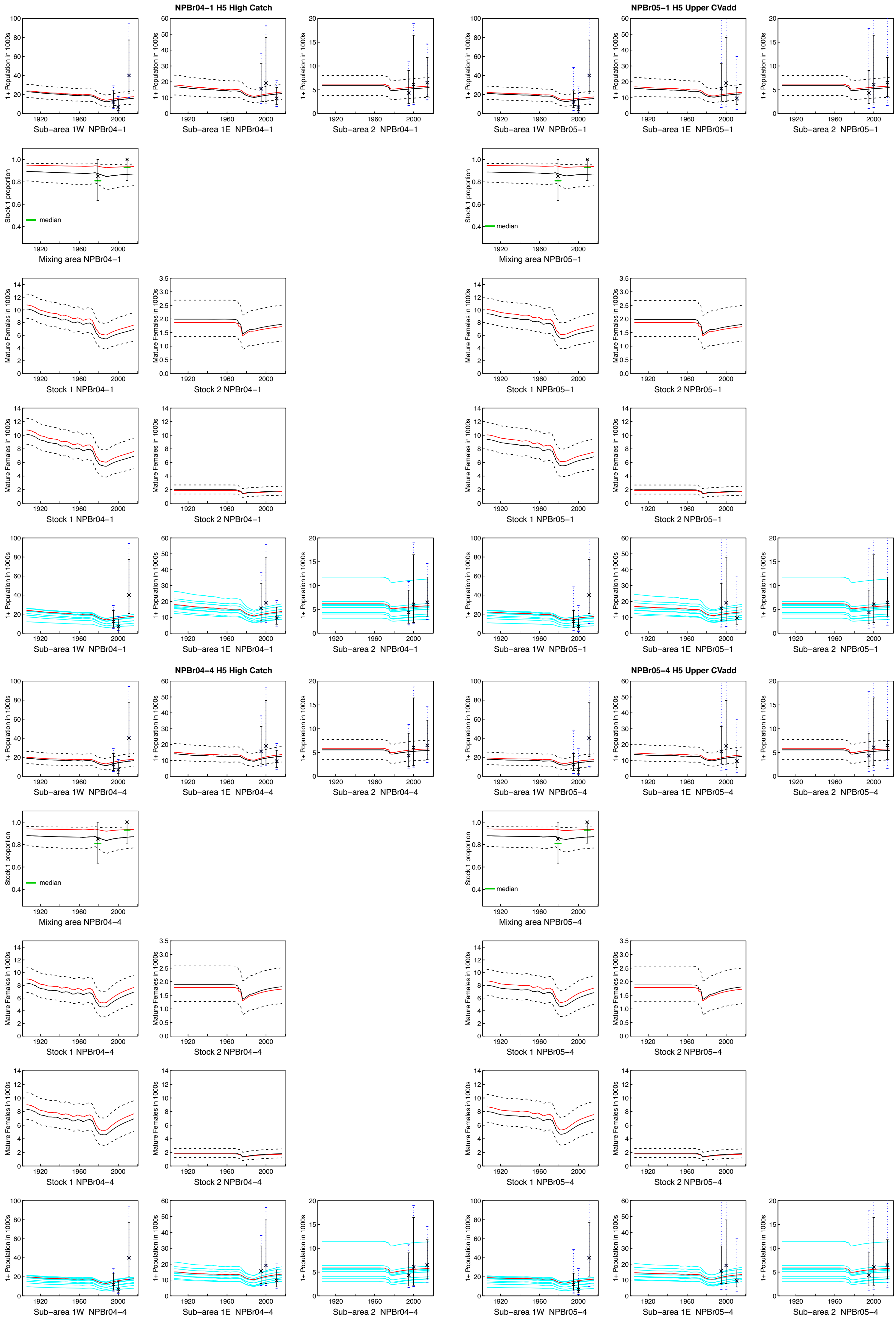
(3) Deterministic (red line), median and 90% confidence intervals for the mature females by stock.

(4) As per (3), but with the same scale.

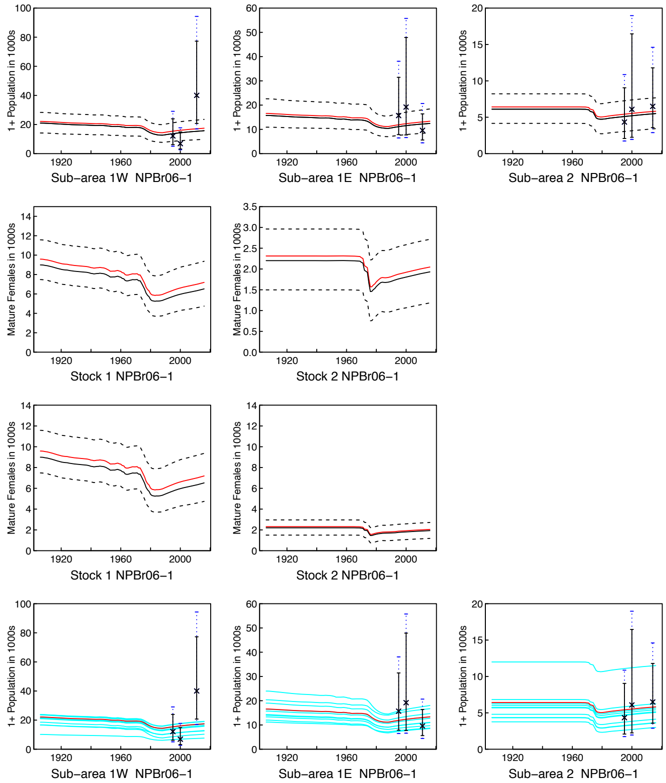
(5) As per (1), but with the first 10 individual trajectories rather than the median and 90% confidence intervals.



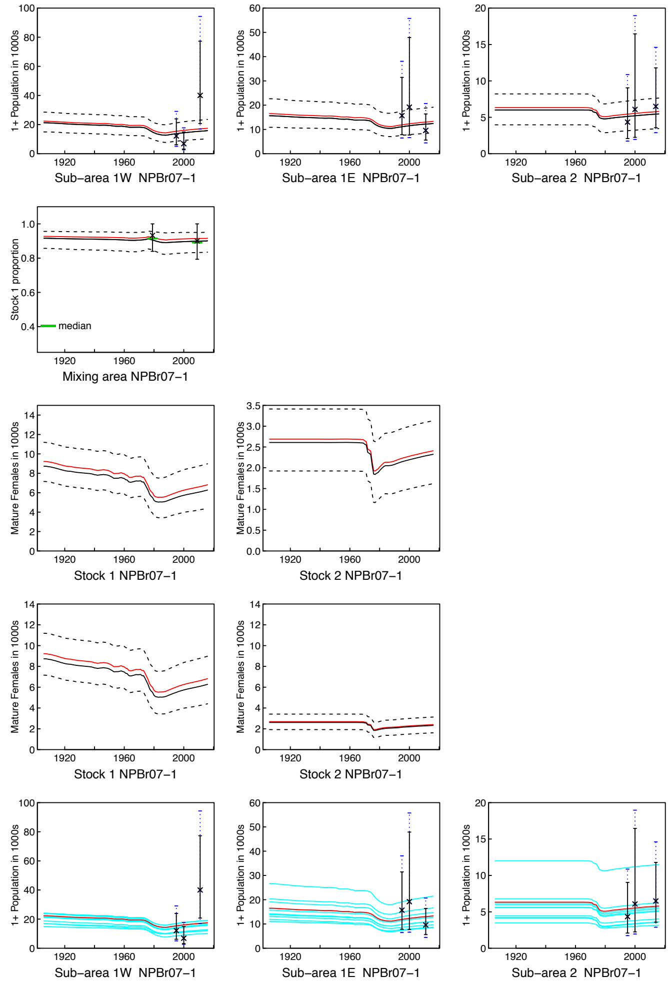

NPBr02–1 H5 Baseline
NPBr03–1 H5 Low Catch
Sub–area 1W NPBr02–1
Sub–area 1E NPBr02–1
Sub–area 2 NPBr02–1
Sub–area 1W NPBr03–1
Sub–area 1E NPBr03–1
Sub–area 2 NPBr03–1
Mixing area NPBr02–1
Mixing area NPBr03–1
median
Stock 1 NPBr02–1
Stock 2 NPBr02–1
Stock 1 NPBr03–1
Stock 2 NPBr03–1
NPBr02–4 H5 Baseline
NPBr03–4 H5 Low Catch
Sub–area 1W NPBr02–4
Sub–area 1E NPBr02–4
Sub–area 2 NPBr02–4
Sub–area 1W NPBr03–4
Sub–area 1E NPBr03–4
Sub–area 2 NPBr03–4
Mixing area NPBr02–4
Mixing area NPBr03–4
Stock 1 NPBr02–4
Stock 2 NPBr02–4
Stock 1 NPBr03–4
Stock 2 NPBr03–4
1+ Population in 1000s
Stock 1 proportion
Mature Females in 1000s


NPBr04–1 H5 High Catch
NPBr05–1 H5 Upper CVadd
Sub–area 1W NPBr04–1
Sub–area 1E NPBr04–1
Sub–area 2 NPBr04–1
Sub–area 1W NPBr05–1
Sub–area 1E NPBr05–1
Sub–area 2 NPBr05–1
median
Mixing area NPBr04–1
Mixing area NPBr05–1
Stock 1 NPBr04–1
Stock 2 NPBr04–1
Stock 1 NPBr05–1
Stock 2 NPBr05–1
NPBr04–4 H5 High Catch
NPBr05–4 H5 Upper CVadd
Sub–area 1W NPBr04–4
Sub–area 1E NPBr04–4
Sub–area 2 NPBr04–4
Sub–area 1W NPBr05–4
Sub–area 1E NPBr05–4
Sub–area 2 NPBr05–4
Mixing area NPBr04–4
Mixing area NPBr05–4
Stock 1 NPBr04–4
Stock 2 NPBr04–4
Stock 1 NPBr05–4
Stock 2 NPBr05–4
1+ Population in 1000s
Stock 1 proportion
Mature Females in 1000s

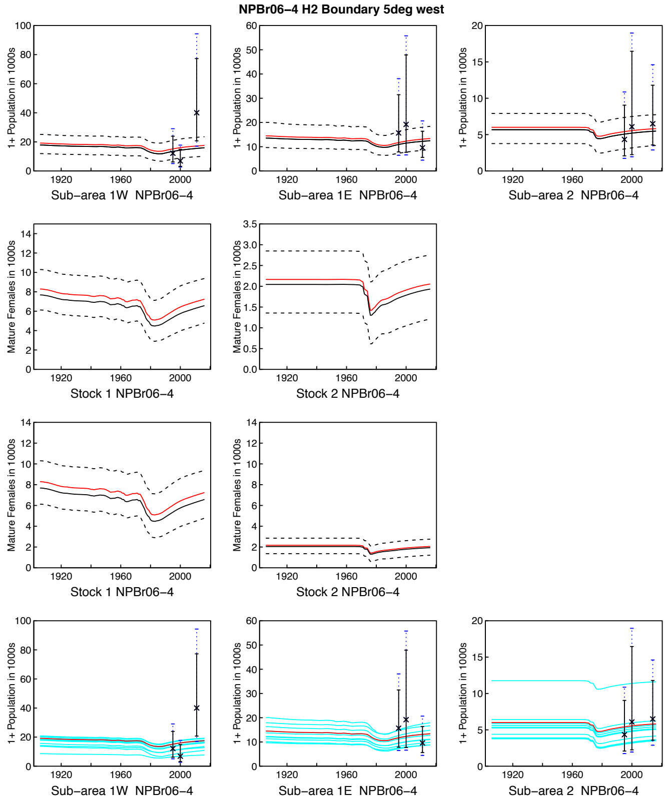
NPBr06–1 H2 Boundary 5deg west



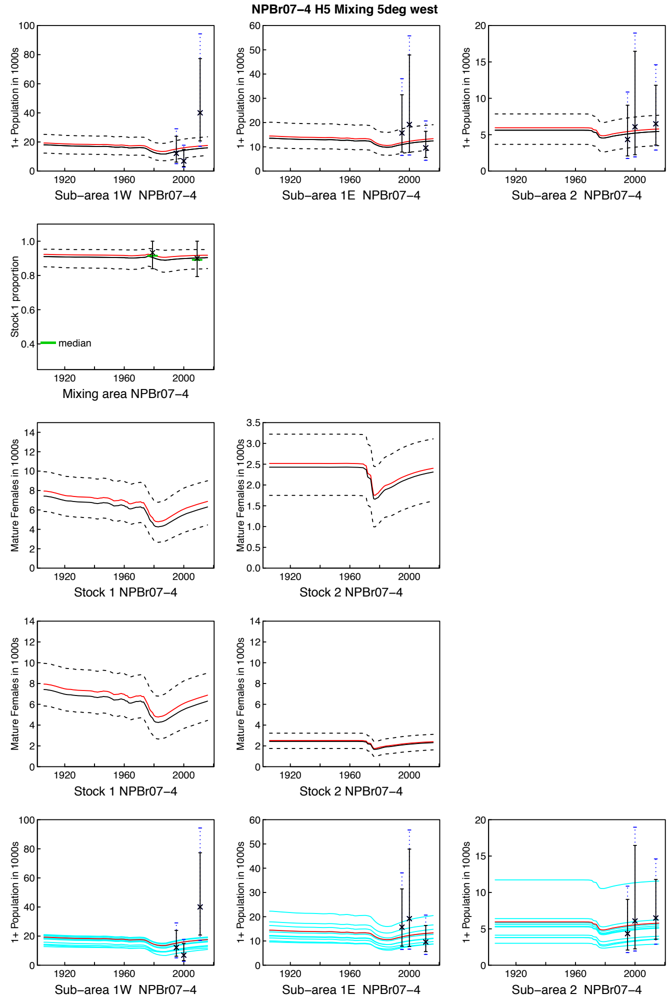
NPBr07–1 H5 Mixing 5deg west



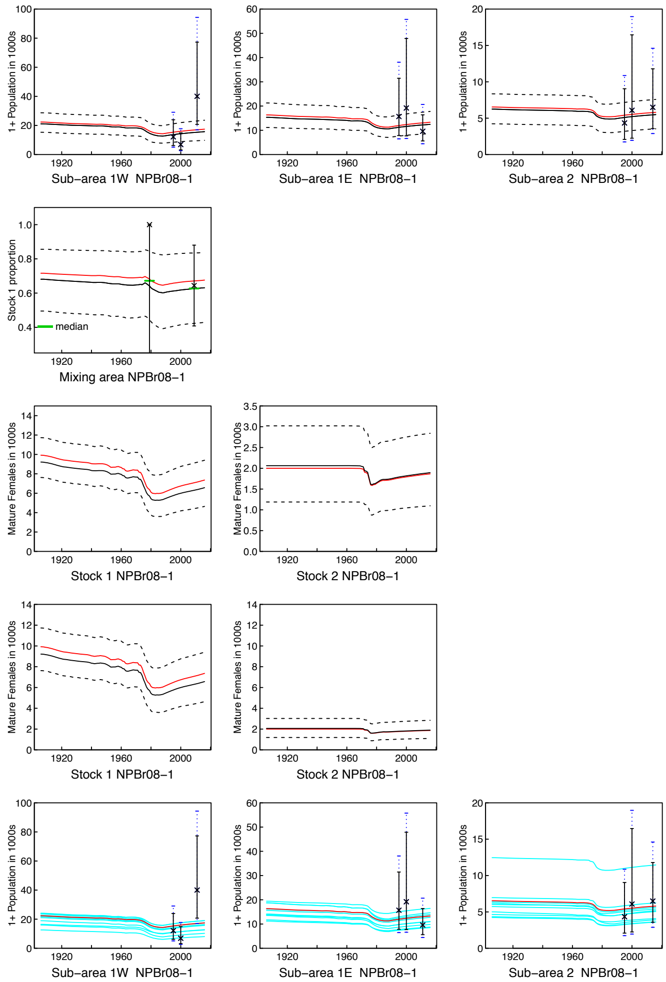
NPBr06–4 H2 Boundary 5deg west



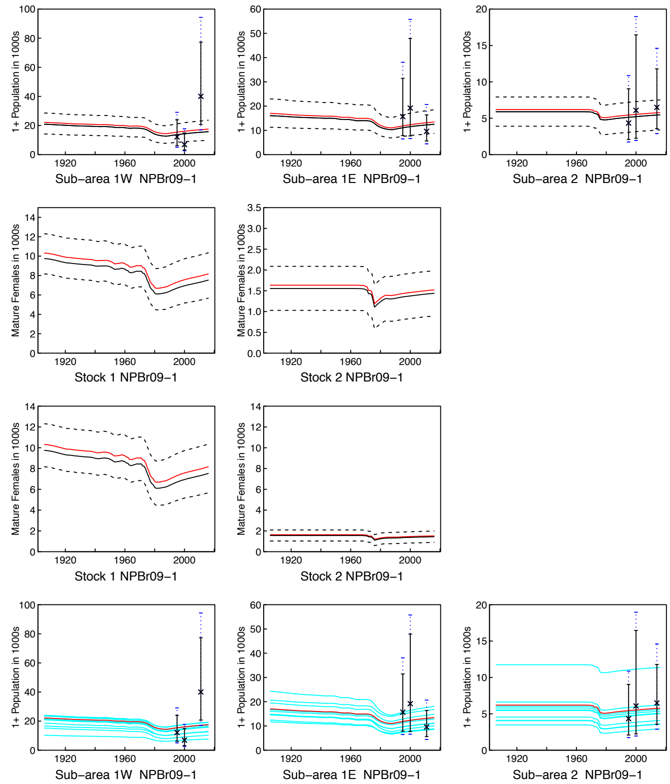
NPBr07–4 H5 Mixing 5deg west



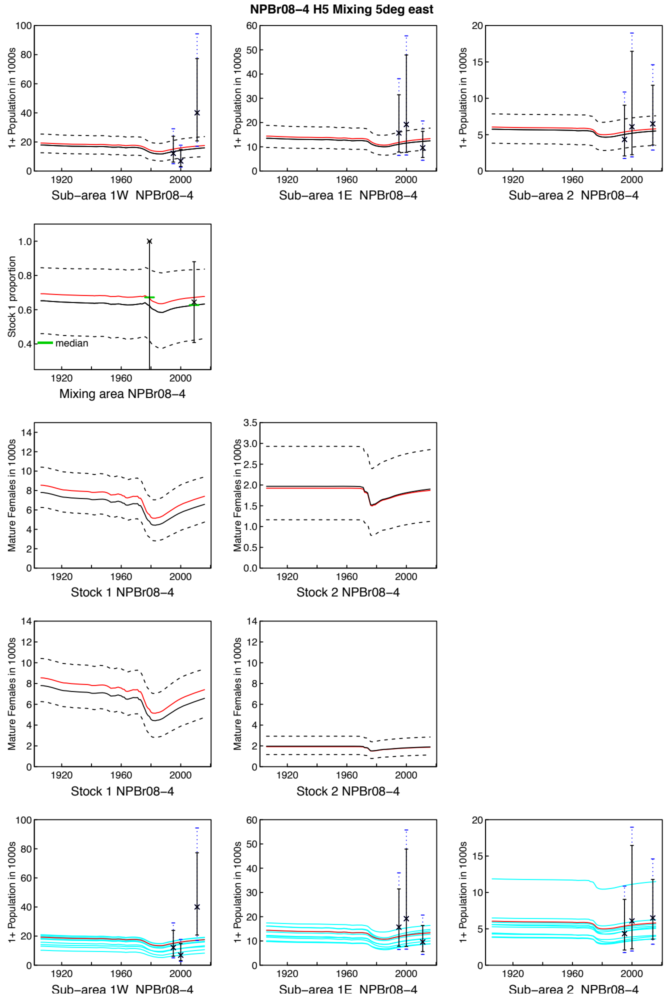
NPBr08–1 H5 Mixing 5deg east



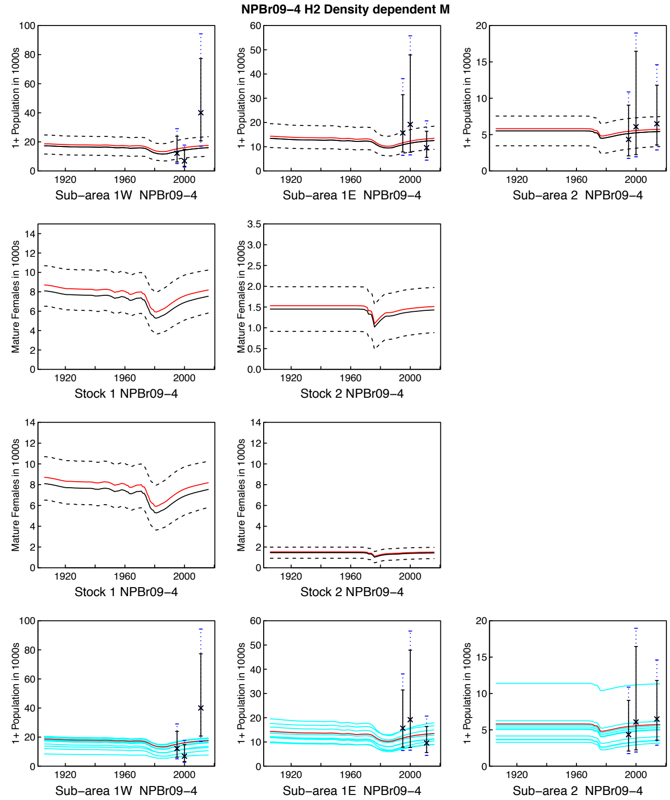
NPBr09–1 H2 Density dependent M

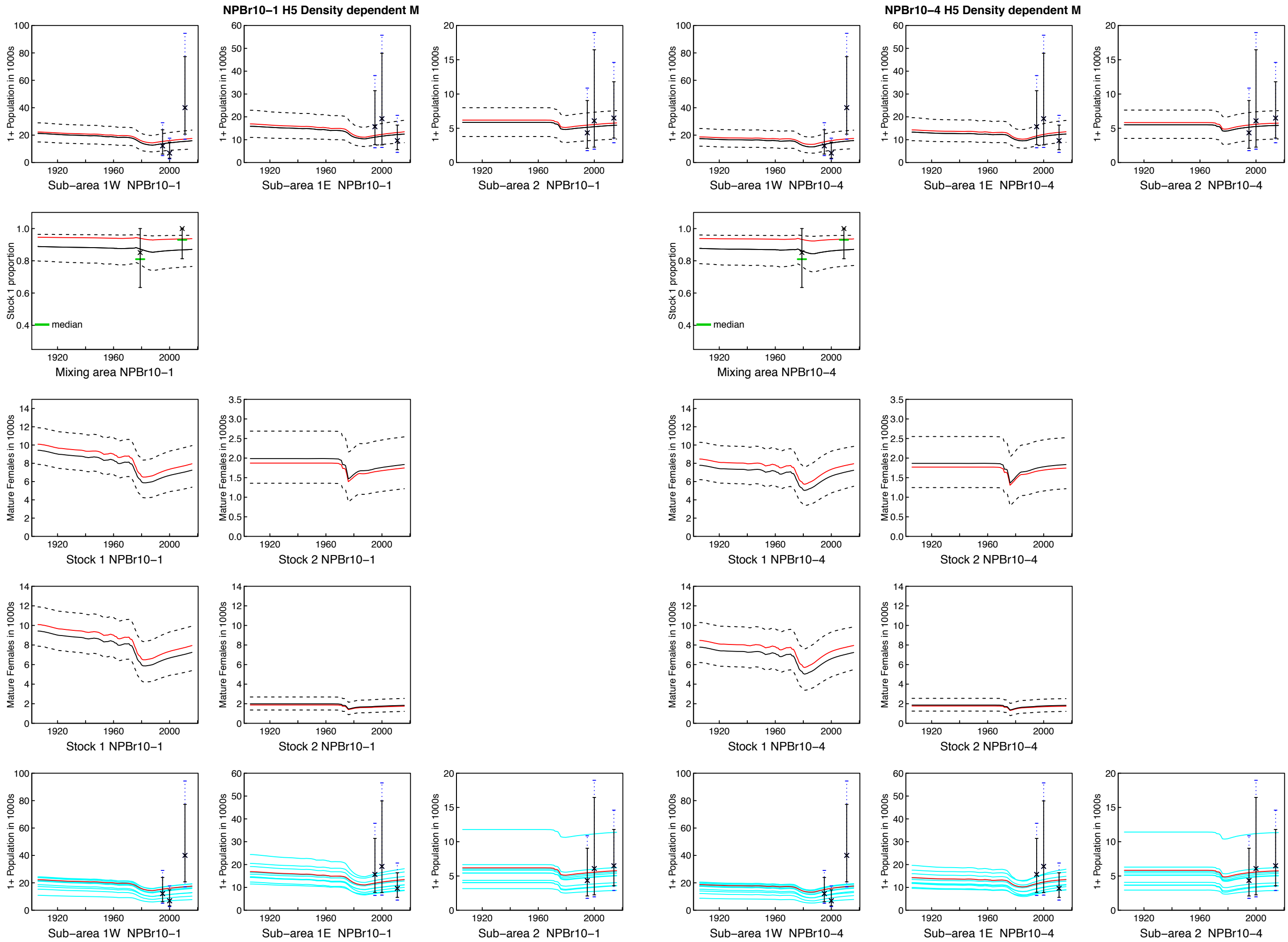


NPBr08–4 H5 Mixing 5deg east



NPBr09–4 H2 Density dependent M





Appendix 5

DRAFT ANNOTATED AGENDA FOR THE FIRST INTERSESSIONAL WORKSHOP ON THE *IMPLEMENTATION REVIEW* FOR WESTERN NORTH PACIFIC MINKE WHALES

1. INTRODUCTORY ITEMS

1.1 Opening remarks

1.2 Election of Chair and appointment of Rapporteurs

1.3 Adoption of Agenda (may need modifying in the light of papers presented)

1.4 Data available

The data protocol applicable to this Workshop is that of Procedure A (see Adjunct 1). The table below summarises the process *assuming arbitrarily that the Workshop is held from 1 March 2019*. N.B. No *new* data are allowed after the completion of the First Intersessional Workshop although new analyses of existing data can be submitted to the First Annual Meeting. It was recognised that for collaborative projects, these dates can be more flexible.

1.5 Available documents

Authors intending to submit papers should advise the Steering Group as soon as possible.

2. SHORT SUMMARY OF THE 2013 *IMPLEMENTATION REVIEW*

A paper will be submitted by the Workshop Steering Group (Donovan, Allison, Kitakado, Tiedemann, Punt, Butterworth, Palka, Pastene, Kim)

2.1 Hypotheses/scenarios considered

2.2 Results and conclusions

2.3 Recommendations/suggestions made for future work

3. STOCK STRUCTURE AND MOVEMENTS

This will require: genetic data (spatially and temporarily resolved); relevant non-genetic data (spatially and temporally resolved. At least data from Japan and Korea are required.

The following table lists available genotyped samples from South Korea (subareas 5 and 6W; data held by Hyun Woo Kim and coworkers) and Japan (other subareas; Pastene, Goto, Taguchi). At SC/67b, the South Korean scientists have kindly agreed to provide their genotype data to Pastene and co-workers for joint analyses.

(1) Any **data owner** wishing data to be used or considered for use in the *Implementation Review* process must (a) submit a description of data sets and formats to be and (b) the template to be used by accredited persons wishing to use the data. Both will be circulated/uploaded by the **Secretariat** upon receipt.	At least 6 months before the meeting	1 September 2018
(2) Accredited persons wishing to use data must submit their data requests (on the agreed template) to the **Secretariat** who will send them to the DAG and the data holders upon receipt	Within two days of receipt	
(3) **DAG** will review proposals and (1) determine acceptance promptly; (2) identify whether methods are considered novel or standard; and (3) inform data holders and proposers	Within 1 week of receipt of proposal	
(4) **Data holders** will send data in agreed format	Within 2 weeks of DAG approval	
(5) If novel methods are used then **authors** of papers using the data should be sent to Secretariat for circulation. Any such papers should include sufficient documentation of the analysis for it to be fully reviewed and any associated analytical software shall be lodged with the Secretariat.	At least 3 months before meeting	1 December 2018
(6) **Secretariat** will circulate/upload such papers	Within 2 days of receipt	3 December 2018
(7) If standard methods are used then **authors** of papers using the data should be sent to Secretariat and circulated/uploaded	At least 2 months before the meeting	3 January 2019
(8) **Secretariat** will circulate/upload such papers	Within 2 days of receipt	3 December 2018
(9) Alternative analyses carried out in response to papers submitted should be sent to Secretariat for circulation	At least 1 month before the meeting	1 February 2019
(10) Final submission of papers circulated/uploaded	At least 1 week before the meeting	22 February 2019
(11) Workshop held		1 March 2019

Expected papers: at least those presenting analyses agreed by the working group

Responsibility: (a) the Workshop Steering Group (see above); and (b) the Advisory Group on genetics (Tiedemann, Hoelzel, Pastene, Goto, Kim, Baker, Wade).

3.1 Review of new analyses including those identified at SC/67b

3.1.1 Genetic data

At SC/67b a work plan was agreed that the following analyses should be performed prior to and reported at the workshop (notwithstanding that further analyses are welcome where feasible and appropriate):

1. F_{ST}, F_{IS}, heterozygosities, haplotype diversity, and related measures;
2. PCA (or FCA) analyses, including partitioning based on multiple components, and DAPC;
3. spatially explicit analyses (BAPS, TESS, Geneland, spatial pattern of diversity measures);
4. updated kinship analyses including most recent samples; and
5. (if possible) Wahlund analyses as undertaken by Waples in 2011 (Tiedemann *et al.*, 2014).

As specified in SC/67b/Rep05, the analyses will be organised and performed by ICR (Pastene and coworkers), under the advice and assistance of the advisory group, where appropriate. Whilst recognising the level of work required (and noting the timing regarding the DAA), authors are encouraged to try to submit papers at least one month before the Workshop.

3.1.2 Non-genetic data

This may include information relating to other data sources e.g. biological parameters, sightings and catch distribution, telemetry, etc. Note that where possible, consolidated papers with genetic data should be presented.

3.2 Determination of hypotheses to be considered in the *Implementation Review*

Whilst these will be finalised at the Workshop and the results of the analyses above are important, participants are encouraged to think about possible conceptual hypotheses that are in accord with the data prior to the workshop and to submit documents – especially in the context of the intersessional analyses when they become available.

It should be noted that assignment of plausibility does not occur until the First Annual Meeting.

3.3 Initial discussion of data that might be used to develop mixing matrices

4. ABUNDANCE

Sightings and associated data (see RMP Guidelines). Data available at the Workshop will need to allow abundance estimates to be generated for appropriate areas/ sub-areas determined under Item 2. At least information from Japanese and Korean surveys required.

4.1 Summary of abundance estimates already agreed by the Scientific Committee, at least for use in conditioning and trials, including g(0)

The Steering Group will produce a summary table with references.

Marker set	Sub-area													Total
	1E	2C	5	6W	6E	7CN	7CS	7E	7WR	8	9	10	11	
mtDNA**	69	338	114	922	916	1178	925	49	89	251	541	15	129	5536
16 microstat loci**	69	338	-*	-*	916	1178	925	49	89	252	541	15	129	4501
26 Microstat loci	26	28	-	-	126	42	148	27	27	35	39	15	25	538

*Microsatellites were also typed in South Korea, but have not yet been cross validated with Japanese typings.
** Japanese samples from, 2016 not yet included.

4.2 New estimates (if any)

4.3 Generation of future estimates and incorporation of uncertainty e.g. with respect to g(0) in trials

5. REMOVALS DATA

5.1 Catch data

These will be provided by the Secretariat and will be available at the appropriate spatial and temporal resolution to account for various hypotheses.

5.2 Bycatch data

Location, timing of bycatch and associated effort (information on past bycatches and effort; hypotheses about future effort trends) for at least Japan and Korea

It will be valuable if both Japan and Korea can provide review papers that not only provide information on bycatches (by year, season/month and at least approximate position) but also explain the nature of the fisheries involved, changes over time (e.g. in temporal and spatial distribution) and information on effort (at the best resolution available for each fishery type. e.g. by year, season/month and approximate areas – even a general comment on changes if no quantitative data are available is helpful).

5.3 Ship strikes data

Location, timing of strike and associated effort

Even if small, it will be helpful if Japan and Korea, at least, can provide any information available on ship strikes.

5.4 Finalise the removals data for use in the trials (taking into account uncertainty) include generation of future data (especially bycatch)

This will allow, for example, development to of 'best', 'high' and 'low' series or identify work to be done to develop the final series at the 'First Annual Meeting'.

6. DEVELOPMENT OF *IMPLEMENTATION SIMULATION TRIAL* STRUCTURE

6.1 Factors to be considered in the trials (including incorporation of uncertainty)

6.1.1 Stock structure hypotheses
6.1.2 Mixing matrices
6.1.3 MSYR
6.1.4 Biological parameters
6.1.5 Bycatches
6.1.6 Other

6.2 Information to be used in conditioning

6.2.1 Abundance
6.2.2 Other

7. FUTURE LIKELY WHALING OPERATIONS

Expressed as RMP variants (specify months and sub-areas; whether selectivity might differ spatially; use of catch capping or catch cascading options etc.)

Papers detailing management options must be submitted by Governments who might wish to catch from these stocks in the future. Advice on format could be sought from the Workshop Steering Group.

8. WORK PLAN TO ENSURE THAT THE OBJECTIVES AT THE FIRST ANNUAL MEETING CAN BE MET

The primary purpose of the First Annual Meeting is to review conditioning results and finalise the *IST*s. The primary output will be the final trial specifications including:

(1) plausibility rankings;
(2) data/research that might reduce hypotheses (including possible time frame);
(3) updates/improvements to standard datasets for use in final trials and assigning plausibility;
(4) final specification of operational variants;
(5) ensure code has ability to test 'options for research' should that prove necessary later in the process; and
(6) begin discussions on defining inputs for an actual application of the RMP.

9. ADOPTION OF REPORT

REFERENCE

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]

Adjunct 1. Extract from 'Data Availability Guidelines'

Procedure A

The following shall apply with respect to data required for the process outlined in IWC (2003, pp.11-12) for the RMP, the AWMP (see IWC, 2003 pp.19-27) and other information used to provide advice on aboriginal subsistence catch limits before the relevant *SLA*s have been completed. The rules apply to all data owners who wish their analyses to be considered as part of the process to provide advice on catch limits. Data owners may submit data to be treated under this procedure, even if they do not intend to analyse the data themselves. When an application for data under this procedure is submitted, the Data Availability Group shall: (a) decide whether an application fulfils the criteria with respect to the objectives of the study; and (b) determine whether the methods proposed are considered standard or novel. The small group may take advice from the data owner, applicant or other relevant scientists in this process.

(1) If they wish analyses to be considered by the Committee, data owners must make data used for the analysis available in an agreed form and specified resolution (if desired, to the Secretariat) **no later than 6 months before the meeting at which they are to be used**.[…] These data shall be made available to accredited persons only under the conditions listed above. Data owners shall be notified of any such requests, including a description of the objectives of the study and the methods to be used.
(2) The Secretariat or data owners shall respond (i.e. send the data) to requests for data approved by the small group promptly, normally within 2 weeks of receiving the request.
(3) If novel methods are to be used, Scientific Committee papers documenting data analysis and results shall be circulated **no less than 3 months** before the meeting at

which they are to be considered. Any such papers should include sufficient documentation of the analysis for it to be fully reviewed and any associated analytical software shall be lodged with the Secretariat.

(4) If standard methods are used, Scientific Committee papers documenting data analysis and results shall be circulated no less than 2 months before the meeting at which they are to be used.

(5) Alternative analyses carried out in response to papers submitted under (3) or (4) shall be circulated no less than 1 month before the meeting at which they are to be used.

REFERENCE

International Whaling Commission. 2003. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1-92.

Annex E

Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures

Members: Donovan (Convenor), Allison, Aoki, Baba, Baird, Bell, Bickham, Brandão, Brandon, Brierley, Brownell, Burkhardt, Butterworth, Cubaynes, De Moor, DeMaster, Doniol-Valcroze, Double, Ferguson, Ferriss, Fortuna, Frey, Gallego, George, Givens, Haug, Hielscher, Holm, Hubbell, Iñíguez, Jaramillo-Legorreta, Johnson, Kitakado, Lang, Litovka, Lundquist, Mallette, Mckinlay, Morishita, Morita, Moronuki, Nelson, Palka, Pastene, Phillips, Punt, Reeves, R., Reeves, S., Ritter, Rodriguez-Fonseca, Rojas Bracho, Safonova, Scordino, Scott, Simmonds, Skaug, Slugina, Smith, Stachowitsch, Stimmelmayr, Suydam, Svoboda, Taylor, Terai, Thomas, Tiedemann, Víkingsson, Wade, Walløe, Walters, Weinrich, Weller, Wilberg, Witting, Zagrebelnyy, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants. The workload this year was immense. Two priority topics are: (1) work towards completion of the remaining *SLA*s for the Greenland hunts; and (2) developing a recommended Aboriginal Whaling Scheme. Both topics have been the subject of intense intersessional work including two workshops in Copenhagen in October 2017 and March 2018, as well as a small technical meeting in December at OSPAR headquarters in London. He stressed that this year, the Commission would be setting new catch/strike limits for all aboriginal subsistence hunts and therefore the third major topic is to provide advice on these. Finally, the SWG will try to complete the *Implementation Review* for Bering-Chukchi-Bering Sea (B-C-B) bowhead whales. He also reminded participants that we will need to provide a two-year workplan and budget.

Donovan noted that Cherry Allison was unable to attend the meeting in person this year and thanked her greatly for all the intersessional work undertaken as well as providing tremendous support from Cambridge. He also thanked Punt, de Moor, Brandão, Witting who have stepped up even more than usual with computing assistance.

He explained that the work of the intersessional Steering Group on developing *SLA*s for the Greenland hunts is ongoing and will continue during this meeting as the report of this group will assist greatly in discussing Item 2. Similarly, the intersessional group on the AWS is continuing and the group's final report will greatly facilitate discussions under Item 3.

1.2 Election of Chair and appointment of Rapporteurs

Donovan and Brandon were named co-Chairs. Brandão, Brandon and Givens acted as rapporteurs with the assistance of the Chair.

1.3 Adoption of Agenda

The agenda was adopted. See Appendix 1.

1.4 Documents available

The documents available included SC/67b/AWMP01rev1, SC/67b/AWMP02-08, SC/67b/AWMP10, SC/67b/AWMP12, SC/67b/AWMP13rev1, SC/67b/AWMP14-19, SC/67b/AWMP20rev1, SC/67b/Rep06, and SC/67b/Rep07.

Donovan drew attention to the fact that Canadian scientists had submitted two papers (Frasier *et al.*, 2015 and Doniol-Valcroze *et al.,* 2015) providing abundance estimates for Eastern Canadian-West Greenland bowhead whales. The SWG **greatly appreciated** these contributions.

2. *SLA* DEVELOPMENT

2.1 Fin whales (Greenland)

2.1.1 Review results of intersessional workshops

Donovan presented SC/67b/Rep06 and provided an overview of progress made during two intersessional Workshops and the small working group meeting.

He reported that considerable progress was made in relation to the following|:

(a) updated abundance estimates (and see Item 5.6.2);
(b) finalisation of the trial structure;
(c) review and approval of conditioning;
(d) initial consideration of new *SLA*s and results.

2.1.2 Review post-Workshop progress

Most of the work undertaken after the final workshop involved *SLA* development. The final trial specifications are provided as Appendix 2. Table 4 of Appendix 2 summarises the main factors considered in the *Evaluation Trials.*

SC/67b/AWMP13 developed a candidate *SLA* for West Greenland fin whales. The new fin whale trials have a large amount of variation in the point estimates of abundance, and the *SLA* takes an inverse variance weighted average of the last three estimates as an estimate of abundance. The strike limit is then calculated as a growth rate fraction of a lower percentile of the abundance measure, conditional on a trend modifier, a snap to need feature, and a protection level. This *SLA* is somewhat simpler than the earlier fin whale *SLA*s developed by Witting. Those fitted a straight line to the abundance estimates in order to obtain a measure of abundance and trend. However, these estimates were unreliable due to the highly variable abundance estimates of the trials. The *SLA* is proposed in three versions, where the D10 statistics for the 5th percentile of the 'Influx' trial F34-1 is tuned to 1.0, 0.9 and 0.8 for the medium (B) need envelope.

SC/67b/AWMP15 presented three potential *SLA*s for West Greenlandic fin whales that are based on a weighted-average interim *SLA* which uses all abundance estimates, but earlier abundance estimates are down-weighted compared to more recent ones. An adjustment to the multiplier of the abundance estimate in the interim *SLA* is applied which depends on the trend of the abundance indices. This approach allows for additional reduction of the *Strike Limit* if the time series of abundances shows a reasonably precise downward trend in abundance. Three candidate *SLA*s are tuned to achieve 1.0, 0.9 and 0.8 for the conservation statistic (D10, relative increase) at the lower 5th percentile for the Influx hypothesis trial GF34-1B with an $MSYR_{1+}$ of 1% and the middle need envelope (B) as suggested at the 2018 Workshop (SC/67b/

Rep06). Dropping the D10 statistic to 0.8 for this trial improves need satisfaction by all other trials without sacrificing conservation performance (except for the Influx hypothesis trials at MSYR1+= 1%). It was noted that these *SLA*s do not have a snap to need feature.

2.1.3 Review final results and performance

In total, seven potential *SLA*s (which include the 'Interim' *SLA* – a modified version of the *Interim SLA* that has been used to provide advice for the last two blocks) were reviewed. As in previous years, an initial examination of the full set of results was undertaken by a 'winnowing' group with the aim to focus the SWG to those aspects of the performance of the *SLA*s that needed to be discussed further. Initially, the focus was on projections of the lower 5th percentiles and medians for 1+ population abundance and 'Zeh' plots for various performance statistics. Focus was given to the exploration of the univariate performance statistics D1 (final depletion) and D10 at the lower 5th percentile. The desired performance for these statistics is to obtain a value of D10 greater or equal to one and for D1 to be above 0.6 (MSYL). In other words, satisfactory performance on the conservation criteria by an *SLA* is deemed if either the population is not at MSYL but it is increasing or the population is increasing/decreasing but is above MSYL.

Tables which highlighted which *SLA* was performing well or not relative to the 'best' performance amongst all the *SLA*s (including the 'Interim' *SLA*) were also examined to evaluate the performance of the proposed *SLA*s. Plots of depletion where examined as the conservation statistics are based on this rather than on population abundance numbers. Trials for which at least one of the proposed *SLA*s failed either the D1 or the D10 conservation statistics were highlighted for further investigation (5 trials). Looking at results on a single dimension was not helpful because the D10 statistic does not need to be at or above one if the population is above MSYL. Thus, further focus on the performance of the *SLA*s was placed rather on the joint statistic of D1 and D10 for these five trials.

The bivariate plots of the D1 and D10 statistics (see fig. 4 of Appendix 3) were examined for all the proposed *SLA*s, with a focus on the simulation results in the quadrant in which D1 <0.6 and D10 <1. The counts of the simulations for all *SLA*s that fall in this quadrant were examined to see if this could help to distinguish the performance amongst the different *SLA*s. Examination of these plots concluded that for all the trials that had failed on at least one of the univariate conservation statistics, only trial F34-1C (a low MSYR, high need case for the Influx model) showed unacceptable conservation performance.

The SWG **agreed** that the proposed *SLA*s performed satisfactorily on the joint conservation statistics for the A and B (but not for C) need envelopes for all trials, and the selection between *SLA*s was narrowed down to those that had been tuned to obtain D10 of 0.8 for the more difficult Influx hypothesis trial F34-1B (B0.8 and L0.8). The focus on selecting amongst the *SLA*s should be on the *SLA* that meets need satisfaction best and that also achieves stability in the catches. 'Zeh' plots were examined for all trials, concentrating on the need satisfaction statistics, N9(20) the average need satisfaction over the first 20 years, N9(100) the average need satisfaction over the 100 years and N12 the mean downstep statistic, which is a modified average annual variability statistic.

It was noted that because of the present incorporation into the trial structure of the widely different 'Influx' and 'partial' hypotheses to explain the variability of the abundance estimates, the need satisfaction over 20 years is more appropriate to consider than over 100 years as it is likely that future *Implementation Reviews* may be able to remove one or other scenario.

After an examination of the full range of results, there was no obvious 'winner' between the two *SLA*s. Depending on the trials considered, and which statistic was examined, the different *SLA*s performed slightly differently but their performance overall was equivalent.

Following an approach originally adopted during the development of the *Bowhead SLA*, the SWG **agreed** that an *SLA* which sets the strike limit to the average of the values obtained by the two *SLA*s tuned to a D10 of 0.8 for the influx trial F34-1B (B0.8 and L0.8) would be preferable, providing performance was as good or better than either individual *SLA*; no snap to need for the averaged *SLA* has been applied. The results of the 'combined *SLA'* are summarised in Appendix 3.

2.1.4 Conclusions and recommendations

The SWG **agreed** that the *SLA* which sets the strike limit to the average of the values obtained by the two *SLA*s tuned to a D10 of 0.8 for the influx trial F34-1B (B0.8 and L0.8) performed satisfactorily in terms of conservation performance and that it was to be preferred over the individual proposed *SLA*s in terms of need satisfaction. The SWG **agreed** that this '*WG-fin SLA*' be used to provide management advice to the Commission on the subsistence hunt for West Greenland fin whales under need scenarios A and B. For the management advice see Item 5.6.

In conclusion, the SWG expressed its **great thanks** to the developers, Brandão and Witting for the vast amount of work put into the development process. It also expressed similar thanks to Allison and Punt for their extensive work developing the operating models and running the trials. It noted that final validation and archiving would be undertaken by Allison.

The SWG also concurred with the intersessional Workshop (SC/67b/Rep06, item 2.7) that one focus of the next *Implementation Review* would be to examine further stock structure in relation to the two hypotheses being considered at present, and especially the influx model which was developed in the context of low abundance estimates in some years rather than genetic information.

Attention: C-A, SC

The Committee ***draws attention*** *to the extensive work undertaken over recent years to develop an* SLA *for the West Greenland hunt for fin whales. In concluding this work, the Committee:*

(1) ***agrees*** *that the combined* SLA *(which sets the strike limit to the average of the values obtained by the two best* SLA*s considered) performed satisfactorily in terms of conservation performance and was to be preferred over the individual* SLA*s in terms of need satisfaction;*
(2) ***recommends*** *that this* 'WG-Fin SLA' *be used to provide management advice to the Commission on the subsistence hunt for West Greenland fin whales (provided the need request falls within need scenarios A and B);*
(3) ***expresses*** *its great thanks to the developers, Brandão and Witting for the vast amount of work put into the development process and to Allison and Punt for their extensive work developing the operating models and running the trials; and*

*(4) **agrees** that one focus of the next Implementation Review will be to examine further stock structure in relation to the two hypotheses being considered at present, and especially the 'influx' model which w\as developed in the context of low abundance estimates in some years, rather than being based upon genetic information.*

2.2 Common minke whales (Greenland)

2.2.1 Review results of intersessional workshops

Donovan summarised report SC/67b/Rep06 and the intersessional progress made on common minke whales. He noted that enormous effort had been devoted to reviewing the new genetic information that had been provided in response to a recommendation at SC/67a. This had greatly assisted in developing the final stock structure hypotheses and mixing matrices to be considered in the trials. These extensive discussions can be found under items 3.3.1 and 3.3.2 of SC/67b/Rep04.

Finally, the Workshop **agreed** that instead of formally using the RMP to set catch limits by sub-area and year for each simulation, the RMP catch limits would be pre-specified based upon baseline hypothesis 1 trials (M01-1 and M01-4). This allows the trials to run more quickly and focus to be given on *SLA* development – the objective of this work. Details can be found in the full trials specification (Appendix 4).

2.2.2 Review post-Workshop progress

Considerable work was undertaken to finalise the list of trials, to ensure that the mixing matrices were correctly specified and to complete and agree conditioning. The final trial specifications are provided as Appendix 4.

Table 9 of Appendix 4 summarises the factors considered in the *Evaluation Trials.*

2.2.3 Candidate SLAs

SC/67b/AWMP14 developed a candidate *SLA* for common minke whales off West Greenland. It operates, like the fin whale *SLA* in SC/67b/AWMP13, on an inverse variance weighted average of the last three abundance estimates. The strike limit is calculated as a growth rate fraction of a lower percentile of the abundance measure, conditional on a snap to need feature, and a protection level. The *SLA* for common minke whales, however, does not include a trend modifier, as it is almost impossible to detect an underlying trend from the abundance data in West Greenland.

The *SLA* was tuned to have a 5th percentile of D10 of 0.80 for a flat need envelope of 164 on the most difficult *Evaluation Trial* (trial M04-1A, where there are two sub-stocks in the western North Atlantic, where the mixing between the Central and the Western stock, and the mixing between the putative western sub-stocks, are minimal, and where the MSYR is 1%). Conservation performance on all other measures was adequate for all trials with a flat need of 164, and the *SLA* produces an expected average need satisfaction of 99% (with a lower 5th percentile of 89%) for the first 20 years, and 89% (5th percentile of 61%) for the 100-year simulation period.

2.2.4 Consideration of results

The SWG **agreed** that conditioning of the *Evaluation Trials* had been completed satisfactorily. A summary of the results of the *Evaluation Trials* is provided in Appendix 5.

In determining satisfactory conservation and need performance when evaluating *SLA*s, the SWG considers the full range of results across all of the *Evaluation Trials* not simply the worst-case scenarios. The SWG **agreed** that conservation performance was satisfactory in all but one of the trials. This trial was a trial with low MSYR and two W-stocks and had been originally considered in the context of potential problems for the hunt to simulate possible local depletion in the hunting area rather than for conservation reasons. It was noted that genetic stock structure in the entire North Atlantic is subtle such that even a hypothesis of almost complete panmixia is not rejected by most of the analyses. Hence, differentiation among C and W is very low. This is even more true for substructure within the W stock (if there is any. Given that trials are conservative in so far to overrate isolation among stocks and the very subtle differentiation among stocks and sub-stocks in the North Atlantic, a single trial (which implements fully separate W1 and W2 sub-stocks for which evidence is weak) not meeting the D1/D10 criteria is not of conservation concern.

In developing this advice, the SWG noted that given the unforeseen situation with Secretariat computing, there had been insufficient time to consider the results of the *Robustness Trials* in the SWG. Such trials are not needed to determine an *SLA* but are examined to ensure that the selected *SLA* has no unforeseen properties in extreme trials. Given the importance of being able to provide the best management advice to the Commission, the SWG agreed that the Steering Group set up for *SLA* development should take responsibility to review the results of the *Robustness Trials* as soon as they become available and report to the Plenary session[1].

2.2.5 Conclusions and recommendations

Given the overall satisfactory performance in the *Evaluation Trials* with respect to meeting the Commission's conservation and management objectives for need envelope A (i.e. constant need over the simulation period), the SWG **agreed** to recommend this, the '*WG-common minke SLA'* to the Committee as the best way to provide management advice for the West Greenland hunt of common minke whales. The management advice developed using the *WG-common minke SLA* is provided under Item 5.5.

In accordance with the AWS (see Item 3), the first *Implementation Review* is scheduled for 2023. The SWG **agreed** that one focus of that review should be consideration of the results of analyses of genetic data using additional samples from Canada (as well as the additional samples that will become available from West Greenland and Iceland). To this end it **agrees** that planning for the *Implementation Review* should begin two years before the scheduled review. A small group comprising Tiedemann, Doniol-Valcroze, Witting and Víkingsson was established to facilitate issues related to obtaining samples.

In conclusion, the SWG expressed its **great thanks** to the developers, Brandão and Witting for the vast amount of work put into the development process. It also expressed similar **thanks** to Allison and Punt for their extensive work developing the operating models and running the trials. It noted that final validation/archiving would be undertaken by Allison.

Attention: C-A, SC

*The Committee **draws attention** to the extensive work undertaken over recent years to develop an* SLA *for the West Greenland hunt for common minke whales. In concluding this work, the Committee:*

[1]Editor's note: this was completed and no problems were detected.

(1) ***agrees*** *that the tested* SLA *which performed satisfactorily in terms of conservation performance;*
(2) ***agrees*** *that this* 'WG-Common minke SLA' *be used to provide management advice to the Commission on the subsistence hunt for West Greenland common minke whales provided the need request falls within need scenario A (i.e. does not exceed 164 annually);*
(3) ***expresses*** *its great thanks to the developers, Brandão and Witting for the vast amount of work put into the development process and to Allison and Punt for their extensive work developing the operating models and running the trials; and*
(4) ***agrees*** *that one focus of the next* Implementation Review *will be to examine further stock structure in relation to the two hypotheses being considered at present, should be also consideration of the results of analyses of genetic data using additional samples from Canada (as well as the additional samples that will become available from West Greenland and Iceland); and*
(5) ***agrees*** *to establish an intersessional group to facilitate issues relating to samples.*

2.3 North Pacific gray whales (Makah whaling)

2.3.1 Management plan proposed by the US for Makah whaling

The Makah Indian Tribe has requested that the US National Marine Fisheries Service (NMFS) authorises a tribal hunt for Eastern North Pacific gray whales in the coastal portion of its 'usual and accustomed fishing area'. The Tribe intends to hunt gray whales from the ENP population, which currently numbers approximately 27,000 animals (Durban *et al.*, 2017). In the management plan, NMFS has taken measures to restrict the number of PCFG whales that are struck or landed in a given 10-year period and to avoid, to the extent possible, striking or killing a Western North Pacific gray whale. The US government has requested that the Committee test this plan to ensure that it meets IWC conservation objectives. An overview of the hunt management plan and how it was operationalised in the coding of the *SLA* trials is provided in Annex E, Appendix 1 of SC/67b/Rep/07.

2.3.2 Review intersessional progress including at the Rangewide Workshop

Donovan summarised the report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales (SC/67b/Rep07rev1). The Workshop was held at the Granite Canyon Laboratory, California of the Southwest Fisheries Science Center from 28-31 March 2018. The primary tasks of the Workshop were to: (a) review the results of the modelling work identified at the Fourth Workshop (IWC, 2018a) and SC/67a (IWC, 2018b); (b) examine the new proposed Makah Management Plan (submitted by the USA – described above and illustrated in SC/67b/Rep/07 under Annex E, Appendix 1 of that report) for gray whaling off Washington state; and (c) to update as possible (and develop a workplan for) the scientific components of the Conservation Management Plan (CMP) for western gray whales.

The major focus of the Workshop related to finalising the specifications for modelling to enable results to be available for SC/67b. A new component included the need to incorporate the recently developed Makah Management Plan (SC/67b/Rep07, Annex E, Appendix 1) into the modelling framework; the Plan is somewhat complex and the Workshop focus was on understanding the intended process and ensuring that it was parameterised in an appropriate way. A further key area was finalising the stock structure hypotheses to be given priority. After a review, the Workshop concluded that Hypotheses 3a and 5a would form the reference cases but that sensitivity trials would be conducted for Hypotheses 3b, 3c, 3e and 6b. The full specifications for these hypotheses are provided in SC/67b/Rep07 (Annex E, Appendix 1 of that report).

In summary, Hypothesis 3a assumes that whilst two breeding stocks (Western and Eastern) may once have existed, the Western breeding stock (WBS) is extirpated. Whales show matrilineal fidelity to feeding grounds, and the Eastern breeding stock includes three feeding aggregations: PCFG (Pacific Coast Feeding Group), NFG (Northern Feeding Group) and WFG (Western Feeding Group). Hypothesis 5a assumes that both breeding stocks are extant and that the WBS feeds off both coasts of Japan and Korea and in the northern Okhotsk Sea west of the Kamchatka Peninsula. Whales feeding off Sakhalin include both whales that are part of the extant WBS and remain in the western North Pacific year-round, and whales that are part of the Eastern breeding stock and migrate between Sakhalin and the eastern North Pacific (the WFG).

Another important component of the trials relates to bycatch. Considerable effort was put into capturing the uncertainty in past and future estimates of bycatch mortality based upon the available data. The base case for trials was that observed deaths due to bycatch account for only 25% of the true incidental human caused mortality. This fraction was based on a study of bottlenose dolphin stranding data off the coast of California (Carretta *et al*. 2016). Trials were also considered with higher rates of cryptic mortality, including scenarios where observations represent only 5% of true incidental human caused mortality.

Abundance estimates for the eastern North Pacific and the PCFG had been approved by the Committee last year (IWC, 2017). New estimates of abundance for western gray whales were provided by Cooke (SC/67B/ASI/02), and correspond with the various stock structure hypotheses for the western feeding group (WFG), WBS and WST (WFG + WBS). These estimates were reviewed and adopted by the SWG on ASI (Annex Q). Modifications were also made to the mixing matrices in the rangewide model based on the new estimates.

Each stock structure hypothesis was combined with multiple assumptions about other factors (e.g. bycatch rates) and this led to the development of 53 'trials' (see Table 6 of SC/67b/Rep07). Each trial was based on 100 simulations that reflect uncertainty in the estimated parameters of the model. Projections thus lead to a very large amount of model output that needed to be distilled to address questions such as the conservation performance of the new management plan for Makah whaling with respect to the stocks in question (in particular, the PCFG and the WFG). The Rangewide Workshop identified several plots and 'performance statistics' to summarise results from each trial (see Section 4.4.5 of SC/67b/Rep07 and Appendix 6).

Brandon presented an update on the code validation for the model. The first phase of code validation was completed prior to Fifth Rangewide Workshop. That effort focused on the code implementing the operating model and the conditioning process. A summary, including a brief overview of the code and input files was provided to the Workshop (SC/M18/CMP03). Like the first phase, the second phase of code validation involved checking the code against the mathematical and statistical model specifications. The focus of this validation phase was on three aspects of the code: (1) future projections and the updated US management plan concerning strike and landing limits for Makah whaling; (2) input files for the factors considered across conditioning trials and; (3) processing results across simulations into relevant performance statistics. Code validation was completed prior to the presentation of model results to the SWG.

The sub-committee on CMP reviewed and approved the conditioning results in the context of the full rangewide review. The SWG reviewed the model results with a focus on conservation performance of the management plan for Makah whaling. To aid in this evaluation, bivariate plots were generated for the lower 5th percentiles of the D1 and D10 performance statistics. Trials for which the D1 statistic is less the 0.6 after 100 years (i.e. the stock is not above its MSYL) and the D10 statistic after 100 years is not larger than 1 (i.e. the stock is not increasing towards MSYL) represent a scenario under which the management plan would not be expected to meet the conservation objectives for ASW (this is denoted by the gray quadrant in fig 1 of Appendix 6). Several trials were identified in this category, but they corresponded with scenarios that were considered to have the low plausibility (e.g. bycatch mortality of ~ 20 PCFG whales per year). The SWG **agreed** that the performance of the management plan for Makah whaling was adequate to meet the Commission's conservation objectives for the PCFG, WFG and northern feeding group gray whales in the context of the proposed Makah hunt.

2.3.3 Conclusions and recommendations

The SWG **agreed** that the newly proposed hunt management plan for the Makah Tribe's gray whale hunt meets the IWC conservation objectives for PCFG, WFG, and ENP gray whales (see Appendix 6). Similar to its recommendations regarding the hunt plan evaluated during the last *Implementation Review* (IWC, 2012; 2013), the new hunt management plan is dependent on photo-identification studies to estimate PCFG abundance and the mixing proportions of PCFG whales available to the hunt (and bycatch in its range). The SWG's conclusions are dependent on the assumption that these studies will continue in the future.

Attention: C-A, SC

The Committee was asked by the USA to review a US Management Plan for a Makah hunt of gray whales off Washington State (the Committee had evaluated a previous plan in 2011 – IWC, 2011; 2012). The Committee conducted this work using the modelling framework developed for its rangewide review of gray whales (SC/67b/Rep07). In conclusion, the Committee:

(1) ***agrees*** *that the performance of the Management Plan was adequate to meet the Commission's conservation objectives for the Pacific Coast Feeding Group, Western Feeding Group and Northern Feeding Group gray whales;*

(2) ***notes*** *that the proposed management plan is dependent on photo-identification studies to estimate PCFG abundance and the mixing proportions of PCFG whales available to the hunt (and to bycatch in its range);*

(3) ***stresses*** *that its conclusions are dependent on the assumption that these studies will continue in the future; and*

(4) ***expresses*** *its great thanks to Punt, Brandon and Allison for their excellent work in developing and validating the testing framework and running the trials.*

2.4 West Greenland bowhead whales

2.4.1 Review results using 400 replicates

Following a previous examination of the precision with which estimates of the 5th percentiles of the performance statistics could be obtained as the number of replicates was increased; an agreement was made that 400 simulations should be used to determine the performance of the selected *SLA* for West Greenland bowhead whales. SC/O17/AWMP03 had showed projection plots for the 5th percentile and the median of the 1+ population for the baseline evaluation trials for this *SLA* based on 400 simulations. For comparison purposes, the projections for the *SLA* under 100 simulations were also shown. These show substantial variability between estimates of the 5th percentile of the distribution of population size.

Wilberg presented an analysis (Appendix 7) based on bootstrapping that was used to determine the effect of the number of simulations on the precision of the estimates of the 5th percentile of several performance measures. Projections for the selected *SLA* for West Greenland bowhead whales showed substantial differences in estimates of the 5th percentile of abundance based on 100 and 400 simulations. With only 100 simulations, the confidence intervals of the 5th percentile were quite wide, but 400 simulations led to a substantial improvement in precision. The investigation concluded that continuing to use 400 trials for the simulations appears to be sufficient to estimate the lower 5th percentile with a reasonable amount of precision.

2.4.2 Testing the Interim Allowance strategy

The SWG noted that the interim relief strategy (see Item 3) has not been examined for this *SLA* yet and **agreed** that this should be added to the workplan.

2.4.3 Conclusions and recommendations

It was agreed that continuing to use 400 replicates for the simulations is sufficient to estimate the lower 5th percentile with adequate precision.

3. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)

The Scientific Committee's Aboriginal Whaling Management Procedure (AWMP) applies stock-specific *Strike Limit Algorithms* (*SLA*s) to provide advice on aboriginal subsistence whaling (ASW) strike/catch limits.

ASW management (as part of an AWS, the aboriginal whaling scheme) incorporates several components, several of which have a scientific component:

(a) *Strike Limit Algorithms* (case-specific) used to provide advice on safe catch/strike limits;
(b) operational rules (generic to the extent possible) including carryover provisions, block quotas and interim relief allocations;
(c) Guidelines for *Implementation Reviews*; and
(d) Guidelines for data and analysis (e.g. guidelines for surveys, other data needs).

3.1 Review intersessional work

In 2017, the Scientific Committee appointed an intersessional correspondence group (Givens (Chair), Allison, Donovan, George, Scordino, Stachowitsch, Suydam, Tiedemann, Witting) to develop draft text regarding the scientific aspects of an Aboriginal Whaling Scheme. The starting place was a previous version agreed by the Scientific Committee (IWC, 2003). Two key components of a new draft AWS were the interim relief allowance and carryover provisions. The report of this group is SC/67b/AWMP21.

Donovan summarised the results from the intersessional workshops on the AWS. In addition to continuation of discussions on the extensive work of the intersessional group under Givens (see above), the Governments of Denmark and the USA had requested advice on the conservation implications of provisions that:

> '…allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit'.

This request was tested using the *Bowhead SLA* (applicable to the Bering-Chukchi-Beaufort Seas stock) and the *WG-Humpback SLA* (applicable to West Greenland) and three types of options were examined:

(1) baseline case – all strikes taken annually (i.e. no need for carryover);
(2) 'frontload' case – strikes taken as quickly as possible within block (+50% limit annually until the block limit is reached); and
(3) two alternative scenarios where carryover strikes are accrued for one or three blocks, followed by a period of carryover usage subject to the +50% limit.

The three-block scenario considered in (3) served as a direct test of the provision described in the request of USA and Denmark/Greenland. The Committee agreed that the Commission's conservation objectives were met for both *SLA*s for all of the options above and would also be met for a proposal carrying forward strikes from the previous two blocks.

Attention: CG-A

The Committee received a request from the USA and Denmark/Greenland (SC/67b/Rep06, Annex F, appendix) on the conservation implications of carryover provisions that:

> *'…allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit'.*

The Committee reviewed the request using its simulation frameworks and the two SLA*s available for stocks hunted by the USA and Greenland available at the time of the Workshop i.e. the* Bowhead SLA *(applicable to the Bering-Chukchi-Beaufort Seas stock) and the* WG-Humpback SLA *(applicable to West Greenland) and*

(1) ***agrees*** *that a carryover provision for up to 3-blocks meets Commission's conservation objectives; and*
(2) ***reiterates*** *its previous advice, applicable for all* SLA*s, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable; and*
(3) ***agrees*** *to evaluate the above request for the other Greenland SLAs at the 2019 Committee meeting.*

3.2 Review proposed updates to the AWS

The SWG considered a proposed update to the previous AWS based upon the work of the intersessional correspondence group. It considers carryover, block quotas, interim relief allocation, *Implementation Reviews* and Guidelines for surveys and data. The agreed text can be found as Appendix 9.

3.3 Conclusions and recommendations

The SWG **recommends** the AWS provided in Appendix 9 to the Committee. It notes that the Commission's AWS may include additional, non-scientific provisions.

Attention: C-R

The Committee has been working for some years to update the scientific components of an Aboriginal Whaling Scheme. It has completed this work and recommends the AWS provided in Appendix 9 to the Commission. It has sections on carryover, block quotas, interim relief allocation (and see Appendix 8), Implementation Reviews and guidelines for surveys and data. It notes that the Commission's AWS may include additional, non-scientific provisions.

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4. *IMPLEMENTATION REVIEW* OF B-C-B BOWHEAD WHALES

From the Committee's Guidelines (IWC, 2013, pp.170-1), 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 a *Strike Limit Algorithm* (*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).

The *Bowhead SLA* was adopted in 2002 (IWC, 2003, p.158) and there was an extensive *Implementation Review* completed in 2007 (IWC, 2008, p.124) with a major focus on stock structure including three intersessional workshops. That included consideration of additional trials investigating management implications of assuming additional population structure even though these were considered of low plausibility. The Committee concluded that the *Bowhead SLA* remained the best tool to provide management advice. The next *Implementation Review* was completed in 2012 (IWC, 2013, p.147); that concluded that there was no need to develop additional trials to those evaluated during the previous *Implementation Review* (IWC, 2008).

In Committee discussions last year (IWC, 2018), it was agreed that at that time, there was no information that suggested that the situation for this stock was outside the tested parameter space. Given that, the Committee had 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 Donovan confirmed that the Data Availability deadlines were met and that papers on the necessary topics were submitted. Donovan thanked the US colleagues for the extremely hard work that they have put in to providing the SWG with papers to facilitate this review.

Discussions within the SWG benefitted from the discussions within two other sub-committees, SD-DNA (Annex I) and ASI (Annex Q) and, as relevant, conclusions from those groups are briefly summarised under the agenda items below.

4.1 Stock structure: review new information

The Working Group on SD-DNA provided a summary of their discussions relevant to the *Implementation Review*. Genetic analyses (SC/67b/SDDNA01) confirmed that B-C-B bowheads and bowheads in the Sea of Okhotsk constitute two distinct stocks. There may be some weak distinction between B-C-B and EC-WG bowheads, but the majority of the evidence found no significant difference between these two populations. There is one known instance of interchange (from east to west), and one set of overlapping telemetry tracks, although those two whales returned to the populations from which they came. SC/67b/AWMP04 presented data from 64 satellite tagged whales, all but one of which followed the well-known counter-clockwise Bering-Beaufort-Chukchi circuit. The unusual track corresponded to a whale tagged in Utqiaġvik(Barrow) in autumn that migrated to the north coast of Chukotka the following spring, rather than swimming east into the Beaufort Sea. Considering the multiple lines of evidence as a whole, the Working Group on SDDNA had concluded that B-C-B bowheads constituted a single population, with no signs of substructure.

The SWG welcomed this information and thanked the hunters for their skill in making the tagging efforts efficient and successful. It **encouraged** continuation of these tagging studies. The SWG **agreed** that there was no need to consider any new *SLA* trials regarding stock structure, since the trials conducted in 2002 and 2007 already covered all plausible stock structure hypotheses.

Attention: SC

With respect to stock structure, considering the multiple lines of evidence, the Committee:

(1) agrees that BCB bowheads comprise a single population, with no signs of substructure;
(2) agrees that there was no need to consider any new SLA trials regarding stock structure, since the trials conducted in 2002 and 2007 already covered all plausible stock structure hypotheses;
(3) welcomes the telemetry information provided, thanks the hunters involved for their skill and assistance;
(4) encourages additional telemetry efforts; and
(5) agrees with the suggestions for future genetic studies in the Arctic provided under Item 11.

4.2 Abundance estimates: review new information

The Working Group on ASI (Annex Q) received new information about the 2011 B-C-B bowhead abundance from a long-term photo-identification capture-recapture study (SC/67b/AWMP01rev1). The estimated 1+ abundance was 27,133 (CV=0.217; 95% CI from 17,809 to 41,337). They concluded that this estimate could be classified as having been examined in detail and found to be suitable for providing management advice and for use in the *SLA*.

The SWG **welcomed** this information and noted that there was a completely independent 2011 abundance estimate from an ice-based survey (Givens *et al.,* 2016). This estimate is 16,820 (CV=0.052; 95% CI 15,176 to 18,643). It is not surprising that these two estimates differ because – in addition to random variability – the ice-based estimate does not count whales that are spatially or temporally excluded from the survey, whereas the photo-id dataset is more likely to contain false negative matches than false positive matches and this imbalance will tend to inflate the resulting abundance estimate.

There are thus two independent estimates for the same year considered suitable for use in the *SLA* (the ice-based estimate is already used). Discussion on how to consider such circumstances is provided under Items 3 and 5.

The Working Group on ASI (Annex Q) also received two reports on future B-C-B bowhead survey plans (SC/67b/AWMP12 and SC/67b/AWMP16). The first is for an ice-based survey in spring 2019, following methods used in earlier such surveys but not including an acoustic component. The availability of bowhead whales will be estimated from past acoustic data, as has been done with previously accepted estimates. The second survey is an August 2019 aerial line transect survey of unprecedented scope for B-C-B bowheads, covering the eastern edge of the Chukchi Sea and the entire Beaufort Sea (including Canadian waters) with most transects extending to the 200 m isobaths and some to the 2,000m isobaths. Detailed plans for the latter survey were presented in SC/67b/AWMP16, and were thoroughly discussed by the Working Group on ASI (see Annex Q).

The SWG thanked the authors for these papers, noting that their presentation is an accord with the AWS Guidelines (see Item 3) that ‘plans for undertaking a survey/census should be submitted to the Scientific Committee in advance of their being carried out, although prior approval by the Committee is not required. This should normally be at the Annual Meeting before the survey/census is carried out’.

The SWG noted that the degree of precision to be achieved by the 2019 aerial survey is unknown and may be lower than for some other recent abundance estimates. The *Bowhead Evaluation and Robustness Trials* mainly specified CVs of 0.25 or less. If the new CV turns out to be higher than this, additional trials may be required at the next *Implementation Review*.

4.3 Biological parameters: review new information

The SWG received new information about length at sexual maturity and pregnancy rate (SC/67b/AWMP07). Studies of bowhead reproduction have been conducted by the North Slope Borough Department of Wildlife Management (Alaska) over the past 35 years, with the co-operation of Alaska Native hunters. Although low calf counts and few pregnant harvested females were a concern at the inception of the programme, the situation has improved markedly since then. For SC/67b/AWMP07, pregnancy rates were estimated from examinations of reproductively mature bowhead whales (n=208) landed during the Alaska Native subsistence harvest from 1976-2016. The estimated pregnancy rate was 0.317 (95% CI 0.251 to 0.385). This suggests an inter-birth interval of just over 3 years. Whales harvested in the autumn at Utqiaġvik (Barrow) and Kaktovik comprise the most reliable pregnancy dataset because pregnancies are easier to detect and whales are more carefully examined. From this restricted dataset (n=33), the pregnancy rate is estimated to be 0.394 (95% CI 0.211 to 0.553); which the authors considered is at the high end of what is plausible for this species.

Logistic regression was used to estimate length at maturity from a separate dataset (n=150) that included whale lengths. Length at maturity was defined, relative to an equally balanced set of mature and immature whales, as the length at which the estimated probability of maturity equals 0.5. Since the actual dataset is neither balanced nor representative, the authors introduced a correction calculation. The resulting length at maturity is estimated to be 13.65m (95% CI 13.29 to 13.94). The authors recognised that their data could be biased by sampling from harvested animals where hunter selectivity occurs and by the approximately 14-month gestation period of bowheads. The estimates are consistent with past investigations and suggest a reproductively robust population. The finding that pregnancy rates are stable or possibly increasing over the past 40 years is also consistent with the increase in population abundance seen over the same time span. Finally, the authors believe that there is no evidence in the reproductive data of density-regulated reproduction or the population approaching carrying capacity.

In discussion, the SWG noted that selectivity patterns in the bowhead harvest make some types of inference from such data difficult. In particular, there are several factors that may affect the determination of pregnancy rate and trends in pregnancy rate. The SWG concluded that it was not possible therefore, to conclude that there had been a long-term increase in pregnancy rate despite the statistically significant positive trend reported in the paper; the authors concurred. However, the SWG noted that the length-at-maturity analysis was specifically corrected for age selectivity in hunting so such concerns do not arise in that analysis.

The SWG welcomed information about the potential use of samples from baleen plates to examine hormone cycles and pregnancy. Since baleen provides up to 20 years of record, it may be possible to correlate reproductive information with other variables such as environmental factors. The SWG **encouraged** future work on this subject.

SC/67b/AWMP03 summarised sightings of bowhead whale calves in the western Beaufort Sea during July-October, 2012-17, from the Aerial Surveys of Arctic Marine Mammals (ASAMM) project. Overall, 76% of the calves recorded were first sighted only after the aircraft broke from the transect line to circle an adult whale sighting. Calves were detected during all months, although more calves were detected in autumn (September-October, 245 calves) than summer (July-August, 160 calves). Total number of calves sighted per year ranged from 22 in 2012 to 155 in 2017. The highest calf ratio (number of calves/number of whales) and sighting rate (number of calves/km of effort) occurred in 2017, although 2013 and 2016 were also high. Preliminary analysis of photo- identification data suggests that it is rare to see an individual calf more than once in a given year.

The SWG welcomed this information, recognising that that it relates to successful pregnancies and, if it can be collected and analysed to provide a calving rate/index representative of the population, can provide valuable information for future *Implementation Reviews*. In discussion, it was also noted that the ASAMM aerial survey data could potentially be useful as an independent index of calf production for comparative purposes with the pregnancy rates presented in SC/67b/AWMP07. The SWG **encouraged** the continuation of the ASAMM surveys and any future collaboration involving life history data from the harvest.

Attention: SC

With respect to biological parameter information, the Committee:

(1) welcomes the extensive information presented;
(2) encourages the continued collection of such data from the hunt;
(3) encourages the work on the baleen plate analyses to examine hormone levels and pregnancy;
(4) encourages continued aerial surveys under the ASAMM surveys and any future collaboration involving life history data from the harvest; and
(5) agrees that the information presented does not suggest the need to consider any new SLA trials regarding stock structure.

4.4 Removals: review new information

The SWG received updated information about the 2017 harvest (SC/67b/AWMP05) and long-term removals (SC/67b/AWMP06). The authors of SC/67b/AWMP05 reported that in 2017, 57 bowhead whales were struck resulting in 50 animals landed. The total landed for the hunt in 2017 was higher than the average over the past 10 years (2007-16 mean of landed=41.7; SD=6.7). Efficiency (no. landed/no. struck) in 2017 was 88%, which was also higher than the average for the past 10 years (mean of efficiency= 75.2%; SD=6.5%). Of the landed whales, 28 were females and 22 were males. Based on total length (>13.4m in length) or pregnancy, 13 females were presumed mature. Six of those animals were examined and two were pregnant, one with a term foetus and another with a mid-term foetus, and one female was lactating. The fact that one third of the mature females were pregnant is consistent with past years.

SC/67b/AWMP06 provided a summary of bowhead whale catches in Alaska between 1974 and 2016. The authors pointed to the excellent cooperation and contribution of the whale hunters from the 11 villages that are members of the Alaska Eskimo Whaling Commission (AEWC). In total, 1,373 whales were landed. Over half (700) were landed in Barrow, while Shaktoolik and Little Diomede landed only one and two whales, respectively. Five of the 11 villages hunt only in the spring, two hunt only in the autumn whilst the remaining four have landed bowhead whales in both the spring and autumn/winter. Three of those villages (Gambell, Savoonga, and Wainwright) used to primarily hunt in the spring, but they now also hunt in the autumn or winter because changing ice conditions have made hunting more difficult in the spring. The efficiency of the hunt has improved over time. In the late 1970s, the efficiency averaged about 50% – because of improved hunting gear, communication, training and other factors, the efficiency now averages about 80%. Kaktovik and Nuiqsut hunt in the autumn in open water conditions and rarely have struck and lost whales. Some villages (Gambell, Savoonga, and Wainwright) on average land longer whales than others (Barrow and Point Hope). The length of landed whales within a season is correlated with the timing of the hunt. During spring, shorter whales tend to be landed earlier in the season while larger whales tend to be landed later. The opposite occurs in the autumn when larger whales tend to be landed earlier. The sex ratio of landed whales is even.

From 2013 to 2017, four bowhead whales (2 females and 2 males) were harvested near Chukotka, mainly in Anadyr Bay (SC/67b/AWMP20). The average length was 14.5m (minimum 13.0m, maximum 17.0m). Although the portion of the annual strike limit allocated to Russia under their bilateral agreement with the USA is five animals, the actual annual take is usually only 1-2 whales per year, and this has been the case since at least 2004.

The SWG thanked the authors of the provision of this information; catch and strike data are used in the *SLA* calculations (see Item 5.)

4.5 Other anthropogenic threats and health: review new information

New information about detection of carcasses in the eastern Chukchi and western Beaufort seas from the ASAMM project (2009-17, see summary under Item 3 above) was reported in SC/67b/AWMP02. A total of 27 bowhead whale carcasses (21 in the eastern Chukchi Sea) was detected, most in September but with the highest sighting rate in October. Survey effort does not account for the difference between the eastern Chukchi and western Beaufort study areas. A total of six carcasses, including all three of the calf/yearling carcasses sighted, showed signs of killer whale injuries; knowledge of killer whale behaviour and the location of the injuries on the whales, suggested to the authors that killer whale predation not scavenging was the cause of death. One carcass, with subsistence hunting gear (i.e., a line and float) attached, was observed in late October 2015. There were two struck and lost whales reported from about that same time; one at Barrow in late September and one in Wainwright in mid-October. Both of those whales were reported by the whaling captains to have likely died.

SC/67b/AWMP08 reported that during 2017, around 14% of landed whales carried injuries from line entanglement but none had ship strike injuries (consistent with 1990-2012 baselines). Two whales landed at Utqiaġvik (Barrow) in spring 2017 were carrying line associated with pot gear and had severe entanglement injuries such that veterinarians and the attending hunters thought that they were dying when captured.

The SWG **agreed** that whilst the present level of unintentional human induced mortality is too low to require new *Implementation* trials or incorporation into the *SLA* calculations, the situation should continue to be monitored and evaluated at the next *Implementation Review*. The SWG **welcomed** information that discussions between the AEWC and the Bering Sea Crabbers Association were ongoing, with the goal of limiting or reducing bowhead mortality attributable to their fishing gear.

The SWG **agreed** with the authors that the carcasses with killer whale injuries were probably a result of predation not scavenging. George expressed his opinion that killer whale/bowhead interactions have increased in the NE Chukchi Sea over the past 40 years. While beachcast gray whale calves killed by killer whales are commonly observed in Alaska along the NE Chukchi coast, dead bowhead calves (or subadults) were first seen only three years ago. There has also been an increase in observations of killer whale predation from ASAMM surveys and from hunters. In fact, a bowhead calf, probably killed by killer whales, was recovered by hunters northeast of Barrow; such a recovery has not happened before in the memory of native Alaskan hunters.

SC/67b/AWMP08 provided a comprehensive review of B-C-B bowhead health. The authors first noted that the strong, steady rate of population increase and the recent estimate of survival rate are possibly the best indicators that this population is healthy. A body condition index has shown a significant increase (fatter whales) over the period 1990-2012 but there is some evidence it has slowed or reduced in the last five years. This may reflect a density dependent effect of a population nearing carrying capacity, but further analysis is required. Post-mortem analyses indicate that whales caught in the spring migration are generally not feeding, while most (75-100%) in the autumn are. This is consistent with past findings and suggests that bowhead whale feeding habitat remains viable and productive.

General health information on landed bowhead whales was obtained from several major retrospective screening survey studies and from pathological analysis of 2017 post-mortem examinations. Key findings included: (i) declining body burden trend (blubber and muscle) in organic pollutants; (ii) limited detection of anthropogenic radionuclides (low levels in muscle); (iii) continued absence of major pathogens that could impact health; (iv) interannual variation of *Giardia* spp. with some suggestion of environmental marine contamination with human faeces; and (v) variable presence of marine biotoxins in faeces suggesting complex environmental drivers of harmful algae blooms in the Arctic. Pathological findings in 2017 were consistent with previous years e.g.: (i) low prevalence of fatty benign tumors in livers and gastric nodules associated with anisakis infection; and (ii) presence of kidney worm infection. Further work is underway on species characterisation of kidney worm specimens. The authors suggest that Arctic climate change (e.g., diminishing sea ice, increased sea surface temperature, opening of the Northwest Passage, range overlap with seasonal southern baleen whale migrants known to carry kidney worms, and prey shifts) may be setting the stage for an evolving host-parasite relationship in B-C-B bowhead whale stock.

The SWG **thanked** the authors for this valuable summary and **agreed** that nothing in the health analyses was cause for concern with respect to the continued application of the *Bowhead SLA*.

Attention: SC

With respect to threats and health to the B-C-B bowhead whales, the Committee:

(1) ***welcomes** the extensive information presented;*
(2) ***agrees** that whilst the present level of unintentional human induced mortality is too low to require new* Implementation *trials or incorporation into the* SLA *calculations, the situation should continue to be monitored and evaluated at the next* Implementation Review*;*
(3) ***agrees** that the health analyses give no cause for concern with respect to the continued application of the* Bowhead SLA*; and*
(4) ***encourages** that the excellent work on health-related issues continues.*

4.6 Conclusions and recommendations (and, if needed, workplan to complete *Review*)

The SWG **concluded** that no additional work was required to complete the *Implementation Review*. It further **concluded** that the range of hypotheses and parameter space already tested in *Bowhead SLA* trials was sufficient and therefore the *Bowhead SLA* could continue to be **recommended** to the Commission as the best way to provide management advice. This advice is presented under Item 5.3.

Attention: SC

With respect to the Implementation Review *of B-C-B bowhead whales, the Committee **concludes** that:*

(1) *the* Implementation Review *has been satisfactorily completed; and*
(2) *the range of hypotheses and parameter space already tested in* Bowhead SLA *trials was sufficient and therefore the* Bowhead SLA *remains the best way to provide management advice for this stock;*

In addition, it thanks the US scientists for the extremely hard work that they have put into providing comprehensive papers to facilitate this review

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5. STOCKS SUBJECT TO ASW (NEW INFORMATION AND MANAGEMENT ADVICE)

The SWG noted that the Commission will be setting new catch/strike limits for at its 2018 biennial meeting in Brazil. It had received written or verbal requests for limits to be considered for each hunt as discussed below.

In addition, there had been a general request to the intersessional workshop from the USA and Denmark (SC/67b/Rep06, annex F) for advice on whether there would be a conservation issue if there was a one-time seven-year block followed by a return to six-year blocks to address logistical issues from a Commission perspective. The SWG **agreed** with the intersessional workshop that there are no conservation issues associated with this suggestion.

5.1 Eastern Canada/West Greenland bowhead whales

5.1.1 New abundance information

Last year, the SWG had recommended that Canadian scientists attend the Committee to present the results of their work on abundance. It was very pleased that Doniol-Valcroze from Department of Fisheries and Oceans Canada and the primary author of the paper on aerial survey abundance estimate was present at the meeting.

The two relevant papers were first discussed by the Standing Working Group on ASI (see Annex Q for details). Doniol-Valcroze *et al.* (2015) provided a fully corrected estimate from the 2013 aerial survey of 6,446 bowheads (CV=0.26, 95% CI 3,722-11,200). The survey covered the major summering area for the Eastern Canada/West Greenland stock. The Working Group on ASI agreed that this was acceptable for management advice and for use within the AWMP. The other paper (ref) contained a genetic mark-recapture estimate that was considered preliminary at this stage.

The SWG **welcomed** this information and recalled that the *WG-Bowhead SLA* had been developed on the conservative assumption that the abundance estimates for the West Greenland area alone (1,274 whales in 2012 (CV=0.12)) represented the abundance of the whole stock, as it believed that it was not possible to assume that a non-member country would continue with regular surveys. Doniol-Valcroze advised the SWG that the present management strategy of Canada does involve obtaining regular abundance estimates. The SWG noted it would be pleased to receive such estimates from Canada being presented to the Committee in the future.

The SWG **welcomed** this information. It **agreed** that consideration of how to incorporate abundance estimates from Canada should be one focus of the next *Implementation Review.* It noted the regular collaboration of Canadian and Greenlandic scientists on other matters such as genetic sampling (*inter alia* for mark-recapture abundance estimation). It **encouraged** further collaboration between Canada, Greenland and the USA for the study of bowhead whales across their range and the presentation of these results at future Committee meetings.

In this regard, Witting reported that Greenland continues its biopsy sampling programme, with 60 biopsy samples collected in 2017. Bickham noted that many SNPs had been developed for B-C-B bowheads (SC/67b/SDDNA01) and that it would be productive for the same markers to be analysed for the Canadian samples since between-lab calibration is straightforward for SNPs and the increased statistical power would improve stock structure analyses, e.g. the ability to identify individual whales could provide information relevant to mixing proportions between areas.

5.1.2 New catch information

SC/67b/AWMP10 provided an update of recent Canadian takes made in the Inuit subsistence harvest of EC-WG bowhead whales. In the eastern Canadian Arctic, the maximum take is 7 bowhead whales per year according to domestic policy, with no carry-over of unused takes between years. Since 2015, five strikes were taken and four bowhead whales were successfully landed (one in 2015, two in 2016 and one in 2017).

The SWG **thanked** Canada for regularly providing catch information. It noted that the reported number of strikes was within the parameter space that was tested for the *WG-Bowhead SLA* and **encouraged** the continued collection of genetic samples from harvested whales.

Witting reported that West Greenland hunters struck no bowheads in 2017. There was one whale of 14.7m in length that died from entanglement in crab gear.

5.1.3 Management advice

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67 and no changes were requested for bowhead whales.

The SWG **agreed** that the *WG Bowhead SLA* remains the best available ways for management advice, and noted that this *SLA* had been developed under the conservative assumption that the number of bowhead whales estimated off West Greenland represented the total abundance between West Greenland and Eastern Canada. Based on the agreed 2012 estimate of abundance for West Greenland (1,274, CV=0.12), the catch of one whale in Canada in 2017, 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 and meets the Commissions conservation objectives.

Although the SWG had not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, Annex F, appendix) for this *SLA,* it **agreed,** based on *WG-bowhead SLA* testing thus far, that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next was acceptable.

Attention: C-A

A general request had been received from the USA and Denmark for advice on whether there would be a conservation issue if there was a one-time 7-year block followed by a return to 6-year blocks to address logistical issues related to the Commission.

The Committee ***agrees*** *there are no conservation issues associated with this suggestion.*

Attention: SC

The Committee greatly appreciated the presence of a Canadian scientist at its meeting. The Committee:

(1) ***welcomes*** *the provision of the abundance estimate for the Eastern Canada/West Greenland stock and (see Item 8.1.2) the regular provision of information on catch data by Canada;*
(2) ***welcomes*** *the attendance of Canadian scientists at its meetings;*
(3) ***agrees*** *that consideration of how to incorporate abundance estimates from Canada should be one focus of the next* Implementation Review *for this stock;*

(4) **notes** *the regular collaboration of Canadian and Greenlandic scientists on other matters such as genetic sampling (inter alia for mark-recapture abundance estimation); and*
(5) **encourages** *further collaboration between Canada, Greenland and the USA for the study of bowhead whales across their range and the presentation of these results at future Committee meetings.*

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67 and no changes were requested for bowhead whales. The Committee therefore:

(1) **agrees** *that the* WG-Bowhead SLA *remains the best available way to provide management advice for the Greenland hunt;*
(2) **notes** *that this SLA had been developed under the conservative assumption that the number of bowhead whales estimated off West Greenland represented the total abundance between West Greenland and Eastern Canada;*
(3) *based on the agreed 2012 estimate of abundance for West Greenland (1,274, CV=0.12), the catch of one whale in Canada in 2017, and using the agreed* WG-Bowhead SLA, ***agrees*** *that an annual strike limit of two whales will not harm the stock and meets the Commissions conservation objectives; and*
(4) *although the Committee has not yet had time to examine the request from the US/Denmark for the WG-Bowhead SLA, reiterates its advice, applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next, is acceptable.*

5.2 North Pacific gray whales

The Russian Federation (SC/67b/AWMP17) had requested advice on the following provision:

'For the **seven** years 2019, 2020, 2021, 2022, 2023, 2024 and 2025, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 980 (i.e. 140 per annum on average) provided that the number of gray whales taken in any one of the years 2019, 2020, 2021, 2022, 2023, 2024 and 2025 shall not exceed 140.'

5.2.1 New information (including catch data)

SC/67b/AWMP20 presented a comparison of gray whale catch data off Chukotka during: (i) the Soviet era (i.e. data from the catcher boat *Zvezdny*, from 1969-91); with (ii) recent data from 2013-17. The average length and weight of harvested whales in recent years is smaller than it was during the Soviet era. This discrepancy could be due to a difference in the selectivity patterns between the Soviet era industrial-sized catcher boat and the small boats used by native Chukotkans. The average annual number of whales was also higher during the Soviet era (150 *vs* 123). The annual biomass of removals in recent years is estimated to be one-third of that during the Soviet era. In recent years, most whales have been taken by the eastern and northeastern settlements of the Chukchi Peninsula – in the Bering Strait and east Chukchi Sea. Authors speculated that more mature whales migrate to the Arctic via the Bering Strait compared to those remaining in Anadyr Bay. Whales caught on Chukotka's Arctic coast were found to be statistically larger with a higher fat index than whales harvested on the eastern coast. Considering the 11% rise of native population in Chukotka since 2010 and also considering the drop in acquired whaling products comparing to 1980s-1990s, the authors concluded that the subsistence need of indigenous people is not satisfied.

Zharikov presented results of the 2017 whaling season in Chukotka. A total of 119 gray whales were struck in 2017 (37 males and 82 females). No whales were struck and lost, and no stinky (inedible) gray whales were taken. Similar whaling methods were employed as in recent years and the overall efficiency of the hunt was almost same as in 2016. It was noted that whale products are a large part of the local diet; there is also exchange with inland aborigines and use for non-nutritional purposes. A total of 615 gray whales have been taken in 2013-17 (SC/67b/AWMP17). Therefore only 105 strikes remain for 2018 under the current block quota, while the average annual take in recent years is 123 whales. The *SLA* trials performed in 2017 at the request of the Government of the Russian Federation (IWC, 2018) showed that a take of up to 136 whales per year by indigenous people of Chukotka will not harm the population. He noted that a possible overrun of 2013-18 quota by Chukotka native whalers was within this catch level and believed that such needs should be taken into account in the near future.

SC/67b/AWMP17 presented proposed text by the Russian Federation for amendments to Paragraph 13(b)(2) of the Schedule for gray whales. It was noted that a specific native diet has been documented. The consumption of relatively high amounts of proteins and fats is a necessary component of health and longevity in the native population of Chukotka. The importance of aboriginal whaling to the social, cultural and economic structure of Chukotka's coastal villages was also noted. Under the current block quota, the annual strike limit is 140 per year (including any strikes allocated to the Makah tribe). The proposed amendments would extend the duration of this block quota from six to seven years. Under the proposed seven-year block quota, the total number of strikes would be increased to 980 (140x7yrs). This provision would continue to be reviewed biannually by the Commission in light of the annual advice of the Scientific Committee.

5.2.2 Management advice

The SWG **agreed** that the *Gray Whale SLA* remains the best available way for management advice for this stock. It **advised** that an average annual strike limit of 140 whales will not harm the stock and meets the Commission's conservation objectives. It also noted that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next was acceptable. It also **advised** that the Makah Management Plan (Item 2.3) is in accord with the Commission's management objectives.

Attention: SC

In reviewing the results of new genetic analyses of gray whales in the North Pacific, the Committee ***agrees*** *that the genetic and photographic data for this species be combined to better assess stock structure-related questions. Given the potential for genomic data to aid in better evaluating the stock structure hypotheses currently under consideration for North Pacific gray whales, the Committee* ***encourages*** *the continuation of work to produce additional genomic data from sampled gray whales.*

Attention: C-A

The Russian Federation (SC/67b/AWMP/17) had requested advice on the following provision:

> *'For the seven years 2019, 2020, 2021, 2022, 2023, 2024 and 2025, the number of gray whales taken in accordance with this sub-paragraph shall not exceed 980 (i.e. 140 per annum on average) provided that the number of gray whales taken in any one of the years 2019, 2020, 2021, 2022, 2023, 2024 and 2025 shall not exceed 140.'*

The Committee therefore:

(1) ***agrees*** *that the* Gray Whale SLA *remains the best available way to provide management advice for the gray whale hunts;*
(2) ***advises*** *that an average annual strike limit of 140 whales will not harm the stock and meets the Commission's conservation objectives;*
(3) ***notes*** *that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next remains acceptable;*
(4) ***advises*** *that the Makah Management Plan (see Item 2.3) also is in accord with the Commission's management objectives.*

5.3 Bering-Chukchi-Beaufort Seas bowhead whale

5.3.1 New information

New information was considered as part of the *Implementation Review* discussed under Item 4.

The USA had indicated that it was proposing no changes to the present catch/strike limits although it may suggest changes to its carryover request in light of the advice received by the Committee as discussed at the intersessional Workshop (SC/67b/Rep06).

The SWG noted that there are now two independent estimates of abundance for this stock in 2011 (see Item 4). Recognising the need to formally consider the general question of how best to combine estimates in such cases as part of the workplan in the next biennium, the SWG noted that if they are combined as a weighted average by the inverse of their variances, there is little difference (it is slightly higher) between the combined estimate and that from the ice-based census estimate that is the approach used to obtain the other estimates used in the *SLA*. It therefore **agreed** to use the ice-based census estimate for 2011 survey (Givens *et al.,* 2016; 16,820, CV=0.052, 95% CI 15,176 to 18,643) as the most recent estimate of abundance for use in the *Bowhead SLA* this year.

5.3.2 Management advice

The SWG **agreed** that the *Bowhead SLA* remains the best available way for management advice for this stock. It **advised** that a continuation of the present average annual strike limit of 67 whales will not harm the stock and meets the Commission's conservation objectives.

The SWG also **advised** that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit' has no conservation implications (see SC/67b/Rep04).

Attention: C-A

The USA indicated that it requested advice on the existing catch/strike limits. The Committee therefore:

(1) ***agrees*** *that the* Bowhead Whale SLA *remains the best available way to provide management advice for this stock;*
(2) ***advises*** *that a continuation of the present average annual strike limit of 67 whales will not harm the stock and meets the Commission's conservation objectives; and*
(3) ***advises*** *that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit, has no conservation implications (see SC/67b/Rep04).*

5.4 Common minke whales off East Greenland

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on an annual take of 20 animals (it had previously been 12).

5.4.1 New information on catches

In the 2017 season, 9 common minke whales were landed in East Greenland, and one was struck and lost. Three of the landed whales were males, 6 were females, and genetic samples were obtained from 8 of the landed whales. One common minke whale died from entanglement in fishing gear. The SWG **encouraged** the continued collection of genetic samples and collaborative studies (see Item 5.1.1).

5.4.2 New information on abundance

The Working Group on ASI endorsed the 2015 aerial survey abundance estimate of 2,762 (CV=0.47; 95%CI 1,160-6,574). This is only a small part of the wider Western and Central stocks.

5.4.2 Management advice

The SWG noted that in the past its advice for the East Greenland hunt had been based upon the fact that the catch was a small proportion of the number of animals in the Central Stock. During the process to develop an *SLA* for common minke whales off West Greenland produced a simulation framework that produces a considerably more rigorous way to provide advice for this hunt, taking into account stock structure issues. In addition, there is for the first time a separate estimate of abundance for common minke whales off East Greenland alone (this is only a small part of the wider western and Central stocks from which the catches can be drawn). The results of the simulation trials that incorporated a continuing catch of 20 whales from East Greenland led to no conservation concerns (see Appendix 4). The SWG noted that a formal *SLA* for this hunt should be developed in the future.

Given the above information, the SWG **advised** that an annual strike limit of 20 whales for the next block will not harm the stock and meets the Commission's conservation objectives.

In response to a request for advice on the length of the season for the common minke whale hunts in SC/67b/AWMP19, the SWG **agreed** that changing the length of the season to 12 months had no conservation implications.

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on an annual take of 20 animals (it had previously been 12). It had also requested advice on any conservation implications of a 12-month hunting season for common minke whales.

The Committee therefore:

*(1) **notes** that in the past its advice for the East Greenland hunt had been based upon the fact that the catch was a small proportion of the number of animals in the Central Stock;*
*(2) **notes** the process to develop an* SLA *for common minke whales off West Greenland resulted in a simulation framework that produces a considerably more rigorous way to provide advice for this hunt than before, by taking into account stock structure issues;*
*(3) **notes** that the results of the simulation trials that incorporated a continuing catch of 20 whales from East Greenland gave rise to no conservation concerns;*
*(4) **notes** that the 2015 aerial survey abundance estimate of 2,762 (CV=0.47; 95%CI 1,160-6,574) is only a small part of the wider western and central stocks;*
*(5) **advises** that a continuation of the present average annual strike limit of 20 whales will not harm the stock and meets the Commission's conservation objectives;*
*(6) **advises** that changing the length of the season to 12 months had no conservation implications; and*
*(7) **agrees** that an* SLA *should be developed for this hunt in the future; and*
*(8) **encourages** the continued collection of samples for collaborative genetic analyses (and see Item 7.1.2.3).*

5.5 Common minke whales off West Greenland

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on annual strikes of 164 animals (i.e. no change).

5.5.1 New information on catches

In the 2017 season, 129 common minke whales were landed in West Greenland and four were struck and lost. Of the landed whales, there were 95 females, 33 males and one of unknown sex. Genetic samples were obtained from 104 of these common minke whales in 2017, and the SWG was pleased to note that samples were already part of the data used in the 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.

5.5.2 New information on abundance

The Working Group on ASI endorsed the 2015 aerial survey abundance estimate of 5,095 (CV=0.46; 95%CI 2,171-11,961) as discussed in Annex Q.

5.5.3 Management advice

The SWG **agreed** that the new *WG-common minke SLA* (Item 2.2) is the best available way to provide management advice for this stock. It **advised** that an annual strike limit of 164 whales will not harm the stock and meets the Commission's conservation objectives. Although the SWG had not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, Annex F, appendix) for this new *SLA,* it **agreed,** based on *WG-common minke SLA* testing thus far, that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next was acceptable.

In response to a request for advice on the length of the season for the common minke whale hunts in SC/67b/AWMP19, the SWG **agreed** that changing the length of the season to 12 months had no conservation implications.

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC67. It requested advice on annual strikes of 164 animals (i.e. no change). It had also requested advice on any conservation implications of a 12-month hunting season for common minke whales.

The Committee therefore:

*(1) **agrees** that the WG-Common minke SLA is the best available way to provide management advice for this stock under need scenario A;*
*(2) **advises** that a continuation of the present average annual strike limit of 164 whales will not harm the stock and meets the Commission's conservation objectives;*
(3) although the Committee has not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, annex F, appendix) for this SLA, reiterates its previous advice, applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable;
*(4) **advises** that changing the length of the season to 12 months had no conservation implications; and*
*(5) **encourages** the continued collection of samples for collaborative genetic analyses (and see Item 7.1.2.3).*

5.6 Fin whales off West Greenland

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on annual strikes of 19 animals (i.e. no change).

5.6.1 New information on the catch

A total of seven fin whales (five females and two males) was landed, and one was struck and lost, off West Greenland during 2017. The SWG was pleased to note that genetic samples were obtained from five of these, and that the genetic samples are analysed together with the genetic samples from the hunt in Iceland. It **encouraged** the continued collection of samples and collaborative work on analyses.

5.6.2 New information on abundance

The Working Group on ASI endorsed the 2015 aerial survey abundance estimate of 2,215 (CV=0.41; 95%CI 1,017-4,823) as discussed in Annex Q.

5.6.3 Management advice

The SWG **agreed** that the new *WG-fin SLA* (Item 2.2) is the best available way to provide management advice for this stock. It **advised** that an annual strike limit of 19 whales will not harm the stock and meets the Commission's conservation objectives.

Although the SWG had not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, Annex F, appendix) for this new *SLA,* it **agreed,** based on *WG-fin SLA* testing thus far, that its previous advice that the interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next was acceptable.

In response to a request for advice on length limits for fin whales in SC/67b/AWMP19, the SWG **agreed** that removing the length limits had no conservation implications.

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on annual strikes of 19 animals (i.e. no change). It also requested advice on whether there were any conservation implications of removing length limits (while retaining the prohibitions relating to calves.

The Committee therefore:

(1) *agrees that the* WG-Fin SLA *is the best available way to provide management advice for this stock;*
(2) *advises that a continuation of the present average annual strike limit of 19 whales will not harm the stock and meets the Commission's conservation objectives;*
(3) *although the Committee has not yet had time to examine the request from the US/Denmark (SC/67b/Rep06, annex F, appendix) for this SLA, reiterates its advice, applicable for all SLAs, that interannual variation of 50% within a block with the same allowance from the last year of one block to the first year of the next is acceptable;*
(4) *advises that removing the length limits had no conservation implications; and*
(5) *encourages the continued collection of samples for collaborative genetic analyses (and see Item 7.1.1.3).*

5.7 Humpback whales off West Greenland

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on annual strikes of 10 animals (i.e. no change).

5.7.1 New information on catches

A total of two (two females) humpback whales were landed and none were struck and lost in West Greenland during 2017. The SWG was pleased to learn that genetic samples were obtained from all the landed whales. The SWG again **emphasised** the importance of collecting genetic samples and photographs of the flukes from these whales.

The SWG noted that five humpback whales were observed entangled in fishing gear in West Greenland in 2017. Of these, one died, two became free and one was successfully disentangled by a disentanglement team. The remaining animal was alive and still entangled when it was last sighted.

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 requested IWC disentanglement training that took place in 2016 and that they successfully disentangled one humpback whale.

5.7.2 New information on abundance

The Working Group on ASI endorsed the 2015 aerial survey abundance estimate of 993 (CV=0.46; 95%CI 434-2,272) as discussed in Annex Q.

5.7.3 Management advice

The SWG **agreed** that the *WG humpback SLA* remains the best available tool for management advice for this stock. It **advised** that a continuation of the present average annual strike limit of 10 whales will not harm the stock and meets the Commission's conservation objectives.

The SWG also **advised** that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit' has no conservation implications (see SC/67b/Rep04).

Attention: C-A

SC/67b/AWMP19 reported Greenland's plans for requesting aboriginal whaling provisions at IWC/67. It requested advice on annual strikes of 10 animals (i.e. no change).

The Committee therefore:

(1) ***agrees*** *that the* WG-Humpback SLA *is the best available way to provide management advice for this stock;*
(2) ***advises*** *that a continuation of the present average annual strike limit of 10 whales will not harm the stock and meets the Commission's conservation objectives;*
(3) ***advises*** *that that provisions allowing for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit' has no conservation implications (see SC/67b/Rep04); and*
(4) ***encourages*** *the continued collection of samples and photographs for collaborative analyses.*

5.8 Humpback whales off St Vincent and The Grenadines

The alternate Commissioner for St Vincent and The Grenadines advised that no change to the present limits were envisaged.

5.8.1 New information on catch

It was reported that one humpback whale was struck and landed in 2017 by St Vincent and The Grenadines.

5.8.2 New information on abundance

Last year, the Committee had requested that the USA provide a new abundance estimate for the western North Atlantic based upon the available NOAA data (IWC, 2018). Clapham and Wade provided a progress report on this work with a focus on information on abundance estimates generated by the MONAH study, conducted in 2004 and 2005 on Silver Bank (a breeding ground in the West Indies) and in the Gulf of Maine feeding ground. The best estimate was judged to be a genotype-based two-year pooled feeding-to-breeding male-only Chapman estimate. This estimate was 6,156 (95% CI 4,344, 7,977), which when doubled (to account for females) equals 12,312. This was slightly higher than, although not significantly different from, the best estimate from the YONAH project from 1992/93, which was 10,400 (8,000, 13,600). The lack of strong population growth was unexpected given information on rates of increase from some other areas of the North Atlantic, and may reflect either a true rate of increase, unidentified sampling bias, and/or the idea that Silver Bank as a habitat has reached a maximum capacity. Given this, it was not clear whether the MONAH estimate is representative of the entire population, nor whether it can be applied to the southeastern Caribbean in the context of the St Vincent hunt. Four animals from the southeastern Caribbean have been linked to animals seen in the Gulf of Maine (one was caught in the hunt).

The SWG also noted the recent new abundance estimates of humpback whales in the North Atlantic including 993 (95% CI: 434-2,272) in West Greenland in 2015, 4,223 (95% CI: 1,845-9,666) in East Greenland in 2015 and Iceland-Faroes with 12,879 (95% CI 5,074; 26455) estimated from the 2007 ship survey

It has now been nearly two decades since the IWC has undertaken an In-Depth Assessment on North Atlantic humpback whales. The SWG **agreed** that it would be a valuable exercise to perform a North Atlantic Rangewide review of humpback whales, similar in scope to the Rangewide Review for North Pacific gray whales and taking into account recent work on stock structure including that of Stevick *et al.* (2018).

5.8.3 Management advice

The SWG noted that it did not have an approved abundance estimate for western North Atlantic since that in 1992. In accord with the advice provided in the AWS (see Appendix 9), it therefore considered the available evidence to see if was sufficient to provide safe management advice. Given the information above on recent abundance in the North Atlantic and the size of the requested catch/strikes (an average of four annually), the SWG **advised** that continuation of the present limits will not harm the stock.

The SWG also **repeats** its earlier advice that:

(1) the status and disposition of genetic samples collected from past harvested whales be determined and reported next year;
(2) photographs for photo-ID (where possible) and genetic samples are collected from all whales landed in future hunts; and that
(3) the USA (NOAA, NMFS) provides an abundance estimate from the MONAH data as soon as possible for the Committee.

Attention: C-A

The alternate Commissioner for St Vincent and The Grenadines advised that no change to the present limits were envisaged. The Committee therefore:

(1) ***notes*** *that it does not have an approved abundance estimate for western North Atlantic since that in 1992;*
(2) ***notes*** *that in accord with the advice provided in the AWS (see Appendix 9), it therefore considered the available evidence to see if was sufficient to provide safe management advice; and*
(3) ***advises*** *that, given the information above on recent abundance in the North Atlantic combined with the size of the requested catch/strikes (an average of four annually), continuation of the present limits will not harm the stock;*

The Committee also ***reiterates*** *its previous advice that:*

(1) the status and disposition of genetic samples collected from past harvested whales be determined and reported next year;
(2) photographs for photo-ID (where possible) and genetic samples are collected from all whales landed in future hunts; and that
(3) the USA (NOAA, NMFS) provides an abundance estimate from the MONAH data as soon as possible for the Committee.

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6. WORKPLAN 2019-20 (INCLUDING WORKSHOPS AND INTERSESSIONAL GROUPS)

Table 1 summarises the work plan for work related to aboriginal subsistence whaling.

Simulation testing of interim relief allowances has been conducted for B-C-B bowheads and WG humpbacks (item 3 of Appendix 9). Interim relief will be tested for eastern NP gray whales at the next *Implementation Review* for that stock. Testing for the remaining ASW stocks will be added to the future workplan of the Committee.

7. BUDGETARY ITEMS 2019-20

The SWG has no budget requests for the next biennium.

8. ADOPTION OF REPORT

The Chair noted that this meeting represented the end of a long journey – with the adoption of the two new *SLA*s, the SWG had completed the development tasks it had been assigned by the Commission. He thanked all of the people who have made such a wonderful contribution over the years – the SWG has, in his view, achieved ground-breaking work over the last two decades in a spirit of great collaboration and co-operation, even when there were disagreements as inevitably there were. At this meeting, he thanked the rapporteurs, and especially John Brandon for their hard work. Primarily, though thanks were due to André Punt, Lars Witting and Anabela Brandão for their herculean efforts in developing and running trials and developing *SLA*s. However, greatest praise should go to Cherry Allison who under extremely difficult circumstances provided superb support from Cambridge. The whole SWG sends their thanks, support and best wishes.

Table 1

Work plan for matters related to aboriginal subsistence whaling.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
(1) Annual review of catch/strike limits		Carry out		Carry out
(2) *Implementation Review*		Gray whales based upon rangewide review		West Greenland humpback whales
(3) *SLA*s		Consider development of an *SLA* for the hunt of common minke whales off East Greenland based on operational models developed for the West Greenland hunt		Adopt *SLA* if it is decided one is necessary
(5) Interim relief allowance testing	Run trials for gray whale hunts	Review results	Run trials for West Greenland common minke whales and fin whales	Review results
(6) Carryover (US/Denmark request)	Run trials for remaining Greenland hunts (West Greenland common minke whales, bowhead whales and fin whales	Review results		

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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
   - 2.1 Fin whales (Greenland)
     - 2.1.1 Review results of intersessional Workshops
     - 2.1.2 Review post-Workshop progress
     - 2.1.3 Review final results and performance
     - 2.1.4 Conclusions and recommendations
   - 2.2 Common minke whales (Greenland)
     - 2.2.1 Review results of intersessional Workshops
     - 2.2.2 Review post-Workshop progress
     - 2.2.3 Review description of and results for candidate *SLA*s
     - 2.2.4 Conclusions and recommendations
   - 2.3 North Pacific gray whales (Makah Management Plan)
     - 2.3.1 Summarise the plan
     - 2.3.2 Review intersessional progress including at the Rangewide Workshop
     - 2.3.3 Conclusions and recommendations
   - 2.4 WG-bowhead whales
     - 2.4.1 Review results using 400 replicates
     - 2.3.2 Testing the Interim Allowance strategy
     - 2.3.3 Conclusions and recommendations
3. Aboriginal Whaling Management Scheme (AWS)
   - 3.1 Review results of intersessional Workshops
   - 3.2 Review proposed updates to the AWS
   - 3.2 Conclusions and recommendations
4. *Implementation Review* of B-C-B bowhead whales
   - 4.1 Stock structure: review new information (including advice from SD)
   - 4.2 Abundance estimates: review new information (including advice from ASI)
   - 4.3 Biological parameters: review new information
   - 4.4 Removals: review new information
   - 4.5 Other anthropogenic threats and health: review new information
   - 4.6 Conclusions and recommendations (and, if needed, work plan to complete *Review*)
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. Work plan 2019-20 (including workshops and intersessional groups)
7. Budgetary items 2019-20
8. Adoption of report

Appendix 2

WEST GREENLAND FIN WHALE *SLA* TRIAL SPECIFICATIONS

In initial trials, fin whales off West Greenland were modelled as a single isolated population (see discussion in IWC [2016, p.476], with this approach justified as being more conservative in terms of population risk compared to modelling the whole North Atlantic). Following a new point estimate of abundance from a 2015 survey that was significantly smaller than the previous one, the abundance is modelled 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 is drawn from a distribution (see section B). An alternative 'Influx' model is also trialled.

A. The population dynamics model

The underlying dynamics model is deterministic, age- and sex-structured, and based on the Baleen II model (Punt, 1999).

A.1 Basic dynamics

Equations A1.1 provide the underlying 1+ dynamics.

$$\begin{aligned} R^{m/f}_{t+1,a+1} &= (R^{m/f}_{t,a} - C^{m/f}_{t,a})S_a + U^{m/f}_{t,a} S_a \delta_{a+1} && 0 \le a \le x-2 \\ R^{m/f}_{t+1,x} &= (R^{m/f}_{t,x} - C^{m/f}_{t,x})S_x + (R^{m/f}_{t,x-1} - C^{m/f}_{t,x-1})S_{x-1} \\ U^{m/f}_{t+1,a+1} &= U^{m/f}_{t,a} S_a (1-\delta_{a+1}) && 0 \le a \le x-2 \end{aligned} \qquad \text{(A1.1)}$$

$R^{m/f}_{t,a}$ is the number of recruited males/females of age a at the start of year t;

$U^{m/f}_{t,a}$ is the number of unrecruited males/females of age a at the start of year t;

$C^{m/f}_{t,a}$ is the catch of males/females of age a during year t (whaling is assumed to take place in a pulse at the start of each year);

δ_a is the fraction of unrecruited animals of age a-1 which recruit at age a (assumed to be independent of sex and time);

S_a is the annual survival rate of animals of age a:

$$S_a = \begin{cases} S_J S_{1+} & \text{if } a = 0 \\ S_J & \text{if } 1 \le a \le a_T \\ S_{1+} & \text{if } a > a_T \end{cases} \qquad \text{(A1.2)}$$

S_J is the juvenile survival rate (note that for calves, a=0, the assumption made above is that if the mother dies, the calf dies too);

S_{1+} is the survival rate for animals older than age a_T;

a_T is the age at which survival rate changes from juvenile to adult; and

x is the maximum (lumped) age-class (all animals in this and the x-1 class are assumed to be recruited and to have reached the age of first parturition). x is taken to be 15 for fin whales for these trials.

A.2 Births

The number of births at the start of year t+1, B_{t+1}, is given by Equation A2.1:

$$B_{t+1} = b_{t+1} N^f_{t+1} \qquad \text{(A2.1)}$$

N^f_t is the number of mature females at the start of year t:

$$N^f_t = \sum_{a=a_m}^{x} (R^f_{t,a} + U^f_{t,a}) \qquad \text{(A2.2)}$$

a_m is the age-at-maturity (the standard IWC 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+1} is the probability of birth/calf survival for mature females:

$$b_{t+1} = \max(0, b_K\{1 + A(1-[N^{1+}_{t+1}/K^{1+}]^z)\}) \qquad \text{(A2.3)}$$

$$N_t^{1+} = \sum_{a=1}^{x} (R_{t,a}^f + U_{t,a}^f + R_{t,a}^m + U_{t,a}^m) \qquad \text{(A2.4)}$$

$$K^{1+} = \sum_{a=1}^{x} (R_{-\infty,a}^f + U_{-\infty,a}^f + R_{-\infty,a}^m + U_{-\infty,a}^m)$$

b_k is the average number of live births per year per mature female at carrying capacity;

A is the resilience parameter; and

z is the degree of compensation.

The number of female births, B_t^f , is computed from the total number of the births during year *t* using Equation A2.5:

$$B_t^f = 0.5 \ B_t \qquad \text{(A2.5)}$$

The numbers of recruited/unrecruited calves is given by:

$$\begin{array}{ll} R_{t,0}^f = \alpha_0 B_t^f & R_{t,0}^m = \alpha_0 (B_t - B_t^f) \\ U_{t,0}^f = (1-\alpha_0) B_t^f & U_{t,0}^m = (1-\alpha_0)(B_t - B_t^f) \end{array} \qquad \text{(A2.6)}$$

α_0 is the proportion of animals of age 0 which are recruited (0 for these trials).

A.3 Removals

The historical ($t \leq 2015$) removals are taken to be equal to the total reported removals (including struck and lost, bycatch, ship strikes etc.) (Table 1). National progress reports indicate that mortality rates due to by-catches and ship strikes off West Greenland are low and so are ignored in future in these trials. The sex-ratio of future aboriginal catches is assumed to be 50:50 F:M. Catches are taken uniformly from the recruited component of the population:

$$C_{t,a}^m = C_t^m \, R_{t,a}^m / \sum_{a'} R_{t,a'}^m \ ; \ \ C_{t,a}^f = C_t^f \, R_{t,a}^f / \sum_{a'} R_{t,a'}^f \qquad \text{(A3.1)}$$

$C_t^{m/f}$ is the number of males/females removed from the population during year *t*.

The total removal in a given future year is the sum of:

(a) the minimum of the need for that year, Q_t, and the corresponding strike limit; and

(b) bycatches in fisheries and ship strikes (taken to be 0 in these trials).

Table 1

Total removals of fin whales (direct catches and bycatches) from West Greenland.
Catches of unknown sex are allocated to sex assuming a 50:50 ratio.

Year	Male	Female	Year	Male	Female	Year	Male	Female	Year	Male	Female
1940			1960	0	0	1980	6.5	6.5	2000	3.5	3.5
1941			1961	0	0	1981	3.5	3.5	2001	3.5	4.5
1942			1962	0	0	1982	4.5	4.5	2002	5	8
1943			1963	0	0	1983	4	4	2003	3.5	5.5
1944			1964	0.5	0.5	1984	5	5	2004	6	7
1945			1965	0.5	0.5	1985	4	5	2005	1.5	11.5
1946	26	21	1966	0	0	1986	5	4	2006	3	7
1947	29	22	1967	0	0	1987	4	5	2007	7	5
1948	10	11	1968	1.5	1.5	1988	4	5	2008	9.5	4.5
1949	5	16	1969	0	0	1989	7	7	2009	2	8
1950	18	18	1970	0	0	1990	11	8	2010	0.5	5.5
1951	8	7	1971	0	0	1991	8.5	9.5	2011	0	5
1952	4	12	1972	0.5	0.5	1992	8.5	13.5	2012	0.5	4.5
1953	6	9	1973	1	1	1993	2.5	11.5	2013	3.5	5.5
1954	17	5	1974	2.5	2.5	1994	11	11	2014	6.5	5.5
1955	14	8	1975	0.5	0.5	1995	9	3	2015	3	9
1956	17	11	1976	4.5	4.5	1996	8.5	10.5			
1957	11	10	1977	6.5	6.5	1997	6.5	6.5			
1958	2	6	1978	4.5	3.5	1998	2	9			
1959	0	0	1979	3.5	3.5	1999	4	5			

A.4 Recruitment

The proportion of animals of age a that would be recruited if the population was pristine is a knife-edged function of age at age a_r, i.e.:

$$\alpha_a = \begin{cases} 0 & \text{if } 0 \le a < a_r \\ 1 & \text{otherwise} \end{cases} \tag{A4.1}$$

a_r is the age-at-recruitment (assumed to be 1 for fin whales).

The (expected) number of unrecruited animals of age a that survive to age a+1 is $U_{t,a}^{m/f} S_a$. The fraction of these that then recruit is:

$$\delta_{a+1} = \begin{cases} [\alpha_{a+1} - \alpha_a]/[1-\alpha_a] & \text{if } 0 \le \alpha_a < 1 \\ 1 & \text{otherwise} \end{cases} \tag{A4.2}$$

A.5 Maturity

Maturity is assumed to be a knife-edged function of age at age a_m.

A.6 Initialising the population vector

The numbers at age in the pristine population are given by:

$$\begin{aligned} R_{-\infty,a}^{m/f} &= 0.5\ N_{-\infty,0}\ \alpha_a \prod_{a'=0}^{a-1} S_{a'} && \text{if } 0 \le a < x \\ U_{-\infty,a}^{m/f} &= 0.5\ N_{-\infty,0}\ (1-\alpha_a) \prod_{a'=0}^{a-1} S_{a'} && \text{if } 0 \le a < x \\ R_{-\infty,x}^{m/f} &= 0.5\ N_{-\infty,0} \prod_{a'=0}^{x-1} \frac{S_{a'}}{(1-S_x)} && \text{if } a = x \end{aligned} \tag{A6.1}$$

$R_{-\infty,a}^{m/f}$ is the number of animals of age a that would be recruited in the pristine population;

$U_{-\infty,a}^{m/f}$ is the number of animals of age a that would be unrecruited in the pristine population; and

$N_{-\infty,0}$ is the total number of animals of age 0 in the pristine population.

The value for $N_{-\infty,0}$ is determined from the value for the pre-exploitation size of the 1+ component of the population using the equation:

$$N_{-\infty,0} = K^{1+} / \left(\sum_{a=1}^{x-1} \left(\prod_{a'=0}^{a-1} S_{a'} \right) + \frac{1}{1-S_x} \prod_{a'=0}^{x-1} S_{a'} \right) \tag{A6.2}$$

In common with the trials for the Eastern North Pacific gray whales (IWC, 2012), these trials are based on the assumption that the age-structure at the start of year τ is stable rather than modelling the population from its pre-exploitation equilibrium size. The determination of the age-structure at the start of year τ involves specifying the effective 'rate of increase', γ, that applies to each age-class. There are two components contributing to γ, one relating to the overall population rate of increase (γ+) and the other to the exploitation rate. Under the assumption of knife-edge recruitment to the fishery at age a_r, only the γ+ component (assumed to be zero following Punt and Butterworth (2002) applies to ages of a_r or less. The number of animals of age a at the start of year τ relative to the number of calves at that time, $N_{\tau,0}^*$, is therefore given by the equation:

$$N_{\tau,a}^* = \begin{cases} 1 & \text{if } a = 0 \\ N_{\tau,a-1}^* S_{a-1} & \text{if } 1 \le a \le a_r \\ N_{\tau,a-1}^* S_{a-1}(1-\gamma^+) & \text{if } a_r < a < x \\ N_{\tau,x-1}^* S_{x-1}(1-\gamma^+)/(1-S_x(1-\gamma^+)) & \text{if } a = x \end{cases} \tag{A6.3}$$

B_τ is the number of calves in year τ and is derived directly from equations A2.1 and A2.3 - for further details see Punt (1999):

$$B_\tau = \left(1 - \left[1/(N_\tau^f b_K) - 1\right]/A\right)^{1/z} \frac{K^{1+}}{N_\tau^{1+,*}} \tag{A6.4}$$

The effective rate of increase, γ, is selected so that if the population dynamics model is projected from year τ to a year Ψ, the size of the 1+ component of the population in a reference year Ψ equals a value, P_Ψ which is drawn from a prior (see Table 2).

Table 2

The prior distributions.

Parameter	Prior distribution
Non-calf survival rate, S_{1+}	U[0.90, 0.995]
Age-at-maturity, a_m	U[4, 14]
Transition age from juvenile to adult survival, a_T	0
Carrying capacity, K^{1+}	U[0, 20,000]
$MSYL_{1+}$	Pre-specified
$MSYR_{1+}$	Pre-specified
Maximum pregnancy rate, $1/f_{max}$	U[1.7, 3.3]
Additional variation (population estimates), CV_{add}, in year Ψ (where Ψ = 1987)	U[0, 0.35]
Abundance in year Ψ (=2005), P_Ψ	$\ell nP_{2005} = N(\ell n3{,}230;(0.44^2 + CV_{add}^2))$

A.7 z and A

A, z and S_0, are obtained by solving the system of equations that relate *MSYL*, *MSYR*, S_0, S_{1+}, f_{max} a_m, a_T, *A* and *z,* where f_{max} is the maximum possible pregnancy rate (Punt, 1999).

A.8 Conditioning

The method for conditioning the trials (i.e. selecting the 100 sets of values for the parameters a_m, a_T, S_0, S_{1+}, K^{1+}, *A* and *z*) is based on a Bayesian assessment. The algorithm for conducting the Bayesian assessment is as follows.

(a) Draw values for the parameters S_{1+}, f_{max}, a_m, a_T, $MSYR_{1+}$, $MSYL_{1+}$, K^{1+}, P_Ψ, and CV_{add} (the additional variance for the estimates of 1+ abundance in year Ψ), from the priors in Table 2. It is not necessary to draw values for $MSYR_{1+}$ and $MSYL_{1+}$ because the values for these quantities are pre-specified rather than being determined during the conditioning process.

(b) Solve the system of equations that relate *MSYL*, *MSYR*, S_0, S_{1+}, f_{max}, a_m, a_T, *A* and *z* to find values for S_0, *A* and *z*.

(c) Calculate the likelihood of the projection which is given by[1]: $L=L_1$ where:

$$L_1 = \prod_t \frac{1}{\sqrt{\Omega_t^2 + CV_{add2,t}^2}} \exp\left(-\frac{(\ell n P_t^{obs} - \ell n\left(B_c \hat{P}_t\right))^2}{2(\Omega_t^2 + CV_{add2,t}^2)} \right) \quad \text{(A8.1a)}$$

P_t^{obs} is the estimate of the (1+) abundance at the start of year *t* (Table 3);

$\hat{P}_t$ is the model-estimate of the (1+) abundance which pertains to the survey estimate of abundance at the start of year *t*:

$$\hat{P}_t = \tilde{S}^f \sum_{a=1}^{x} (R_{t,a}^f + U_{t,a}^f) + \tilde{S}^m \sum_{a=1}^{x} (R_{t,a}^m + U_{t,a}^m) \quad \text{(A8.2)}$$

Ω_t is the (sampling) standard deviation of the logarithm of P_t^{obs} (approximated by its coefficient of variation, $CV_{est,t}^{obs}$ - see Table 3);

$\tilde{S}^f, \tilde{S}^m$ are the relative selectivities for females and males (1:1 for fin whales); and

$E(CV_{add2,t}^2)$ is the square of the actual CV of the additional variation for year *t* (using the formula developed under the RMP first stage screening trials for a single stock [IWC (1991), IWC (1994)]):

$$E(CV_{add2,t}^2) = \eta(0.1 + 0.013P^* / \hat{P}_t) = CV_{add2}^2 \frac{0.1 + 0.013P^* / \hat{P}_t}{0.1 + 0.013P^* / \hat{P}_\Psi} \quad \text{(A8.3)}$$

Steps (a)-(c) are repeated a large number (typically 1,000,000) of times.

100 sets of parameters vectors are selected randomly from those generated using steps (a)-(c), assigning a probability of selecting a particular vector proportional to its likelihood. The number of times steps (a)-(c) are repeated is chosen to ensure that each of the 100 parameter vectors is unique.

The trials for fin whales are conditioned on the estimates of absolute abundance (Table 3) (there is no series of relative abundance estimates).

Table 3

Estimates of absolute abundance

Year	Estimate	CV	Reference
1987	1,100	0.35	IWC (1992); IWC (1993)
2005	9,800	0.62	Heide-Jørgensen *et al.* (2008); IWC (2008)
2007	15,957	0.72	Heide-Jørgensen *et al.* (2010); IWC (2010)
2015	2,215	0.41	Hansen *et al* (2016); Annex Q of this report

[1]The priors for the survey bias and additional variation are integrated out as these are nuisance parameters.

B. Data generation

B.1 Absolute abundance estimates

The historical ($t \leq 2015$) abundance estimates (and their CVs) are provided to the *SLA* and are taken to be those in Table 3. An estimate of abundance together with an estimate of its CV is generated, and is provided to the *SLA,* once every *U* years during the management period (starting in year 2025 for the base case trials i.e. *U*=10 years beyond the year with the last estimate of abundance [2]). The CV of future abundance estimates (CV_{true}) is different from the CV provided to the *SLA*.

The survey estimate, $\hat{S}$, may be written as:

$$\hat{S} = B_A P Y w / \mu = B_A P^* \beta^2 Y w \qquad \text{(B1.1)}$$

B_A is the bias;

P is the current 1+ population size ($= \hat{P}_t$); (B1.2)

Y is a lognormal random variable: $Y = e^{\phi}$ where: $\phi \sim N[0; \sigma_\phi^2]$ and $\sigma_\phi^2 = \ell n(1+\alpha^2)$; (B1.3)

w is a Poisson random variable, independent of *Y*, with $E(w) = \text{var}(w) = \mu = (P / P^*) / \beta^2$; and (B1.4)

P^* is the reference population level (the pristine value of $\hat{P}_t$).

[3]The steps used in the program to generate the abundance estimates and their CVs are listed below.

The *SLA* is provided with estimates of CV_{est} for each future sightings estimate. The estimate of $CV_{est,t}$ is given by:

$$\hat{C}V_{est,t} = \sqrt{\sigma_t^2 (\chi_n^2 / n)} \qquad \sigma_t^2 = \ell n(1 + E(CV_{est,t}^2)) \qquad \text{(B1.5)}$$

$E(CV_{est,t}^2)$ is the sum of the squares of the actual CVs due to estimation error:

$$E(CV_{est,t}^2) = \theta^2 (a^2 + b^2 / w\beta^2) \qquad \text{(B1.6)}$$

χ_n^2 is a random number from a χ^2 distribution with *n* (=19; the value assumed for the single stock trials for the RMP) degrees of freedom; and

a^2, b^2 are constants and equal to 0.02 and 0.012 respectively.

The relationship between CV_{est} and CV_{true} is given by:

$$\eta = [E(CV_{true}^2) - E(CV_{est}^2)] / (0.1 + 0.013 P^* / P) \qquad \text{(B1.7)}$$

where η is a constant known as the additional variance factor whose value is based on the population size and CVs for year Ψ:

$$\eta = CV_{add}^2 / (0.1 + 0.013 P^* / P_\Psi) \qquad \text{(B1.8)}$$

The values of α and β are then computed as:

$$\alpha^2 = \theta^2 a^2 + \eta \;\; 0.1, \qquad \beta^2 = \theta^2 b^2 + \eta \;\; 0.013 \qquad \text{(B1.9)}$$

In initial trials, fin whales off West Greenland were modelled as a single isolated population. Following a new point estimate of abundance from a 2015 survey that was significantly smaller than the previous one (2,215 in 2015 compared to 15,957 in 2007) the trials were modified to model the abundance as a two-component process whereby each year either all whales in the population enter the West Greenland region, or only a proportion of those whales. See IWC (2018, p552-3) for further discussion of this '**partial presence**' hypothesis.

The two years 2005 and 2007 (with the highest estimates of abundance) are considered to be instances where all whales entered the West Greenland region and were available to be surveyed. The probability in a future year that this would occur is modelled by a Beta(3;3) distribution, which reflects the posterior resulting from the assumption of a uniform

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[2] The next survey is assumed to take place in 2020 for trials with a 5 year survey interval and in 2030 for those with a 15 year survey interval.

[3]The steps used to generate estimates of abundance and their CVs are as follows (steps (i)-(iii) are part of the conditioning process).

(i) Read in CV_{est} (Table 4). Generate values of CV^2_{add} for year Ψ.

(ii) Set η using equation B1.8 and the value of CV_{add} from step (i).

(iii) Set θ^2 using equation B1.6 with the values for CV_{est} from step (i) and $w\beta^2 = P/P^* = P_{1968}/P^*$. Set α^2 and β^2 using equation B1.9.

(iv) Generate *w* (Poisson random variable – equation B1.4) and ϕ (lognormal random variable – equation B1.3).

(v) Set abundance estimate $\hat{S}$ using equation B1.1.

(vi) Generate $\hat{C}V_{est,t}$ from a χ_n^2 distribution using equation B1.5.

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(2;8) distribution, which implies a proportion of 20% on average, and allows the operating model to mimic the available abundance estimates. Further details are given in Adjunct 2.

High CVs are associated with the high abundance estimates and vice versa – perhaps because of the higher school sizes observed when there are more whales. Hence two different values of the CVest (the expectation value of CVX) are used: 0.38 in years when the abundance is low and 0.67 in high abundance years.

An alternative '**influx**' hypothesis is also modelled where only a total WG-associated stock is present for the years with low abundance estimates, and the years with high estimates reflect mixing from adjacent stocks (the 'extra' stock). Details of the changes to the operating model required for this hypothesis are given in Adjunct 3.

C. Need

The level of need supplied to the *SLA* is the total need for the six-year period for which strike limits are to be set. The scenarios regarding need are listed in Table 4.

D. Trials

Table 4 lists all of the factors considered in the trials. The set of *Evaluation Trials* is given in Table 5 and the set of *Robustness Trials* in Table 6. See Adjunct 1 for the equations used in the Asymmetric environmental stochasticity trials. The *SLA* is applied every six years, starting in 2016.

Table 4

Factors to be tested in the trials for fin whales off West Greenland

Factors	Levels (Reference levels shown bold and underlined)
$MSYR_{1+}$	1%, **2.5%**, **4%,** 7%
$MSYL_{1+}$	**0.6**
Time dependence in *K* *	**Constant**, halve linearly over 100yr
Time dependence in natural mortality, *M* *	**Constant,** double linearly over 100yr
Episodic events *	**None**, 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the animals die, Events occur every 5 years in which 5% of the animals die
Population Drop	**None**, 50% in 2016, 80% in 2016; 50% in 2051; 80% in 2051
Need envelope	A: constant 19; B: 19 to 38 over 100 years; C: 19 to 57 over 100 years
Survey frequency	5 yr, **10 yr**, 15 yr
Historical survey bias	0.8, **1.0**, 1.2
First year of projection, τ	**1950**
Strategic surveys	Extra survey if a survey estimate is half of the previous survey estimate
Asymmetric environmental stochasticity parameters[$]	$\rho = 0.320$
Depletion (as used for env. stochasticity trials)[$]	Depletion = 0.3
Abundance hypothesis	**Partial Presence *p* = 0.5; proportion generated from beta (2,8)** Partial Presence alternative parameters: *p* = 0.189; *p* = 0.811 proportion generated from beta (1,9) Influx hypothesis with upper bound on the uniform prior for K = 6,000 or 9,000
Future Survey CV (CV_{est}). Values are given for Low abundance / High abundance years	0.20 / 0.50, 0.33 / 0.62, **0.38 / 0.67,** 0.43 / 0.72

* Effects of these factors begin in year 2016 (i.e. at start of management). The adult survival rate is adjusted so that if catches were zero, then the average population size during years 250-500 equals the carrying capacity. (Note: for some biological parameters and levers of episodic events, it may not be possible to find an adult survival rate which satisfies this requirement).

[$] Details of the asymmetric environmental stochasticity model and the parameters used are given in Adjunct 1.

Table 5

The *Evaluation Trials* for fin whales. Values given in bold type show differences from the base case values. For all 'Partial Presence' (PP) trials, the probability *p* that all animals are off West Greenland when a survey takes place = 0.5; if some whales are not off W. Greenland, the proportion off W. Greenland is generated from a beta distribution with parameters (2,8).

Trial	Description	$MSYR_{1+}$	Need Scenarios	Survey freq.	Historical Survey Bias	No of Replicates	Future Survey CV (CV_{est})	Abundance Model	Conditioning Option
1-4	$MSYR_{1+}$ = 4%	4%	A, B, C	10	1	400	0.38 / 0.67	PP	Y
1-2	$MSYR_{1+}$ = 2.5%	2.5%	A, B, C	10	1	400	0.38 / 0.67	PP	Y
1-1	$MSYR_{1+}$ = 1%	**1%**	A, B, C	10	1	400	0.38 / 0.67	PP	Y
1-7	$MSYR_{1+}$ = 7%	**7%**	A, B, C	10	1	400	0.38 / 0.67	PP	Y
2-4	5 year surveys	4%	A, B	**5**	1	400	0.38 / 0.67	PP	1-4
2-2	5 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	**5**	1	400	0.38 / 0.67	PP	1-2
3-4	15 year surveys	4%	A, B	**15**	1	400	0.38 / 0.67	PP	1-4
3-2	15 year surveys; $MSYR_{1+}$ =2.5%	2.5%	A, B, C	**15**	1	400	0.38 / 0.67	PP	1-2
3-1	15 year surveys; $MSYR_{1+}$ =1%	**1%**	A, B, C	**15**	1	400	0.38 / 0.67	PP	1-1
4-4	Survey bias = 0.8	4%	A, B	10	**0.8**	400	0.38 / 0.67	PP	Y
4-2	Survey bias = 0.8; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	**0.8**	400	0.38 / 0.67	PP	Y
5-4	Survey bias = 1.2	4%	A, B	10	**1.2**	400	0.38 / 0.67	PP	Y
5-2	Survey bias = 1.2; $MSYR_{1+}$ =2.5%	2.5%	A, B	10	**1.2**	400	0.38 / 0.67	PP	Y
6-4	3 episodic events (20% reduction)	4%	A, B	10	1	400	0.38 / 0.67	PP	1-4
6-2	3 episodic events (20%); $MSYR_{1+}$ =2.5%	2.5%	A, B, C	10	1	400	0.38 / 0.67	PP	1-2
6-1	3 episodic events (20%); $MSYR_{1+}$ =1%	**1%**	A, B, C	10	1	400	0.38 / 0.67	PP	1-1
7-4	Stochastic events (5%) every 5 years	4%	A, B	10	1	**100**	0.38 / 0.67	PP	1-4
7-2	Stochastic events (5%) every 5 years	2.5%	A,B	10	1	**100**	0.38 / 0.67	PP	1-2
8-4	Asymmetric environmental stochasticity	4%	A, B	10	1	**100**	0.38 / 0.67	PP	Y
8-2	Asymmetric environmental stochasticity	2.5%	A, B, C	10	1	**100**	0.38 / 0.67	PP	Y
8-1	Asymmetric environmental stochasticity	**1%**	A, B, C	10	1	**100**	0.38 / 0.67	PP	Y
9-2	$MSYR_{1+}$ =2.5%; future survey CV 0.33/0.62	2.5%	A, B, C	10	1	400	**0.33 / 0.62**	PP	1-2
10-2	$MSYR_{1+}$ =2.5%; future survey CV 0.43/0.72	2.5%	A, B, C	10	1	400	**0.43 / 0.72**	PP	1-2
34-1	Influx-hypothesis; K prior of U[0,6000]	1%	A,B,C	100	1	400	0.38 / 0.67	Influx	Y
35-2	Influx-hypothesis; K prior of U[0,6000]	2.5%	A,B,C	100	1	400	0.38 / 0.67	Influx	Y
36-2	Influx-hypothesis; K prior of U[0,9000]	2.5%	A,B,C	100	1	400	0.38 / 0.67	Influx	Y

Table 6

The *Robustness Trials* for fin whales (On review, trials 24-2 and 24-4 were deleted as low plausibility). All *Robustness Trials* use the 'Partial Presence' hypothesis for survey abundance.

Trial No.	Factor	$MSYR_{1+}$	Need Scenario	No of Rep	Future Survey CV	Conditioning opt.
21-4	Linear decrease in *K* in future	4%	A, B	100	0.38 / 0.67	1-4
21-2	Linear decrease in *K* in future	2.5%	A, B	100	0.38 / 0.67	1-2
22-4	Linear increase in *M* in future	4%	A, B	100	0.38 / 0.67	1-4
22-2	Linear increase in *M* in future	2.5%	A, B	100	0.38 / 0.67	1-2
23-4	Strategic Surveys	4%	A, B	100	0.38 / 0.67	1-4
23-2	Strategic Surveys	2.5%	A, B	100	0.38 / 0.67	1-2
~~24-4~~	~~*p*=0.5; Propn generated from beta (7,3)~~	~~4%~~	~~A, B~~	~~100~~	~~0.40~~	~~Y~~
~~24-2~~	~~*p*=0.5; Propn generated from beta (7,3)~~	~~2.5%~~	~~A, B~~	~~100~~	~~0.40~~	~~Y~~
25-4	*p*=0.5; Propn generated from beta (1,9)	4%	A, B	100	0.38 / 0.67	Y
25-2	*p*=0.5; Propn generated from beta (1,9)	2.5%	A, B	100	0.38 / 0.67	Y
26-4	*p*=0.189 Propn generated from beta (2,8)	4%	A, B	100	0.38 / 0.67	Y
26-2	*p* =0.189 Propn generated from beta (2,8)	2.5%	A, B	100	0.38 / 0.67	Y
27-4	*p* =0.811 Propn generated from beta (2,8)	4%	A, B	100	0.38 / 0.67	Y
27-2	*p* =0.811 Propn generated from beta (2,8)	2.5%	A, B	100	0.38 / 0.67	Y
28-2	Baseline with future survey CV 0.2/0.50	2.5%	A, B	100	**0.20 / 0.50**	1-2
29-2	*p*=0.5; beta (1,9); future survey CV 0.2/0.50	2.5%	A, B	100	**0.20 / 0.50**	25-2
30-2	Population drop of 50% in 2016	2.5%	A, B	100	0.38 / 0.67	1-2
31-2	Population drop of 80% in 2016	2.5%	A, B	100	0.38 / 0.67	1-2
32-2	Population drop of 50% in 2051 (year 35)	2.5%	A, B	100	0.38 / 0.67	1-2
33-2	Population drop of 80% in 2051 (year 35)	2.5%	A, B	100	0.38 / 0.67	1-2

E. Statistics

The risk- and recovery-related performance statistics are computed for the mature female and for the total (1+) population sizes (i.e. P_t is either the size of the mature female component of the population, N_t^f, or the size of the total (1+) population, N_t^{1+}). P_t^* is the population size in year *t* under a scenario of zero strikes over the years $t \geq 2016$ (defined as t=0 below). Note that incidental removals may still occur in the absence of strikes. To emphasise this distinction, $P_t^*(0)$ is used to denote the population size in year *t* under a scenario of zero strikes or removals of any kind, and $P_t^*(\text{inc}) = P_t^*$ reflects the case when there are zero strikes but some incidental removals may occur. K^* is the population size in year *t* if there had never been any anthropogenic removals.

The trials are based on a 100-year time horizon, but a final decision regarding the time horizon will depend *inter alia* on interactions between the Committee and the Commission regarding need envelopes and on the period over which recovery might occur. To allow for this, results are calculated for T=20 and 100 (T* denotes the number of blocks for a given T; T* is 3 and 19 respectively for T=20 and T=100).

Statistics marked in bold face are considered the more important. Note that the statistic identification numbers have not been altered for reasons of consistency over time. Hence, there are gaps in the numbers where some statistics have been deleted.

E.1 Risk

D1. Final depletion: P_T/K. In trials with varying K this statistic is defined as P_T/K_t^*.

D2. Lowest depletion: $\min(P_t/K)$:t=0,1,…,T. In trials with varying K this statistic is defined as $\min(P_t/K_t^*)$:t=0,1,…,T.

D6. Plots for simulations 1-100 of $\{P_t: t = 0,1,..,T\}$ and $\{P_t^*: t = 0,1,..,T\}$.

D7. Plots of $\{P_{t[x]}: t = 0,1,..,T\}$ and $\{P_t^*{}_{[x]}: t = 0,1,..,T\}$ where $P_{t[x]}$ is the xth percentile of the distribution of P_t. Results are presented for x=5 and x=50.

D8. Rescaled (1+) final population: P_T/P_T^*. There are two versions of this statistic: D8(0)=P_T/P_T^* (0) and D8(inc)=P_T/P_T^* (inc).

D9. Minimum (mature female) population level: $\min(P_t)$: t=0,1,…,T.

D10. Relative increase of 1+ population size, P_T/P_0.

E.2 Need

N1. Total need satisfaction: $\sum_{t=0}^{T-1} C_t \,/ \sum_{t=0}^{T-1} Q_t$.

N2. Length of shortfall = (negative of the greatest number of consecutive years in which $C_b < Q_b$) / T^*, where C_b is the catch for block b and Q_b is the total need for block b.

N4. Fraction of years in which $C_t = Q_t$.

N7. Plot of $\{V_{t[x]} : t = 0,1,T-1\}$ where $V_{t[x]}$ is the xth percentile of the distribution of $V_t = C_t / Q_t$.

N8. Plots of V_t for simulations 1-100.

N9. Average need satisfaction: $\frac{1}{T}\sum_{t=0}^{T-1}\frac{C_t}{Q_t}$.

N10. AAV (Average Annual Variation): $\sum_{b=0}^{T^*-1}\left|C_{b+1} - C_b\right| / \sum_{b=0}^{T^*-1} C_b$.

N11. Anti-curvature: $\frac{1}{T^*-1}\sum_{b=0}^{T^*-2}\left|\frac{C_b - M_b}{\max(10, M_b)}\right|$ where $M_b = (C_{b+1} + C_{b-1}) / 2$.

N12. Mean downstep (or modified AAV): $\sum_{b=0}^{T^*-1}\left|\min(C_{b+1} - C_b, 0)\right| \;/\; \sum_{b=0}^{T^*-1} C_b$

E.3 Recovery

R1. Relative recovery: $P_{t_r^*} / P_{t_r^*}^*$ where t_r^* is the first year in which P_t^* passes through $MSYL$. If P_t^* never reaches $MSYL$, the statistic is P_T / P_t^*. If $P_0 > MSYL$ the statistic is min (1, $P_T/MSYL$).

The following plots are to be produced to evaluate conditioning.

Time-trajectories of 1+ population size in absolute terms and relative to carrying capacity, along with the fits to abundance estimates. This plot allows an evaluation of whether conditioning has been achieved satisfactorily.

Histograms of the 100 parameter vectors for each trial. This plot allows an evaluation of whether and how conditioning has impacted the priors for these parameters.

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Adjunct 1. The Environmentally-Driven Stochasticity Model

A. Basic principles

The number of calves born annually is modelled as:

$$C_y = f_y N_y^{mat} \qquad \text{(Adj.1.1)}$$

where f_y is the fecundity during year y, and N_y^{mat} is the number of mature females at the start of year y; f_y is assumed to be density-dependent:

$$f_y = f_0(1 + A(1-(N_y^{1+}/K^+)^z)) \quad \text{or} \quad f_y = f_0 + (f_{\max} - f_0)(1-(N_y^{1+}/K^+)^z) \qquad \text{(Adj.1.2)}$$

To incorporate stochasticity, f_y is modelled as follows:

$$f_y^{act} = \frac{f_{\max} f_0 e^{x_y}}{f_0 e^{x_y} + (f_{\max} - f_0)} \text{ with } x_y = \log\left[\frac{\hat{f}_y (f_{\max} - f_0)}{(f_{\max} - \hat{f}_y) f_0}\right] + \alpha_y \qquad \text{(Adj.1.3)}$$

where $\hat{f}_y$ is the 'expected' value of f_y from equation App.1.1, and α_y accounts for auto-correlated noise. At the maximum value of f ($f_{\max}$), $\mathrm{var}(f_y) = 0$, and var(f_y) increases with decreasing f_y. The noise term α_y is modelled as:

$$\alpha_y = \rho_\alpha \alpha_{y-1} + \sqrt{1+\rho_\alpha^2}\,\eta_y \qquad \eta_y \sim N(0;\sigma_\alpha^2) \qquad \text{(Adj.1.4)}$$

where σ_α and ρ_α determine the extent of the variation and its auto-correlation respectively.

B. Parameterisation

The values for σ_α and ρ_α for West Greenland fin whales, humpbacks and bowheads are based on the realised variation and temporal autocorrelation of calving rates for the Eastern North Pacific humpback whales and the Bering-Chuckhi-Beaufort Seas stock of bowhead whales (Fig. App.1.1, left panel). The value for σ_α is computed for each stock by projecting equations App.1.1-App.1.4 forwards with values with $f_{\max}$ and f_0 set to the posterior medians from the conditioning process, and solving for ρ_α so that the resulting value for $\tilde{\sigma}_f$ allows the population model to match the CV of the calving rates (see Fig. App.1.1, right panel).

Application of this approach involves setting N_y^{1+}/K^{1+} in equation App.1.2 (see Fig. App.1.2 for the sensitivity of variation in calving rates to the value of N_y^{1+}/K^{1+}). The base value for N_y^{1+}/K^{1+} is set to 0.3. Sensitivity is examined to values of 0.15 and 0.6 (half and double the base value) in *Robustness Trials* for humpbacks and bowheads.

The base value reflects the fact that the stocks selected by IWC (2014), which included the Eastern North Pacific humpback whales and the Bering-Chuckhi-Beaufort Seas stock of bowhead whales, were assessed to have been mainly at a low level of abundance (no more than approximately 30% of carrying capacity) over the period that the data analysed had been collected. The data for the B-C-B bowheads are too sparse to allow the extent of correlation in calving rates to be estimated reliability. The values of ρ_α for the two stocks are consequently set to the extent of autocorrelation in fecundity estimated by IWC (2014) for humpback whales.

C. Adjusting MSYR

It is well-known (Clark, 1993) that for the same parameter values MSY under stochastic conditions is less than under deterministic conditions. The aim of the trials with environmentally-driven stochasticity is to evaluate the consequences of environmental variation on fecundity without the confounding effect of a lower effective MSYR. Therefore, the input value of MSYR_{1+} is adjusted for the trials with environmentally-driven stochasticity by projecting the operating model forward 100 times for 1000 years when the exploitation rate is MSYR_{1+}, and comparing the realised MSYR_{1+} with the intended MSYR. The MSYR_{1+} value input is then rescaled so that the realised MSYR_{1+} equals the intended MSYR_{1+}. This means that each trial needs to be conducted twice, once to obtain the scaling factor for MSYR_{1+} and the parameters needed to compute σ_α (see Section B above), and again once MSYR_{1+} has been adjusted. The results of the second conditioning are then used to evaluate *SLA* variants.

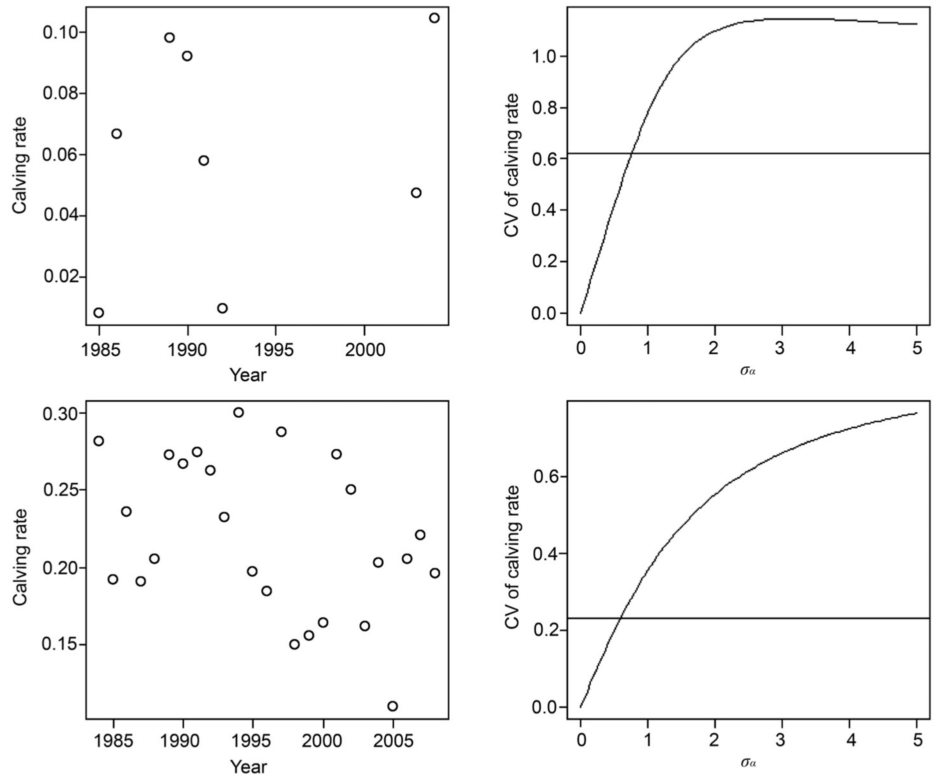

Fig. App.1.1. Calving rates (left panels) and the inferred relationships between the CV of the calving rate and σ_α based on equations App.1.1-App.1.4 (right panels). The horizontal line in the right panels indicates the observed CVs of the calving rates. Results are shown for the Eastern North Pacific humpback whales and the Bering-Chuckhi-Beaufort Seas stock of bowhead whales in the upper and lower sets of panels. The calving rates for the Eastern North Pacific humpback whales are restricted to the years in which the population size was at least 30 animals to avoid the impact of observation error being interpreted as true variation in calving rates.

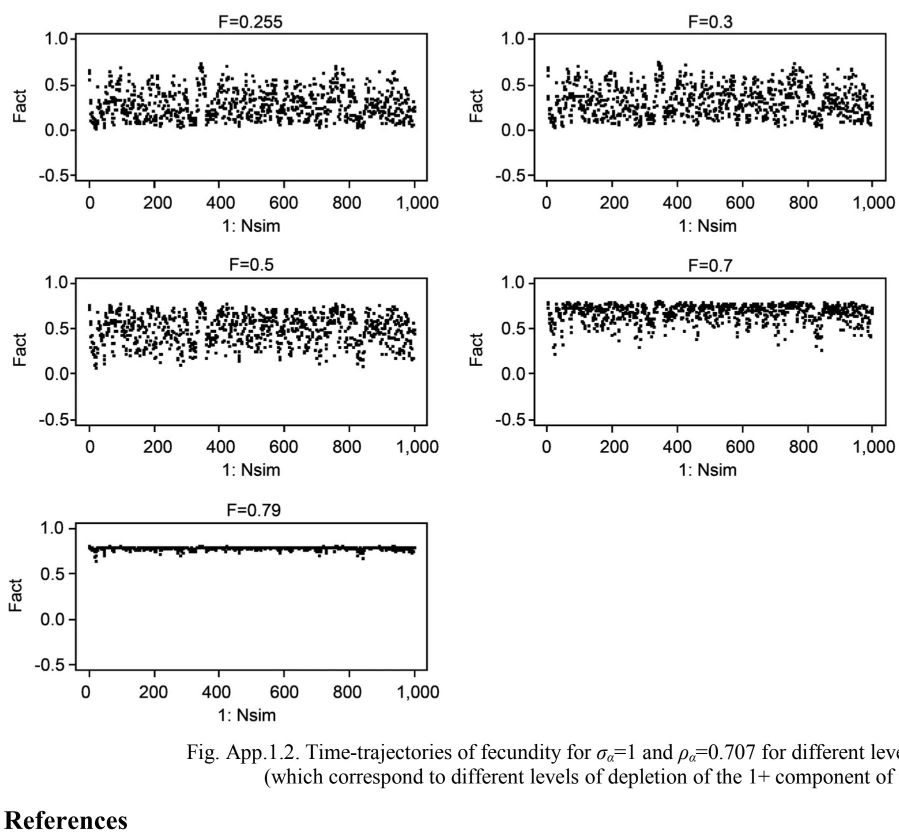

Fig. App.1.2. Time-trajectories of fecundity for σ_α=1 and ρ_α=0.707 for different levels of exploitation rate F (which correspond to different levels of depletion of the 1+ component of the population)

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Adjunct 2. Accounting for a Time-Varying Proportion of Fin Whales off West Greenland – A.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.:

$$L_y \propto \int_{\alpha}^{1} \frac{1}{\sqrt{2\pi}\sigma_y I_y} e^{-(\ell n I_y - \ell n(\beta N_y))^2/(2\sigma_y^2)} \beta^2 (1-\beta)^6 \, d\beta \tag{D.1}$$

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(2,8).

Adjunct 3. Summary of Changes to the Control Program to Implement the 'Influx' Hypothesis – A.E. Punt

- Conditioning is based on the 1987 and 2015 estimates only. The 2005 and 2007 estimates are ignored – there are consequently no 'biased' estimates.
- The abundance of the 'extra stock' is 3,000 animals, with a probability of being off West Greenland of 0.5. The abundance of the 'extra stock' is 1,500 for the purposes of conditioning (but the abundance estimates pertain only to WG stock).
- The catches are allocated to WG stock in the proportion to the number of 1+ WG animals to the total number of animals (WG and Extra) off West Greenland.
- The factor used to determine the Poisson component of the process for generating future abundance estimates is carrying capacity for the WG stock plus half of the size of the 'extra stock'.
- The Prior for carrying capacity for the WG stock is U[0, 5,000]

Appendix 3

WEST GREENLAND FIN WHALE *SLA* PERFORMANCE STATISTICS

Table 1 is a summary of results over all trials for the combined *SLA* for fin whales ('GUP') compared to the Interim *SLA* and two *SLA*s tuned to a D10 of 0.8 for the Influx trial F34-1B (B-0.8 and L-0.8). Figures 1-5 give examples of the plots examined when selecting the *SLA*. The full set of trial results and plots are available from the Secretariat.

Table 1

Proportion of times that each *SLA* meets the conservation performance and need satisfaction (over 20 and 100 years) criteria for various subsets of the 68 evaluation trials for West Greenland fin whales, the minimum lower 5 percentile of the conservation performance and the mean of the lowert5thtpercentile need satisfaction (over 20 and 100 years) and of the conservation performance.

(a) Results by MSY rate

	Interim	B-0.8	L-0.8	GUP
MSYR1+ = 1% (15 trials)				
Conservation performance (D10)	0.8	0.8	0.8	0.8
Mean conservation performance (D10)	1.17	1.16	1.17	1.17
Minimum D10 value	0.62	0.57	0.62	0.59
Mean Need satisfaction 20 yrs	0.8	0.88	0.86	0.86
Mean Need satisfaction 100 yrs	0.74	0.78	0.63	0.68
Proportion Need satisfaction 20 yrs	0.8	1	0.8	1
Proportion Need satisfaction 100 yrs	0.47	0.67	0.13	0.27
MSYR1+=2.5% (33 trials)				
Conservation performance (D10)	0.97	0.97	0.97	0.97
Mean conservation performance (D10)	1.17	1.16	1.17	1.17
Minimum D10 value	0.97	0.96	0.96	0.95
Mean Need satisfaction 20 yrs	0.85	0.92	0.87	0.88
Mean Need satisfaction 100 yrs	0.84	0.89	0.81	0.83
Proportion Need satisfaction 20 yrs	1	1	0.97	1
Proportion Need satisfaction 100 yrs	0.97	0.97	0.76	0.82
MSYR1+=4% (17 trials)				
Conservation performance (D10)	1	1	1	1
Mean conservation performance (D10)	1.08	1.07	1.08	1.08
Minimum D10 value	1.02	1.02	1.02	1.02
Mean Need satisfaction 20 yrs	0.92	0.98	0.93	0.94
Mean Need satisfaction 100 yrs	0.88	0.94	0.87	0.89
Proportion Need satisfaction 20 yrs	1	1	1	1
Proportion Need satisfaction 100 yrs	1	1	1	1
MSYR1+ = 7% (3 trials)				
Conservation performance (D10)	1	0.67	1	1
Mean conservation performance (D10)	1	1	1	1
Minimum D10 value	1	0.99	1	1
Mean Need satisfaction 20 yrs	0.94	0.99	0.94	0.94
Mean Need satisfaction 100 yrs	0.81	0.86	0.72	0.76
Proportion Need satisfaction 20 yrs	1	1	1	1
Proportion Need satisfaction 100 yrs	0.67	1	0.33	0.67

(b) Results by need envelope

	Interim	B-0.8	L-0.8	GUP
Need Scenario A (26 trials)				
Conservation performance (D10)	0.96	0.96	0.96	0.96
Mean conservation performance (D10)	1.15	1.15	1.15	1.15
Minimum D10 value	0.93	0.93	0.92	0.93
Mean Need satisfaction 20 yrs	0.88	0.95	0.91	0.92
Mean Need satisfaction 100 yrs	0.88	0.93	0.87	0.89
Proportion Need satisfaction 20 yrs	1	1	0.96	1
Proportion Need satisfaction 100 yrs	1	1	0.89	0.96
Need Scenario B (26 trials)				
Conservation performance (D10)	0.96	0.96	0.96	0.96
Mean conservation performance (D10)	1.13	1.13	1.13	1.13
Minimum D10 value	0.8	0.8	0.8	0.8
Mean Need satisfaction 20 yrs	0.86	0.93	0.88	0.89
Mean Need satisfaction 100 yrs	0.82	0.88	0.77	0.8
Proportion Need satisfaction 20 yrs	0.96	1	0.96	1
Proportion Need satisfaction 100 yrs	0.89	0.96	0.77	0.81
Need Scenario C (16 trials)				
Conservation performance (D10)	0.88	0.81	0.88	0.88
Mean conservation performance (D10)	1.12	1.12	1.13	1.12
Minimum D10 value	0.62	0.57	0.62	0.59
Mean Need satisfaction 20 yrs	0.83	0.89	0.85	0.86
Mean Need satisfaction 100 yrs	0.75	0.79	0.65	0.7
Proportion Need satisfaction 20 yrs	0.88	1	0.88	1
Proportion Need satisfaction 100 yrs	0.56	0.69	0.13	0.25

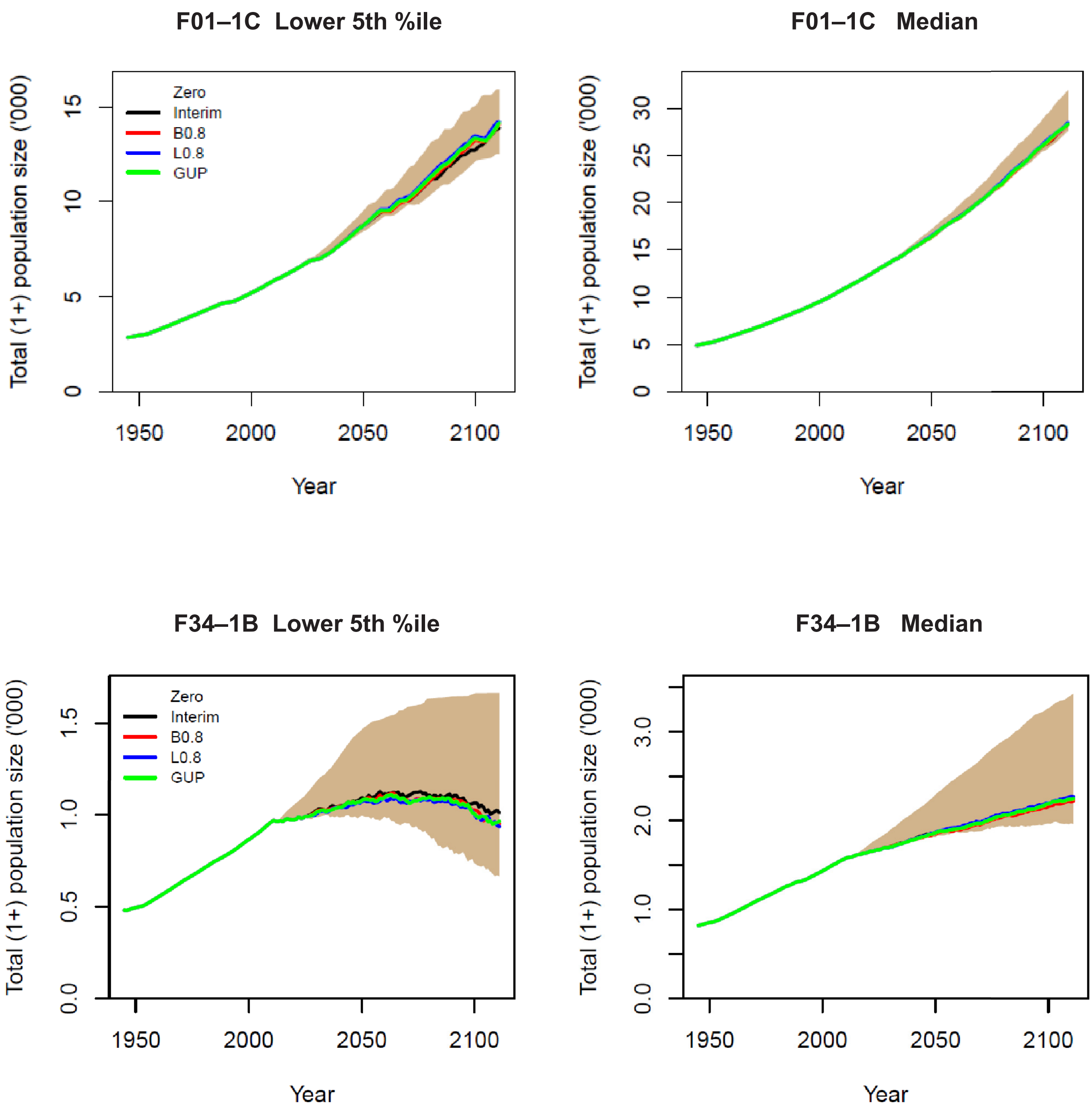

Fig. 1. Examples of the 5th percentile and the median total (1+) population size plots for the combined *SLA* ('GUP') compared to the Interim SLA and the B-0.8 and L-0.8 *SLA*s.

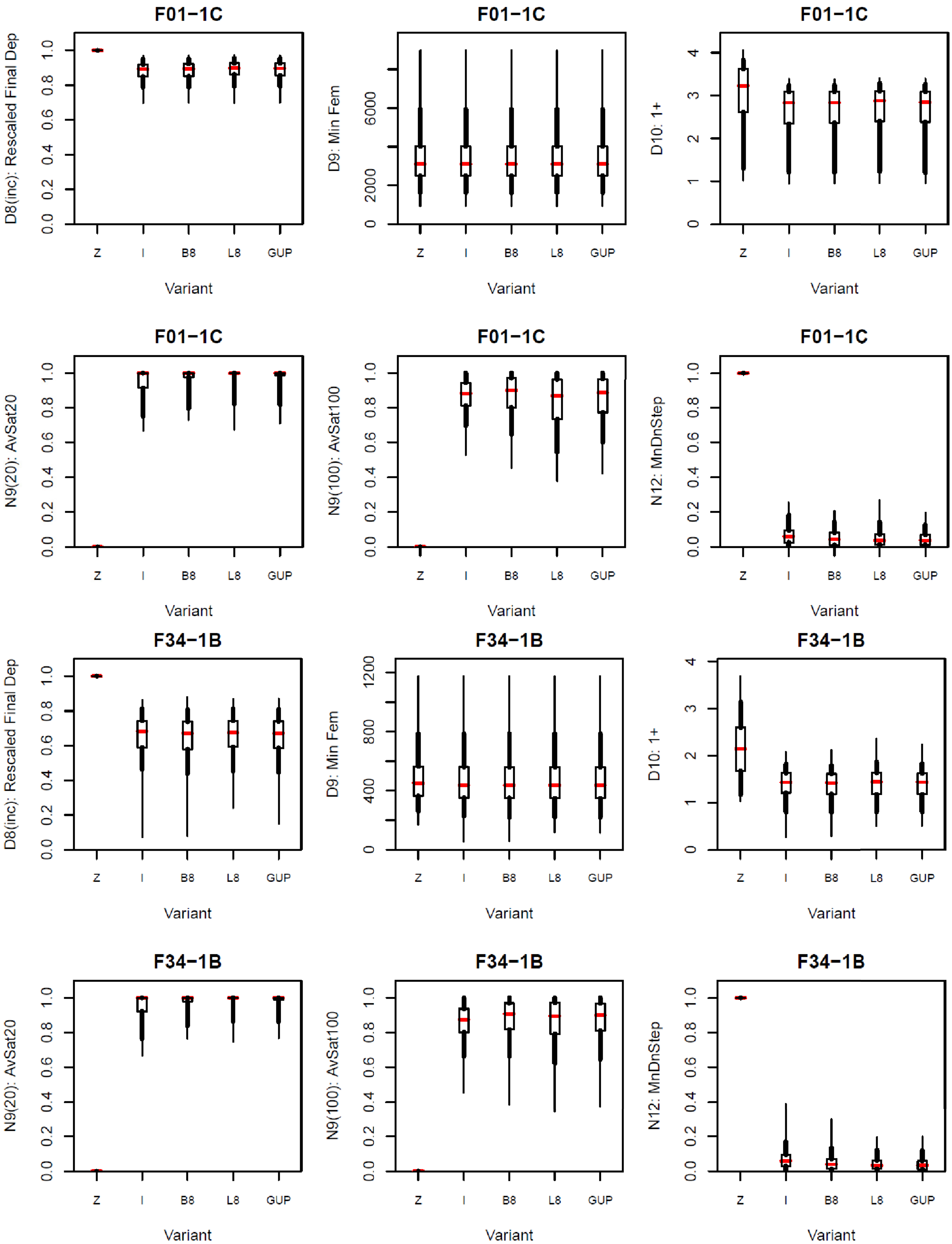

Fig. 2. Examples of the Zeh plots for several performance statistics for the combined *SLA* ('GUP') compared to the Interim *SLA* and the B-0.8 and L-0.8 S*LA*s.

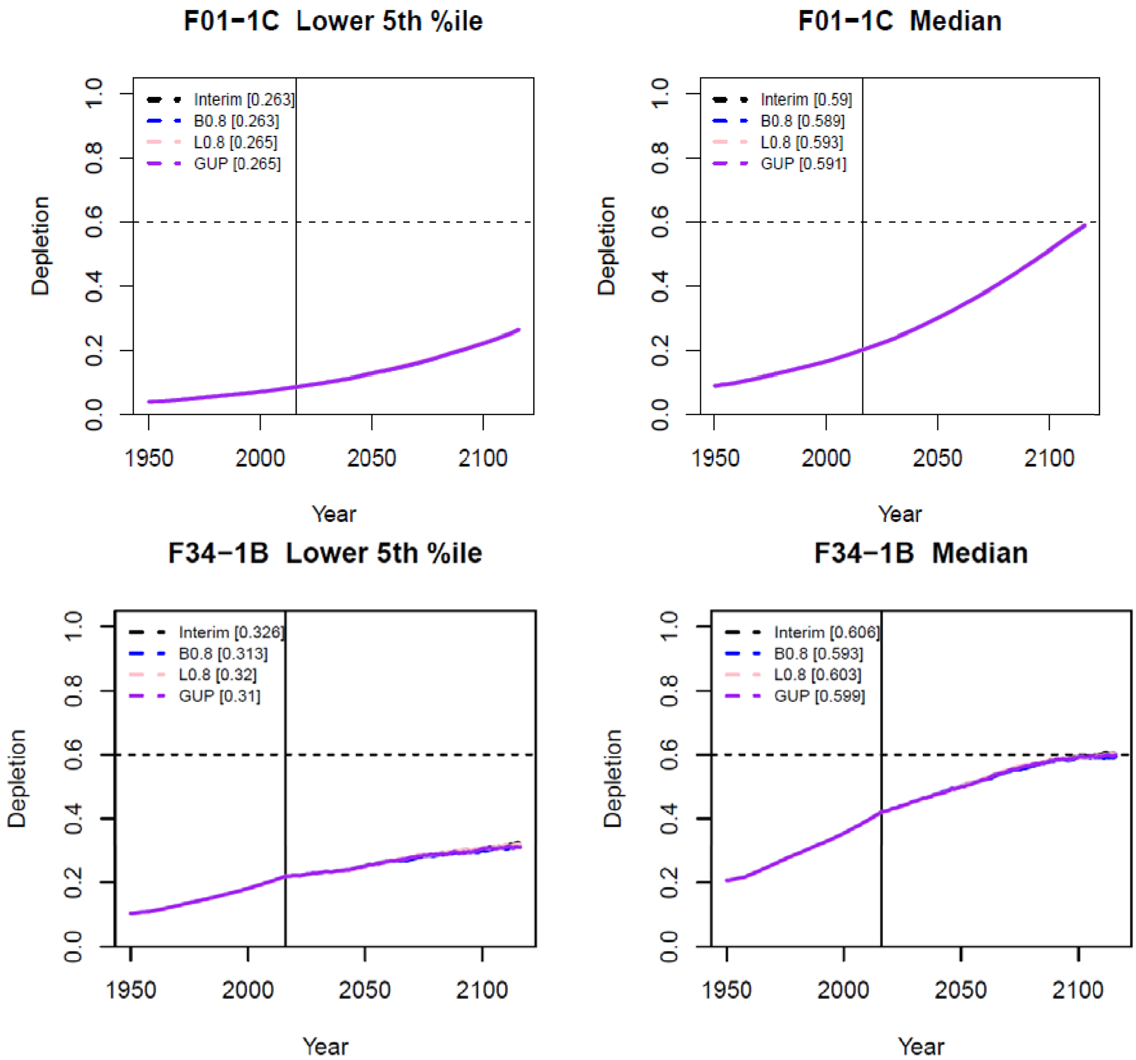

Fig. 3. Examples of plots of the 5th percentile and the median depletion for the combined *SLA* ('GUP') compared to the Interim *SLA* and the B-0.8 and L-0.8 *SLA*s. The numbers in square brackets in the legend are the 5th percentile (LHS) and the median (RHS) final depletion values.

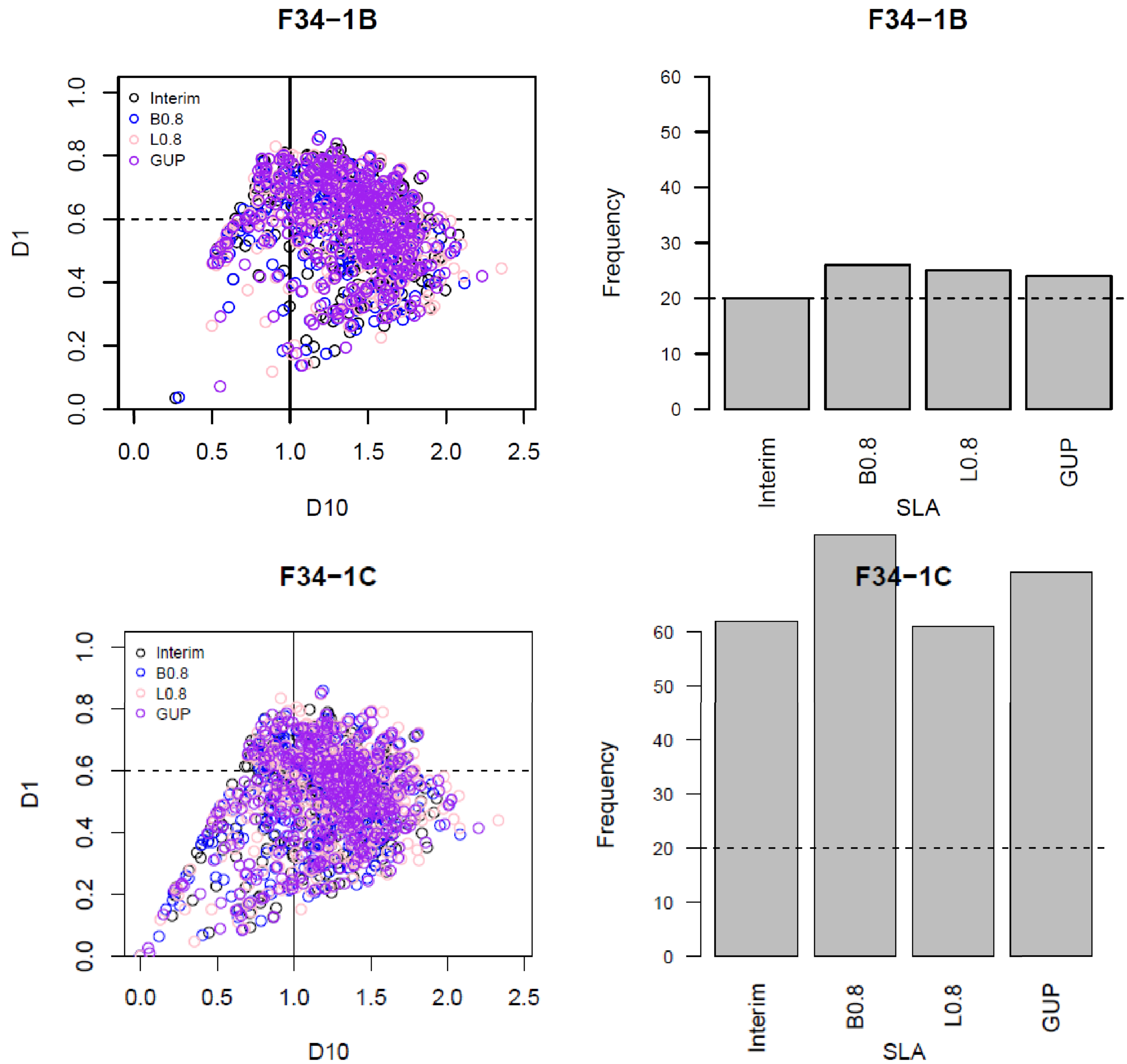

Fig. 4. Example plots of the D1 (final depletion) versus the D10 (relative increase of the 1+ population size) statistics, for each simulation for one of the influx hypothesis trials including the Interim *SLA* together with the frequency of each *SLA* falling within the quadrant of D1 less than 0.6 and D10 less than one. Note that there are 400 replicates for each trial so a "5% criteria" would correspond to more than 5% of replicates having D1 < 0.6 and D10 < 1 simultaneously.

Appendix 4

THE AWMP/RMP *IMPLEMENTATION SIMULATION TRIALS* FOR THE NORTH ATLANTIC MINKE WHALES

The operating model for trials used in the development of an *SLA* is based on the model used in the RMP *Implementation Review* for this species in the North Atlantic (see IWC, 2018a), but with greater focus placed on the western and central North Atlantic.

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; IWC2004a p.12-13, IWC 2009 p.138.

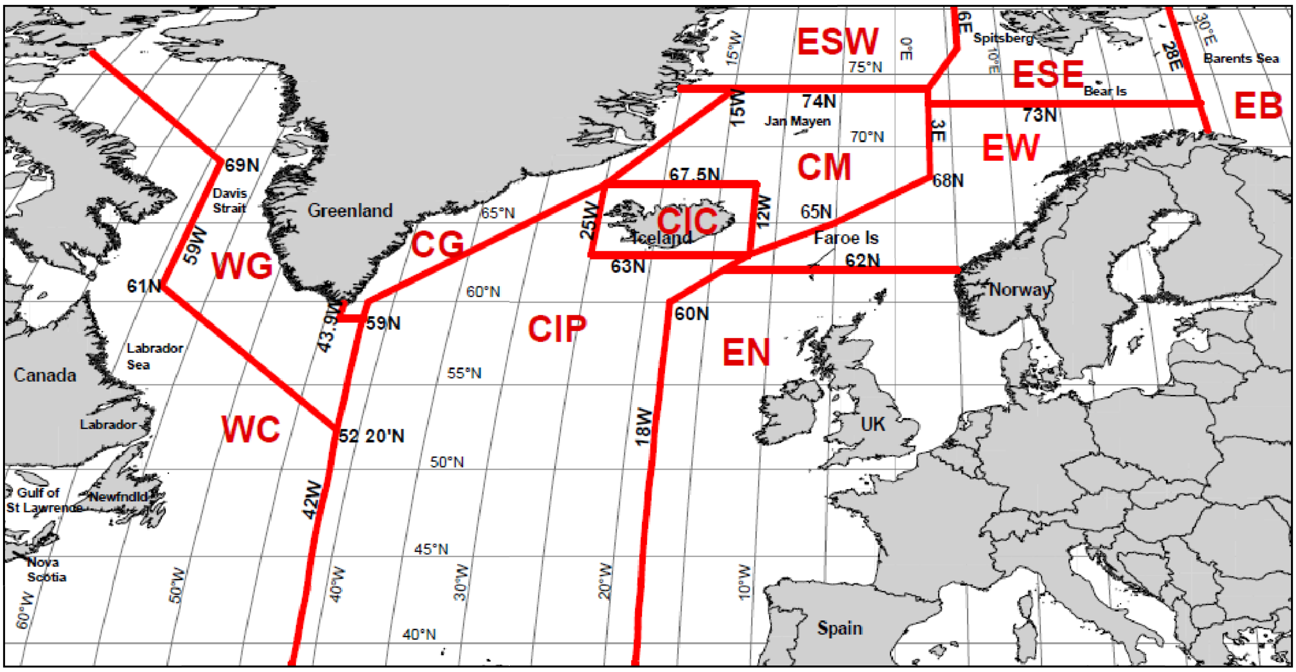

Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic Minke whales.

There are two general hypotheses regarding stock structure (see IWC [2015][1] 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.

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] Hypotheses III and IV tested in the RMP *Implementation Review* were dropped from further consideration because the results of the genetic analyses (SC/67b/Rep06 item 3.2.) indicate that these stock structure hypotheses are not consistent with the available information.

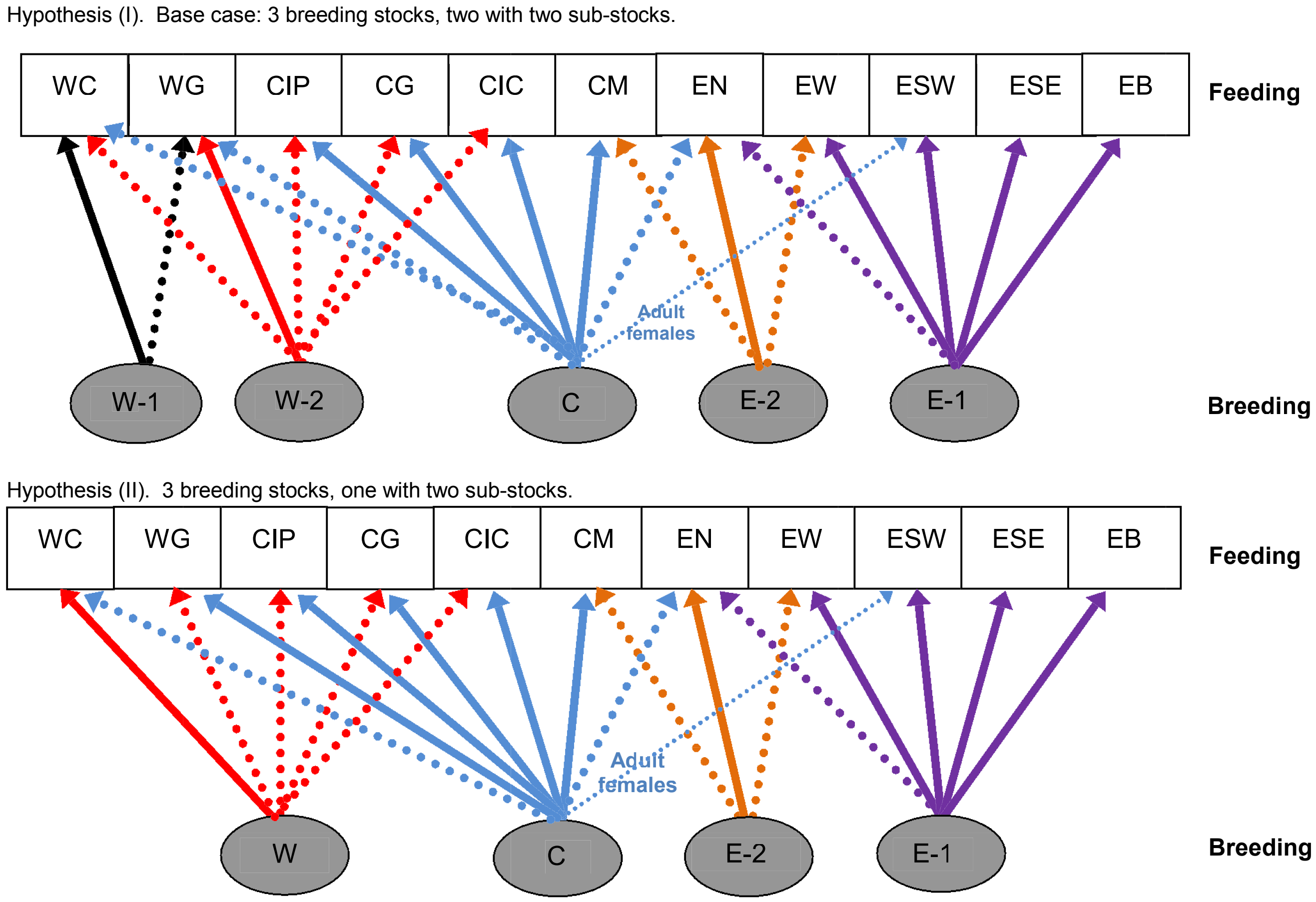

Fig. 1. Stock structure hypotheses for North Atlantic Minke whales [The ranges of the W and C stocks are updated from the model used in the RMP *Implementation Review* based on results of genetic analyses (SC/67b/Rep06, item 3.2)]

B. Basic dynamics

The dynamics of the animals in stock/sub-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/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:

$$N_t^{\mathrm{f},j} = \sum_{a=3}^{x} \beta_a N_{t,a}^{\mathrm{f},j} \tag{C.2}$$

β_a is the proportion of females of age a that have reached the age-at-first partition; and

$K^{\mathrm{f},j}$ is the number of mature females in stock/sub-stock j in the pristine (pre-exploitation, written as t=-∞) population:

$$K^{\mathrm{f},j} = \sum_{a=3}^{x} \beta_a N_{-\infty,a}^{\mathrm{f},j} \tag{C.3}$$

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 ($S_a^g \to 1$) 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 IWC, 2018c p.539-42). 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 (see Table 1) are selected to model the distribution of each stock/sub-stock at the time when the catch is removed / when the surveys are conducted.

Table 1

The mixing matrices. The γs and Ωs indicate that the entry concerned is estimated during the conditioning process.

Stock structure hypothesis I

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W-1	1	γ_{10}	-	-	-	-	-	-	-	-	-
W-2	γ_{11}	1	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{16}	γ_2	γ_3	γ_4	γ_5	0.05	-	0.2 γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	γ_6	γ_8	γ_9
E-2	-	-	-	-	-	0.05	0.9	0.05	-	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$\gamma_{11}\Omega_{11}$	Ω_{12}	$\gamma_{12}\Omega_{13}$	$\gamma_{13}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{16}\Omega_{12}$	$\gamma_2\Omega_{13}$	$\gamma_3\Omega_{14}$	$\gamma_4\Omega_{15}$	$\gamma_5\Omega_{16}$	0.05 Ω_{17}	-	-	-	-
E-1	-	-	-	-	-	-	0.1 Ω_{17}	$\gamma_7\Omega_{18}$	$\gamma_6\Omega_{19}$	$\gamma_8\Omega_{20}$	$\gamma_9\Omega_{21}$
E-2	-	-	-	-	-	0.05Ω_{16}	0.9 Ω_{17}	0.05 Ω_{18}	-	-	-

Stock structure hypothesis II

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W	1	γ_{11}	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{16}	γ_2	γ_3	γ_4	γ_5	0.05	-	0.2 γ_6	-	-
E-1	-	-	-	-	-	-	0.1	γ_7	γ_6	γ_8	γ_9
E-2	-	-	-	-	-	0.05	0.9	0.05	-	-	-
Adult males (ages 10+) and juveniles											
W	Ω_{11}	$\gamma_{11}\Omega_{12}$	$\gamma_{12}\Omega_{13}$	$\gamma_{12}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{16}\Omega_{12}$	$\gamma_2\,\Omega_{13}$	$\gamma_3\Omega_{14}$	$\gamma_4\Omega_{15}$	$\gamma_5\,\Omega_{16}$	0.05 Ω_{17}	-	-	-	-
E-1	-	-	-	-	-	-	0.1 Ω_{17}	$\gamma_7\,\Omega_{18}$	$\gamma_6\,\Omega_{19}$	$\gamma_8\Omega_{20}$	$\gamma_9\Omega_{21}$
E-2	-	-	-	-	-	0.05Ω_{16}	0.9 Ω_{17}	0.05 Ω_{18}	-	-	-

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 2).

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 (IWC, 2018a), are close to the adjusted (target) CVs listed in Table 2.

Table 2

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

[1] value would be < 0 so the actual CV is used here.

Density Dependent mixing

Operating model variants that allow for density-dependent mixing were also developed and are specified in IWC, 2018b. These specifications assume that the extent of density-dependence in dispersal between two stocks depends on the ratio of the depletions of the two stocks. This is equivalent to whales 'seeking' to make depletion constant among the W-1 sub-stock, the W-2 sub-stock and the C stock (for stock structure hypothesis II).

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 2015 could first be used for setting the catch limit in 2017. 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)

$$\hat{P} = P\,Y\,w/\mu = P^*\,\beta^2\,Y\,w \tag{F.1}$$

where Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_\varepsilon^2)$ and $\sigma_\varepsilon^2 = \ell\text{n}(1+\alpha^2)$;

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:

$$P = P_t^K = \sum_{k\in K}\sum_j\sum_g\sum_{a\geq 1} V_{t,a}^{g,j,k} N_{t,a}^{g,j} \tag{F.2}$$

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; and

F is the set of sub-areas making up survey area K.

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; IWC 1994, p.85), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

$$CV^2(\hat{P}) = \tau(0.12 + 0.025P^*/P) \tag{F.3}$$

[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.

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:

$$\tau = \overline{CV^2}(0.12 + 0.025P^* / \overline{P}) \tag{F.4}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \qquad \beta^2 = 0.025\tau \tag{F.5}$$

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 $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2 \chi^2 / n \tag{F.7}$$

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, 2004b).

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	8318	0.25
1987	WG*	3,266	0.31	1995	EN	22536	0.23
1993	WG*	8,371	0.43	1998	EN	13673	0.25
2005	WG	10,792	0.59	2004	EN	6246	0.47
2007	WG	9,066	0.39	2009	EN	6891	0.31
2015	WG	5,095	0.46	1989	EW	20991	0.17
1988	CIP	8,431	0.245	1995	EW	34986	0.12
2001	CIP	3,391	0.82	1996	EW	23522	0.13
2007	CIP	1,350	0.38	2006	EW	27152	0.218
2015	CIP	6,306	0.345	2011	EW	21218	0.32
1995	CIP+CG*	4,854	0.27	1995	ESW	2691	0.29
1987	CG	1,555	0.26	1999	ESW	1932	0.68
2001	CG	7,349	0.31	2008	ESW	5009	0.29
2007	CG	1,048	0.6	1989	ESE	13370	0.19
2015	CG	5,489	0.35	1995	ESE	23278	0.11
1987	CIC	24532	0.32	1999	ESE	16241	0.25
2001	CIC	43633	0.19	2003	ESE	19377	0.33
2007	CIC	20834	0.35	2008	ESE	22281	0.18
2009	CIC	9588	0.24	1989	EB	21868	0.21
2015	CIC	12710	0.53	1995	EB	29712	0.18
1988	CM	4732	0.23	2000	EB	25885	0.24
1995	CM	12043	0.28	2007	EB	28625	0.23
1997	CM	26718	0.14	2013	EB	34125	0.34
2005	CM	26739	0.39				
2010	CM	10991	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*).

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 SC 2016 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) (IWC, 2018c).

Table 4a

Sighting survey plan. The pattern of surveys from 2020-2025 will be repeated every 6 years in the E areas, every 7 years in the C areas and every 10 years in sub-area WG. The years when Assessments are run are also shown (assessments are run every 6 years from 2021 on).

Season	**Country**			**Assessment Year**
	Norway	**Iceland**	**Greenland**	
2014	-	-	-	-
2015	-	CIC, CIP, CG	WG	-
2016	CM*,EB,EW,ESW,ESE$^{\Delta}$	-	-	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.

$^{\Delta}$ 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.

Table 4b

List of past and planned sightings surveys and the constituents used in setting estimates for areas that are combinations of sub-areas.

	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	-	-	-	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

-=No survey, 1=survey. *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 yrs
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, mixing proportions 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:

$$P_t^k = O_t^k \exp[\mu_t^k - (\sigma_t^k)^2/2]\,;\ \mu_t^k \sim N[0;(\sigma_t^k)^2] \tag{G.1}$$

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:

$$L_1 = 0.5\sum_n \frac{1}{(\sigma_n)^2} \ell n\left(P_n / \hat{P}_n\right)^2 \tag{G.2}$$

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) Mixing Proportions

Table 5c lists the mixing proportions of the W and C stocks used to estimate the mixing matrices entries. The rationale for these values is given in SC/67b/Rep06 (item 3.4). In order to ensure that the conditioning leads to the specified model predictions, the mixing proportions are be fixed (not generated) in the conditioning process and assigned low CVs.

Table 5c

The mixing proportions for use in the trials

(a) Stock structure hypothesis I

Scenario	(and basis)	MSYR	Proportion of W-1 stock in sub-area		Proportion of W-2 stock in sub-area				
			WC	WG	WC	WG	CIP	CG	CIC
A1: Base line	(80% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.13	0.13	0.52	0.30	0.60	0.30
A2:	(94% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.60	0.05	0.05	0.60	0.30	0.60	0.30
A3: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.15	0.15	0.65	0.20	0.70	0.20
A4:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.75	0.05	0.05	0.75	0.20	0.70	0.20
A5: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.45	0.10	0.10	0.45	0.40	0.50	0.40
A6:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.03	0.03	0.52	0.40	0.50	0.40

(b) Stock structure hypothesis II

Scenario	MSYR	Proportion of W stock in sub-areas				
		WC	WG	CIP	CG	CIC
B1: Best	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.65	0.30	0.60	0.30
B2: Concentrated	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.80	0.80	0.20	0.70	0.20
B3: Spread out	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.55	0.55	0.40	0.50	0.40

(c) 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:

$$\hat{\lambda}^{1,k} = \frac{\sum_a \sum_j V_{-\infty,a}^{f,j,k} S_a^{f,k} N_{-\infty,a}^{f,j}}{\sum_g \sum_{a'} \sum_{j'} V_{-\infty,a'}^{g,j',k} S_a^{g,k} N_{-\infty,a'}^{g,j'}} \tag{G.4}$$

$\sigma^{1,k}$ is the between-period variation in the sex-ratios for sub-area k during the month in which surveys take place (see Table 6).

$S_a^{g,k}$ is the survey selectivity for gender g in subarea k and is equal to the 'Reference' selectivity $R_a^{g,h\in k}$ where

$$R_a^{g,h} = (1 + e^{-(a-a_{50}^{g,h})/\delta^{g,h}})^{-1} \tag{G.5}$$

$a_{50}^{g,h}$, $\delta^{g,h}$ 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 ($R_a^{g,h=\text{WG-com}}$) 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 $R_a^{g,h}$ (see equation G.5):												
$a_{50}^{g,h}$	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												
$S_a^{g,k}$ =	$R_a^{g,h}$	$R_a^{g,h=\text{WG-com}}$	-	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$	$R_a^{g,h}$
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

Table 9 summarises the factors considered in the trials. Table 10 lists the set of trials. Need envelopes are a constant 164 (A), increasing from 164 to 250 over the 100-year period (B) and increasing from 164 to 350 over the 100-year period (C).

For trials used in the development of an *SLA,* instead of applying the RMP to set the annual catch limits by sub-area and year for each simulation, the RMP catch limits are pre-specified as detailed in Section I.

Table 9

Factors considered in the *Evaluation Trials*.

Factor	Values
MSYR	1% (1+), 4% (mature), 4% (1+)
Need envelope	A: constant 164; B: 164 to 250 over 100 years; C: 164 to 350 over 100 years
Number of W-sub-stocks	2 (stock hypothesis I); 1 (stock hypothesis II)
Scenarios regarding mixing proportions	A1, A2, A3, A4, A5, A6, B1, B2, B3
Mixing	Density-independent[1], density-dependent
Survey bias	0.8, 1, 1.2
Survey period	10, 15
Survey CV (difference from the average CV)	-0.05, 0, 0.05

1: Default until additional trials are coded and evaluated.

Table 10

The final set of trials.

Trial	MSYR	Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
M01	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base	Yes
M02	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base	Yes
M03	1% (1+) & 4 % (mat)	1	A2	Independent	1	10	Base	Yes
M04	1% (1+) & 4 % (mat)	1	A3	Independent	1	10	Base	Yes
M05	1% (1+) & 4 % (mat)	1	A4	Independent	1	10	Base	Yes
M06	1% (1+) & 4 % (mat)	1	A5	Independent	1	10	Base	Yes
M07	1% (1+) & 4 % (mat)	1	A6	Independent	1	10	Base	Yes
M08	1% (1+) & 4 % (mat)	2	B2	Independent	1	10	Base	Yes
M09	1% (1+) & 4 % (mat)	2	B3	Independent	1	10	Base	Yes
~~M10~~	~~1% (1+) & 4 % (mat)~~	~~2~~	~~B4~~	~~Independent~~	~~1~~	~~10~~	~~Base~~	~~Yes~~
M11	1% (1+) & 4 % (mat)	1	A1	Density-dependent	1	10	Base	Yes &
M12	1% (1+) & 4 % (mat)	2	B1	Density-dependent	1	10	Base	Yes &

I. Management Options

Rather than applying the RMP to set the annual catch limits by sub-area and year for each simulation, the RMP catch limits are pre-specified, with trial-specific catch limits by year based on the two Baseline Hypothesis 1 trials (M01-1 and M01-4). Pre-specifying the RMP catches allows the trials to run more quickly. The trials used to calculate the RMP catches will involve (a) using the interim *SLA* to set the strike limit for the WG sub-area, (b) setting the strike limit to 12 [20] for the CG sub-area and (c) applying RMP Variant 5 (IWC, 2018a) to determine RMP catch limits, but capping the CIC catch at 100 whales. The cap is introduced because catches in the CIC sub-area have the most impact on stocks in the WG sub-area, and the catch being set is much higher than is currently taken (the highest annual catch in the CIC sub-area since 1986 is 81 whales).

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 risk- and recovery-related performance statistics are computed for the mature female and for the total (1+) population sizes (i.e. P_t is either the size of the mature female component of the population, N^f_t, or the size of the total (1+) population, N_t^{1+}). P_t^* is the population size in year t under a scenario of zero strikes over the years $t \geq 2016$ (defined as t=0 below). Note that incidental removals may still occur in the absence of strikes. To emphasise this distinction, $P_t^*(0)$ is used to denote the population size in year t under a scenario of zero strikes or removals of any kind, and $P_t^*(\text{inc}) = P_t^*$ reflects the case when there are zero strikes but some incidental removals may occur. K^* is the population size in year t if there had never been any anthropogenic removals.

The trials are based on a 100-year time horizon, but a final decision regarding the time horizon will depend *inter alia* on interactions between the Committee and the Commission regarding need envelopes and on the period over which recovery might occur. To allow for this, results are calculated for T=20 and 100 (T* denotes the number of blocks for a given T; T* is 3 and 19 respectively for T=20 and T=100).

Statistics marked in bold face are considered the more important. Note that the statistic identification numbers have not been altered for reasons of consistency over time. Hence, there are gaps in the numbers where some statistics have been deleted.

E.1 Risk

D1. Final depletion: P_T/K. In trials with varying K this statistic is defined as P_T/K_t^*.

D2. Lowest depletion: $\min(P_t/K)$:t=0,1,…,T. In trials with varying K this statistic is defined as $\min(P_t/K_t^*)$:t=0,1,…,T.

D6. Plots for simulations 1-100 of $\{P_t$: $t = 0,1,..,T\}$ and $\{P_t^*$: $t = 0,1,..,T\}$.

D7. Plots of $\{P_{t[x]}$: $t = 0,1,..,T\}$ and $\{P_t^*{}_{[x]}$: $t = 0,1,..,T\}$ where $P_{t[x]}$ is the xth percentile of the distribution of P_t. Results are presented for x=5 and x=50.

D8. Rescaled (1+) final population: P_T/P_T^*. There are two versions of this statistic: D8(0)=P_T/P_T^* (0) and D8(inc)=P_T/P_T^* (inc).

D9. Minimum (mature female) population level: $\min(P_t)$: t=0,1,…,T.

D10. Relative increase of 1+ population size, P_T/P_0.

E.2 Need

N1. Total need satisfaction: $\sum_{t=0}^{T-1} C_t \,/\, \sum_{t=0}^{T-1} Q_t$.

N2. Length of shortfall = (negative of the greatest number of consecutive years in which $C_b < Q_b$) / T^*, where C_b is the catch for block b and Q_b is the total need for block b.

N4. Fraction of years in which $C_t = Q_t$.

N7. Plot of $\{V_{t[x]} : t = 0,1,T-1\}$ where $V_{t[x]}$ is the xth percentile of the distribution of $V_t = C_t / Q_t$.

N8. Plots of V_t for simulations 1-100.

N9. Average need satisfaction: $\frac{1}{T}\sum_{t=0}^{T-1}\frac{C_t}{Q_t}$.

N10. AAV (Average Annual Variation): $\sum_{b=0}^{T^*-1}\left|C_{b+1} - C_b\right| / \sum_{b=0}^{T^*-1} C_b$.

N11. Anti-curvature: $\frac{1}{T^*-1}\sum_{b=0}^{T^*-2}\left|\frac{C_b - M_b}{\max(10,M_b)}\right|$ where $M_b = (C_{b+1} + C_{b-1})/2$.

N12. Mean downstep (or modified AAV): $\sum_{b=0}^{T^*-1}\left|\min(C_{b+1} - C_b, 0)\right| \,/\, \sum_{b=0}^{T^*-1} C_b$

E.3 Recovery

R1. Relative recovery: $P_{t_r^*} / P_{t_r^*}^*$ where t_r^* is the first year in which P_t^* passes through $MSYL$. If P_t^* never reaches $MSYL$, the statistic is P_T/P_t^*. If $P_0 > MSYL$ the statistic is min (1, $P_T/MSYL$).

The following plots are to be produced to evaluate conditioning.

Time-trajectories of 1+ population size in absolute terms and relative to carrying capacity, along with the fits to abundance estimates. This plot allows an evaluation of whether conditioning has been achieved satisfactorily.

Histograms of the 100 parameter vectors for each trial. This plot allows an evaluation of whether and how conditioning has impacted the priors for these parameters.

K. References

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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) p123-4. 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	1054
1937	0	0	0	0	0	1	0	125	996	0	60	50	1232
1938	0	0	0	0	0	1	0	266	907	0	112	68	1354
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	1914	0	4	6	2115
1942	1	0	0	0	0	18	0	158	1976	0	0	0	2153
1943	0	0	0	0	0	16	0	158	1455	0	0	0	1629
1944	0	0	0	0	0	15	0	97	1252	0	0	0	1364
1945	0	0	0	0	0	16	0	165	1611	0	0	10	1802
1946	0	0	0	0	0	34	0	305	1337	0	140	101	1917
1947	16	0	0	0	0	34	0	373	1810	0	136	237	2606
1948	38	0	4	0	0	102	0	358	2035	0	559	535	3631
1949	38	0	5	0	0	106	7	241	1206	0	701	1693	3997
1950	3	0	9	0	0	80	0	106	1173	0	274	437	2082
1951	55	0	16	0	0	63	0	89	1836	0	155	672	2886
1952	17	0	32	0	0	64	0	122	1273	0	101	1829	3438
1953	0	0	32	0	0	79	0	63	1231	0	62	1079	2546
1954	0	0	22	0	0	54	0	359	1508	0	88	1544	3575
1955	13	0	22	0	6	57	1	435	2138	1	56	1679	4408
1956	57	0	22	0	0	21	3	441	1611	10	483	1111	3759
1957	37	0	24	1	0	37	0	593	1417	12	612	1000	3733
1958	42	0	30	0	0	36	0	639	1658	3	498	1543	4449
1959	18	0	55	0	14	35	2	575	900	15	495	1091	3200
1960	11	0	56	4	12	82	0	628	1039	14	369	1223	3438
1961	22	0	35	1	3	108	72	377	1322	13	208	1187	3348
1962	50	0	72	0	3	134	158	400	1302	22	113	1225	3479
1963	18	0	166	5	10	115	80	340	1043	5	324	1355	3461
1964	54	0	162	1	8	153	151	400	1057	10	233	769	2998
1965	41	0	196	3	0	147	255	268	1062	5	534	253	2764
1966	11	0	225	15	87	123	88	330	633	1	288	671	2472
1967	40	0	244	44	143	193	66	181	901	91	536	118	2557
1968	0	20	315	62	211	409	45	355	893	90	656	114	3170
1969	60	165	269	22	94	214	21	479	667	22	397	467	2877
1970	88	126	207	8	159	222	13	350	632	20	628	282	2735
1971	84	263	196	38	29	228	17	410	385	0	524	483	2657
1972	214	123	156	32	139	199	0	319	231	0	158	1467	3038
1973	3	221	276	24	222	147	0	200	267	3	253	839	2455
1974	3	252	217	12	102	127	15	172	291	0	26	931	2148
1975	4	102	222	15	217	193	0	186	269	0	324	651	2183
1976	3	187	191	3	81	216	0	186	148	0	365	1190	2570

Year	WC	WG-comm.	WG-aborig.	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB	Total
1977	1	75	285	0	1	194	0	118	281	0	749	551	2255
1978	2	75	180	0	130	199	3	83	312	0	162	826	1972
1979	9	75	250	0	119	198	1	76	446	0	62	1202	2438
1980	10	78	258	0	119	202	0	67	259	0	477	1004	2474
1981	8	61	204	0	45	201	0	62	385	0	714	610	2290
1982	4	66	250	0	109	212	0	60	344	0	655	723	2423
1983	4	68	268	0	98	204	15	36	158	0	623	871	2345
1984	6	70	235	0	25	178	90	19	219	0	183	209	1234
1985	7	52	222	0	44	145	55	23	171	0	209	231	1159
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	1003	863	0	0	2	2	3	3
1942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	64	1112	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
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

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
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	1013	779	0	0	47	89	162	72
1948	24	14	0	0	0	0	0	0	0	0	38	28	0	0	207	148	1100	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	1030	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	1185
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	1156	972	1	0	18	37	620	1053
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	1052
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	1014
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	1412	1214	3531	155	101	1360	1021	2425	1690	598	1122	8036	5058	28011	21840	140	198	5050	13444	13481	22758

References

Allison 2015. IWC Summary catch database version 6.1.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure, Appendix 5. *J. Cetacean Res. Manage. (Suppl.)* 17:120-24.

Adjunct 2 Data used to estimate the Survey and Fishery Sex Ratios (see Appendix 4, Tables 6 and 8)

C. Allison

The sex ratios in the catches of North Atlantic minke whales have been shown to be both spatially and seasonally variable (see IWC, 2015 item 5, pp.120-122). 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 4).

'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 for 1986 on as the sex ratio from the recent aboriginal hunt differs from that in the earlier commercial catches (see IWC, 2015, pp.120-122). 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		
1948	10	5							16	10			M	F
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		
2000			2	11							2	12		
2001			5	15							0	0		

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	
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

References

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure, Appendix 5. *J. Cetacean Res. Manage. (Suppl.)* *17*:120-24.

Appendix 5

WEST GREENLAND MINKE WHALE *SLA* PERFORMANCE STATISTICS

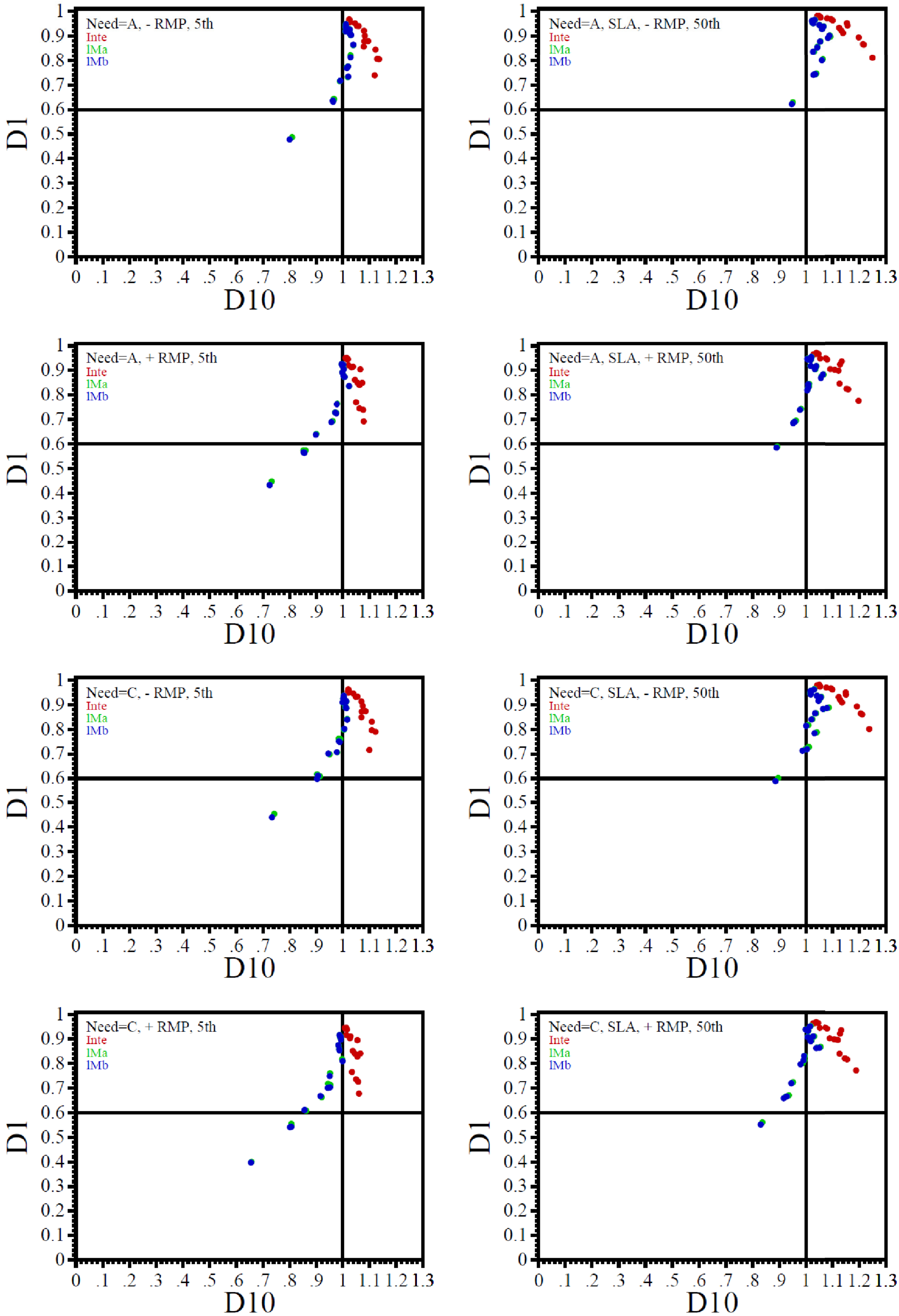

Figure 1. D10 - D1 trade-off plots for need envelopes A and C, with and without the (pre-specified) RMP catches. Points in the lower left quadrant are of interest

Table 1.

Performance statistics for *Evaluation Trials* with need envelopes A and C, with no RMP catches for the Interim *SLA* and two tuning versions (lMa and lMb - with lMa being the final selected *SLA*). Figures in bold indicate possible conservation issues.

		Need: A										Need: C									
Trial	SLA	D1l	D1m	D10l	D10m	N20l	N20m	N100l	N100m	N12U	N12m	D1l	D1m	D10l	D10m	N20l	N20m	N100l	N100m	N12U	N12m
M01-1A	Inte	.806	.865	1.129	1.217	.238	.299	.285	.470	.310	.211	.796	.860	1.109	1.212	.234	.293	.258	.430	.316	.217
	lMa	.643	.743	.965	1.034	.916	1.000	.662	.924	.074	.027	.617	.720	.903	.999	.910	1.000	.622	.885	.077	.033
	lMb	.632	.741	.963	1.028	.934	.999	.700	.938	.069	.022	.611	.713	.906	.987	.927	.995	.651	.901	.071	.030
M01-4A	Inte	.940	.963	1.060	1.101	.239	.299	.281	.456	.312	.214	.933	.962	1.055	1.100	.235	.293	.255	.417	.318	.220
	lMa	.903	.928	1.030	1.061	.916	1.000	.689	.933	.075	.023	.887	.920	1.014	1.050	.910	1.000	.638	.888	.082	.031
	lMb	.904	.928	1.031	1.061	.934	1.000	.708	.942	.067	.020	.886	.916	1.014	1.047	.927	.998	.668	.903	.073	.026
M02-1A	Inte	.878	.922	1.081	1.133	.237	.292	.275	.458	.320	.216	.872	.920	1.071	1.129	.233	.286	.249	.421	.329	.218
	lMa	.772	.857	1.016	1.044	.914	1.000	.640	.910	.075	.030	.762	.841	.984	1.024	.908	1.000	.595	.872	.083	.038
	lMb	.769	.853	1.016	1.043	.932	.996	.666	.919	.066	.024	.751	.840	.985	1.021	.925	.992	.621	.889	.074	.032
M02-4A	Inte	.959	.977	1.024	1.046	.239	.294	.269	.447	.322	.218	.954	.976	1.019	1.046	.235	.288	.244	.409	.332	.221
	lMa	.936	.956	1.011	1.024	.914	1.000	.622	.915	.073	.029	.925	.950	1.002	1.018	.907	1.000	.586	.878	.082	.035
	lMb	.936	.955	1.011	1.025	.931	.999	.654	.917	.068	.024	.925	.949	1.002	1.018	.924	.993	.609	.892	.075	.029
M04-1A	Inte	.739	.811	1.120	1.250	.239	.301	.297	.469	.292	.209	.716	.801	1.100	1.238	.235	.295	.267	.435	.305	.215
	lMa	**.487**	**.629**	**.809**	**.951**	**.920**	**1.000**	**.678**	**.918**	**.075**	**.029**	.454	.602	.742	.896	.914	1.000	.625	.870	.082	.036
	lMb	**.478**	**.622**	**.800**	**.947**	**.939**	**1.000**	**.706**	**.931**	**.065**	**.024**	.440	.588	.734	.886	.932	.998	.651	.887	.076	.030
M04-4A	Inte	.921	.952	1.080	1.154	.243	.309	.309	.479	.290	.209	.913	.950	1.070	1.150	.239	.302	.277	.439	.302	.215
	lMa	.863	.902	1.040	1.090	.921	1.000	.705	.943	.068	.021	.842	.883	1.017	1.067	.915	1.000	.654	.906	.080	.030
	lMb	.865	.901	1.040	1.088	.939	1.000	.730	.949	.060	.017	.839	.883	1.017	1.064	.932	1.000	.685	.918	.068	.023
M06-1A	Inte	.845	.894	1.123	1.198	.238	.293	.286	.473	.315	.214	.831	.893	1.109	1.192	.234	.287	.257	.430	.317	.218
	lMa	.732	.805	1.019	1.064	.916	1.000	.643	.921	.071	.028	.706	.788	.979	1.041	.910	1.000	.605	.885	.077	.034
	lMb	.734	.801	1.021	1.060	.934	.997	.684	.934	.064	.022	.707	.784	.977	1.032	.927	.994	.634	.899	.070	.029
M06-4A	Inte	.951	.971	1.046	1.080	.239	.296	.266	.460	.315	.218	.946	.970	1.040	1.077	.235	.290	.241	.419	.325	.222
	lMa	.927	.945	1.026	1.051	.916	1.000	.649	.925	.070	.027	.913	.937	1.014	1.042	.909	1.000	.610	.892	.077	.033
	lMb	.926	.944	1.026	1.050	.934	1.000	.692	.941	.066	.022	.914	.936	1.014	1.041	.926	.996	.639	.906	.069	.027
M08-1A	Inte	.857	.912	1.079	1.139	.239	.297	.288	.458	.312	.212	.849	.909	1.070	1.136	.235	.291	.261	.424	.322	.219
	lMa	.715	.837	.988	1.031	.916	1.000	.660	.917	.076	.028	.698	.817	.950	1.009	.910	1.000	.610	.877	.080	.037
	lMb	.717	.836	.990	1.027	.934	1.000	.697	.926	.062	.023	.701	.814	.945	1.001	.927	.996	.643	.897	.073	.030
M08-4A	Inte	.956	.975	1.026	1.055	.242	.300	.274	.447	.317	.217	.949	.974	1.021	1.053	.237	.294	.249	.412	.321	.223
	lMa	.919	.951	1.011	1.027	.919	1.000	.640	.921	.079	.026	.909	.943	1.001	1.018	.913	1.000	.602	.885	.082	.035
	lMb	.919	.951	1.011	1.028	.936	1.000	.688	.931	.072	.022	.910	.942	1.000	1.018	.930	.997	.629	.898	.077	.029
M09-1A	Inte	.901	.933	1.083	1.125	.237	.293	.272	.457	.331	.217	.895	.931	1.075	1.124	.233	.287	.245	.422	.338	.222
	lMa	.822	.878	1.029	1.055	.910	.999	.630	.907	.077	.031	.799	.865	1.005	1.038	.903	.998	.584	.873	.084	.038
	lMb	.813	.877	1.029	1.053	.928	.993	.662	.916	.071	.026	.802	.865	1.006	1.034	.920	.990	.618	.887	.078	.031
M09-4A	Inte	.967	.981	1.024	1.043	.236	.293	.263	.446	.339	.223	.963	.979	1.021	1.042	.232	.287	.237	.410	.347	.228
	lMa	.947	.962	1.012	1.024	.913	1.000	.616	.903	.078	.031	.936	.957	1.004	1.019	.907	1.000	.578	.868	.085	.040
	lMb	.947	.961	1.012	1.023	.930	.996	.647	.912	.070	.026	.936	.956	1.004	1.018	.923	.991	.604	.882	.078	.032
M11-1A	Inte	.805	.867	1.136	1.214	.234	.285	.274	.456	.341	.228	.790	.864	1.123	1.206	.230	.279	.246	.432	.349	.233
	lMa	.642	.747	.967	1.039	.889	.991	.608	.892	.095	.035	.609	.728	.913	1.011	.882	.989	.559	.863	.101	.044
	lMb	.636	.744	.962	1.034	.904	.984	.642	.912	.083	.031	.598	.719	.903	1.004	.897	.979	.596	.878	.086	.038
M11-4A	Inte	.941	.968	1.053	1.094	.226	.279	.211	.407	.380	.253	.932	.967	1.049	1.094	.222	.274	.196	.375	.385	.260
	lMa	.911	.939	1.027	1.067	.834	.973	.511	.841	.114	.050	.890	.932	1.010	1.058	.826	.970	.467	.800	.119	.054
	lMb	.909	.938	1.027	1.066	.841	.971	.537	.862	.105	.044	.889	.930	1.011	1.056	.834	.966	.494	.823	.113	.048
M12-1A	Inte	.879	.942	1.095	1.156	.214	.259	.134	.362	.470	.274	.874	.941	1.086	1.151	.211	.254	.122	.334	.470	.279
	lMa	.776	.897	1.020	1.092	.683	.926	.317	.751	.187	.069	.761	.888	.990	1.087	.675	.920	.295	.707	.193	.077
	lMb	.775	.892	1.020	1.083	.693	.939	.334	.773	.183	.060	.748	.886	.988	1.079	.685	.932	.311	.721	.184	.066
M12-4A	Inte	.965	.981	1.026	1.050	.224	.268	.182	.355	.412	.284	.959	.981	1.023	1.050	.220	.263	.165	.327	.416	.288
	lMa	.940	.965	1.013	1.034	.761	.930	.438	.759	.148	.072	.927	.964	1.005	1.031	.754	.915	.408	.716	.152	.076
	lMb	.940	.965	1.013	1.033	.773	.932	.468	.791	.140	.066	.927	.962	1.005	1.030	.766	.926	.435	.745	.142	.071

Table 2.

Performance statistics for *Evaluation Trials* with need envelopes A and C, with RMP catches for the Interim *SLA* and two tuning versions (lMa and lMb - with lMa being the final selected *SLA*). Figures in bold indicate possible conservation issues.

		Need: A										Need: C									
Trial	SLA	D1l	D1m	D10l	D10m	N20l	N20m	N100l	N100m	N12U	N12m	D1l	D1m	D10l	D10m	N20l	N20m	N100l	N100m	N12U	N12m
M01-1A	Inte	.745	.823	1.063	1.159	.238	.299	.279	.464	.312	.216	.736	.817	1.050	1.155	.234	.293	.253	.424	.319	.220
	lMa	**.574**	**.690**	**.860**	**.956**	**.916**	**1.000**	**.646**	**.921**	**.077**	**.028**	**.555**	**.665**	**.806**	**.924**	**.910**	**1.000**	**.606**	**.872**	**.085**	**.039**
	lMb	**.564**	**.685**	**.855**	**.952**	**.934**	**.999**	**.682**	**.932**	**.072**	**.024**	**.542**	**.659**	**.806**	**.917**	**.927**	**.994**	**.637**	**.887**	**.074**	**.032**
M01-4A	Inte	.915	.944	1.039	1.080	.239	.299	.277	.454	.311	.216	.911	.943	1.029	1.080	.235	.293	.251	.414	.322	.222
	lMa	.873	.904	1.007	1.035	.916	1.000	.684	.924	.077	.025	.855	.894	.987	1.021	.910	1.000	.630	.880	.084	.033
	lMb	.873	.905	1.007	1.033	.934	1.000	.699	.940	.068	.022	.854	.891	.987	1.018	.927	.998	.659	.899	.075	.028
M02-1A	Inte	.849	.902	1.056	1.109	.237	.292	.266	.453	.332	.218	.840	.899	1.046	1.107	.233	.286	.239	.413	.335	.221
	lMa	.729	.834	.970	1.011	.914	1.000	.637	.907	.075	.032	.718	.814	.944	.994	.907	1.000	.585	.868	.083	.041
	lMb	.728	.830	.971	1.009	.932	.996	.664	.916	.067	.025	.701	.814	.943	.991	.924	.992	.619	.884	.074	.033
M02-4A	Inte	.946	.966	1.014	1.036	.239	.292	.263	.443	.324	.218	.942	.966	1.011	1.035	.235	.286	.238	.406	.334	.222
	lMa	.918	.944	1.000	1.011	.913	1.000	.621	.908	.075	.030	.908	.938	.989	1.004	.907	1.000	.582	.872	.083	.037
	lMb	.917	.943	1.000	1.011	.931	.999	.652	.914	.070	.025	.908	.937	.990	1.003	.924	.993	.608	.885	.075	.030
M04-1A	Inte	.692	.776	1.079	1.198	.239	.300	.287	.464	.295	.211	.678	.772	1.061	1.189	.235	.294	.257	.428	.309	.217
	lMa	**.448**	**.589**	**.733**	**.893**	**.920**	**1.000**	**.644**	**.913**	**.076**	**.030**	**.400**	**.561**	**.657**	**.837**	**.914**	**1.000**	**.606**	**.866**	**.088**	**.038**
	lMb	**.433**	**.585**	**.725**	**.890**	**.939**	**1.000**	**.683**	**.921**	**.066**	**.026**	**.397**	**.552**	**.655**	**.831**	**.931**	**.998**	**.633**	**.879**	**.077**	**.033**
M04-4A	Inte	.904	.937	1.066	1.135	.243	.306	.306	.474	.292	.211	.895	.936	1.055	1.133	.239	.299	.274	.434	.303	.217
	lMa	.835	.883	1.024	1.067	.921	1.000	.704	.941	.070	.021	.818	.865	.998	1.042	.915	1.000	.651	.904	.080	.033
	lMb	.836	.883	1.024	1.064	.939	1.000	.723	.946	.061	.018	.810	.863	1.000	1.039	.932	1.000	.682	.911	.071	.024
M06-1A	Inte	.770	.846	1.050	1.127	.238	.293	.275	.462	.319	.217	.766	.840	1.035	1.127	.234	.287	.247	.422	.324	.222
	lMa	.641	.743	.900	.982	.916	1.000	.636	.918	.073	.029	.609	.724	.862	.952	.910	1.000	.598	.873	.081	.037
	lMb	.638	.739	.898	.978	.934	.997	.671	.924	.067	.024	.611	.720	.856	.945	.927	.993	.627	.887	.070	.031
M06-4A	Inte	.921	.948	1.021	1.053	.239	.294	.263	.453	.318	.219	.916	.946	1.014	1.052	.235	.288	.239	.413	.328	.223
	lMa	.892	.918	.999	1.018	.916	1.000	.647	.924	.071	.028	.875	.910	.983	1.008	.909	1.000	.608	.882	.081	.033
	lMb	.891	.918	.999	1.018	.933	1.000	.686	.934	.066	.023	.875	.908	.983	1.007	.926	.996	.637	.900	.069	.029
M08-1A	Inte	.840	.899	1.063	1.123	.239	.297	.280	.455	.312	.213	.829	.896	1.055	1.120	.235	.291	.254	.419	.320	.222
	lMa	.693	.823	.961	1.006	.916	1.000	.654	.913	.076	.028	.663	.801	.920	.987	.910	1.000	.606	.875	.082	.036
	lMb	.689	.819	.956	1.005	.934	1.000	.689	.921	.067	.024	.668	.797	.915	.980	.927	.995	.640	.895	.073	.031
M08-4A	Inte	.945	.967	1.020	1.047	.242	.300	.274	.444	.317	.217	.939	.966	1.016	1.046	.237	.294	.249	.410	.321	.223
	lMa	.907	.943	1.004	1.019	.916	1.000	.640	.919	.080	.026	.900	.934	.992	1.009	.910	1.000	.602	.884	.083	.034
	lMb	.904	.943	1.004	1.018	.934	1.000	.682	.928	.072	.023	.898	.934	.992	1.008	.927	.997	.629	.894	.077	.029
M09-1A	Inte	.861	.905	1.046	1.092	.237	.291	.261	.451	.333	.221	.852	.903	1.038	1.090	.233	.285	.235	.415	.340	.225
	lMa	.764	.845	.979	1.012	.909	.999	.620	.896	.077	.033	.761	.831	.951	.995	.903	.998	.574	.864	.084	.041
	lMb	.762	.843	.977	1.009	.927	.993	.662	.913	.071	.026	.749	.831	.950	.993	.920	.989	.610	.881	.078	.034
M09-4A	Inte	.950	.965	1.011	1.028	.236	.291	.260	.443	.342	.225	.946	.965	1.008	1.027	.232	.285	.235	.405	.346	.228
	lMa	.925	.947	.996	1.006	.913	1.000	.615	.897	.078	.032	.916	.940	.987	1.000	.907	1.000	.576	.863	.086	.041
	lMb	.925	.946	.996	1.005	.930	.996	.645	.908	.071	.027	.916	.939	.987	.999	.923	.990	.603	.880	.078	.032
M11-1A	Inte	.739	.825	1.077	1.153	.233	.285	.264	.447	.342	.231	.726	.821	1.058	1.147	.229	.279	.239	.423	.350	.233
	lMa	**.574**	**.695**	**.851**	**.963**	**.881**	**.991**	**.600**	**.884**	**.102**	**.037**	**.547**	**.671**	**.807**	**.936**	**.871**	**.988**	**.554**	**.856**	**.095**	**.047**
	lMb	**.566**	**.690**	**.852**	**.958**	**.896**	**.984**	**.636**	**.903**	**.086**	**.033**	**.541**	**.666**	**.801**	**.928**	**.885**	**.978**	**.589**	**.868**	**.091**	**.041**
M11-4A	Inte	.913	.949	1.033	1.075	.226	.278	.208	.403	.380	.254	.903	.948	1.027	1.074	.222	.272	.193	.373	.384	.261
	lMa	.880	.917	1.003	1.040	.831	.972	.509	.838	.116	.051	.860	.911	.986	1.031	.825	.968	.463	.791	.122	.055
	lMb	.878	.917	1.003	1.038	.839	.970	.534	.854	.108	.046	.859	.911	.986	1.027	.833	.965	.492	.817	.114	.051
M12-1A	Inte	.849	.924	1.073	1.129	.214	.258	.132	.355	.472	.278	.841	.922	1.066	1.129	.211	.254	.119	.330	.472	.280
	lMa	.727	.875	.976	1.058	.681	.925	.311	.745	.187	.069	.713	.868	.952	1.055	.673	.919	.290	.689	.195	.077
	lMb	.724	.869	.975	1.056	.691	.938	.328	.759	.183	.061	.703	.864	.951	1.050	.683	.931	.306	.711	.184	.068
M12-4A	Inte	.950	.971	1.016	1.039	.224	.268	.181	.351	.414	.285	.947	.970	1.014	1.038	.220	.263	.165	.325	.417	.289
	lMa	.923	.954	1.002	1.021	.760	.927	.433	.755	.148	.072	.908	.953	.994	1.018	.753	.913	.404	.713	.152	.077
	lMb	.923	.954	1.002	1.020	.772	.931	.463	.785	.141	.067	.908	.952	.993	1.016	.764	.925	.430	.740	.142	.071

Appendix 6

SOME PLOTS PERTINENT TO THE EVALUATION OF CONSERVATION PERFORMANCE FOR THE MAKAH MANAGEMENT PLAN

André E. Punt

The evaluation of conservation performance relates to two factors: (a) whether the final depletion (quantified using the D1 statistic) exceeds the MSYL (nominally 0.6K) with high probability (conventionally 95% in the AWMP evaluation process), and (b) whether the stock is projected to increase (quantified by the D10 statistic) if it is below MSYL with high probability. A failure to achieve conservation objectives could be considered a case where there is more than a 5% chance (i.e. 5 simulations out of 100) where the stock is not above MSYL and not increasing and the trial is considered sufficiently plausible to be considered in the 'evaluation set'.

To examine the conservation performance for the Makah Management Plan, 'Brandon Plots' have been produced by stock (left panels of Fig. 1). These plots identify trials (see Table 1 for the list of trials) where the lower 5th percentiles of the D1 and D10 statistics (individually) are less than 0.6 and 1 respectively. These trials are 5a11 (for the WFG) and 3a16, 5a16 and 5a20 (for the PCFG). Figure 2 examines this issue using 'Wilberg-Brandao' plots, which show the D1 vs D10 statistics by simulation for trials 3a16, 5a11, 5a16 and 5a20. Figure 2 indicates that more than 5% of simulations are 'in the gray' and need to be examined further.

The four trials 'in the gray' in Figure 1 are all trials that involve higher levels of bycatch than for the baseline trials (see the column 'Bycatch' in Table 1). The question then arises whether the 'poor' performance is due to the Makah Management Plan, the harvest at Chukotka, or future bycatch.

The right panels of Figure 1 consequently examine (using 'Brandon Plots') the values for the D8 and D10 statistics. The D8 statistic is the ratio of the final depletion when the Makah Management Plan is implemented, harvest occurs at Chukotka, and there is future bycatch to the final depletion when harvest occurs at Chukotka, and there is future bycatch, but no catches occur off Washington. Values close to 1 on the y-axis indicate that the harvest off Washington has a negligible effect compared to the other two sources of modelled removals. This is most evident for the Northern Feeding Aggregation and the Western Feeding Group and (as expected) to a lesser extent for the PCFG. These results suggest that the poor performance in Figures 1 (left) and 2 are due primarily to bycatch (most likely) and catches of Chukotka (less likely given they do not involve the WFG and PCFG for almost all trials).

Table 1

List of Trials

Trial	Description/stock hypothesis	PCFG or WFG in BSCS	MSYR$_{1+}$ North	MSYR$_{1+}$ PCFG	MSYR$_{1+}$ WFG	PCFG Imm.	PCFG Pulse	Bycatch	Conditioning
Base-case Trials									
0A	Reference 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
0B	Reference 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
Sensitivity tests									
1A	Lower MSYR PCFG 3a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
1B	Lower MSYR PCFG 5a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
2A	Higher MSYR PCFG & North 3a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
2B	Higher MSYR PCFG & North 5a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
3A	Lower WBS in Sakhalin 5a (Hyp 3e)	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
3B	Higher WBS in Sakhalin 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4A	PCFG mixing based on Northern WA only 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4B	PCFG mixing based on Northern WA only 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
5A	No PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
5B	No PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
6A	Higher PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
6B	Higher PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
7A	Lower Pulse into PCFG 3a (& no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
7B	Lower Pulse into PCFG 5a (& no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
8A	Higher pulse into PCFG 3a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
8B	Higher pulse into PCFG 5a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
9A	Bycatch=Dead + MSI 3a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
9B	Bycatch=Dead + MSI 5a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
10A	Bycatch x 10 3a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
10B	Bycatch x 10 5a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
11A	Bycatch x 20 3a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
11B	Bycatch x 20 5a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
12A	PCFG in BSCS 3a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
12B	PCFG in BSCS 5a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13A	WFG in BSCS 3a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13B	WFG in BSCS 5a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 3a	No		**Est**		2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 5a	No		**Est**		2	20	D x 4	Yes
15A	MSYR1+ estimated (by FA) 3a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
15B	MSYR1+ estimated (by FA) 5a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
16A	Lower PCFG immigration & higher bycatch 3a (& no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
16B	Lower PCFG immigration & higher bycatch 5a (& no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
17A	MSYR estimated & lower pulse 3a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
17B	MSYR estimated & lower pulse 5a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
18A	Stock hypothesis 3b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18B	Stock hypothesis 6b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18C	Stock hypothesis 3c	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
19A	Lower PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
19B	Lower PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
20A	Lower PCFG immigration & higher bycatch 3a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
20B	Lower PCFG immigration & higher bycatch 5a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
21A	Survival = 0.95; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
21B	Survival = 0.95; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
22A	Future catastrophic events (once in each of yrs 1-50 & 51-99) - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
22B	Future catastrophic events (once in each of yrs 1-50 & 51-99) - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
23A	Summer S&L rate = 0.5 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
23B	Summer S&L rate = 0.5 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
24A	PCFG false negative rate = 0.1 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
24B	PCFG false negative rate = 0.1 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
25A	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
25B	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes

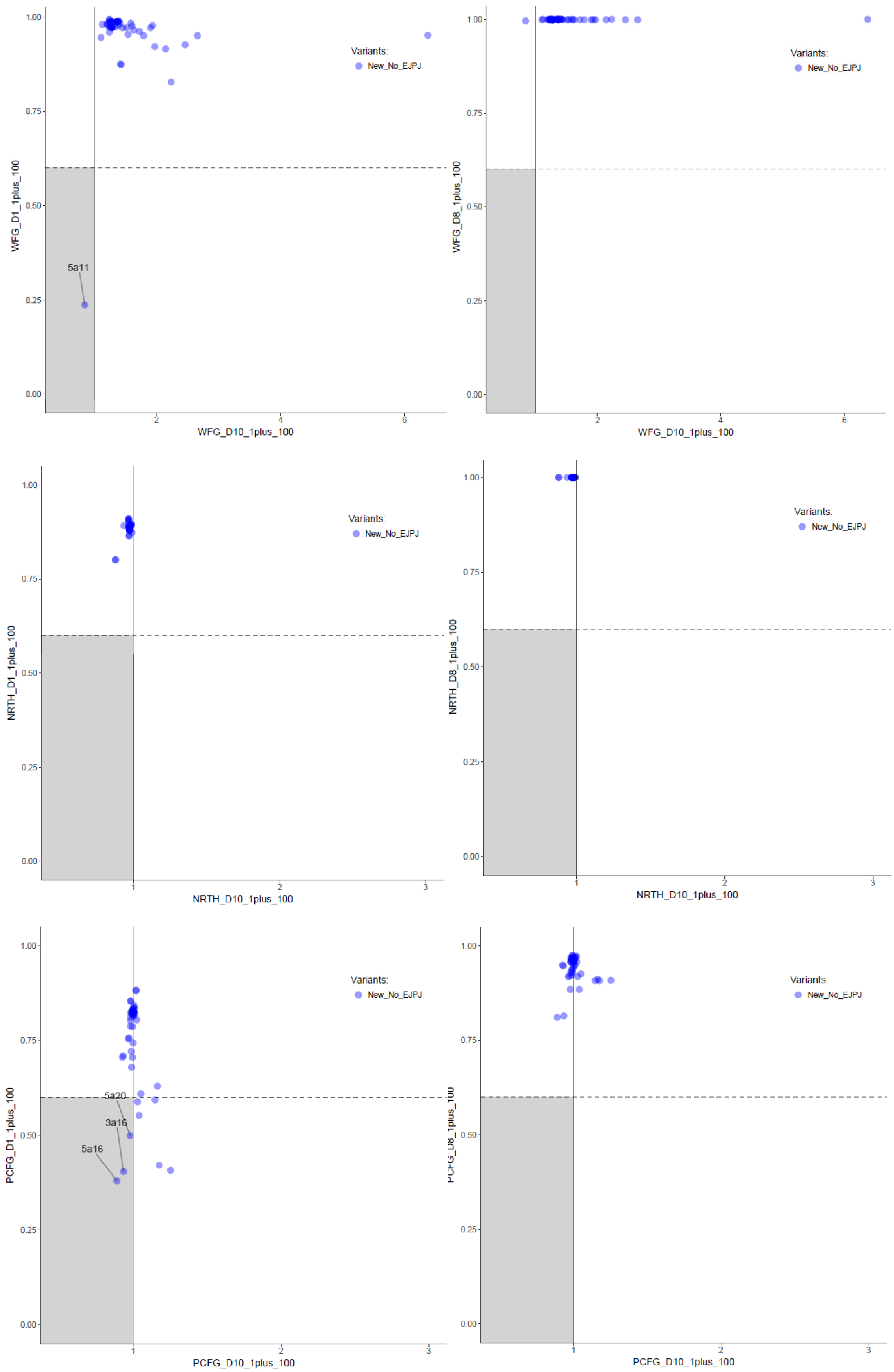

Figure 1. Lower 5th percentile of the D1 statistic versus the lower 5th percentile of the D10 statistic by stock (left panels) and the lower 5th percentile of the D8 statistic versus the lower 5th percentile of the D10 statistic by stock

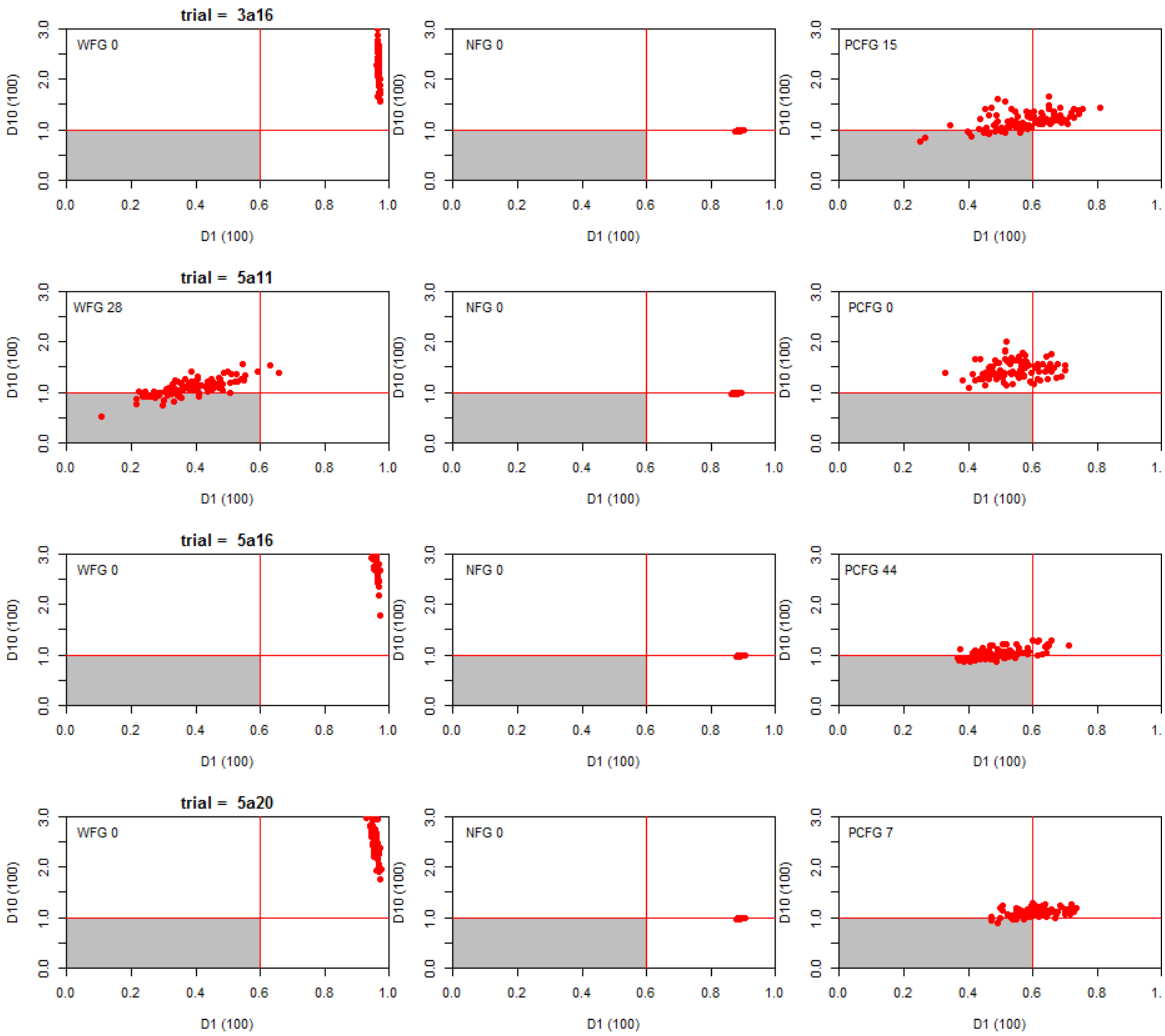

Figure 2. 'Wilberg-Brandao' plots (individual values for D1 and D10 by simulation) for the four simulations highlighted in Figure 1. The number in the top left corner of each panel is the number of simulations 'in the gray'.

Appendix 7

INVESTIGATING THE VARIABILITY OF THE 1+ POPULATION PROJECTIONS BASED ON 400 AND 100 SIMULATIONS FOR WEST GREENLAND BOWHEAD WHALES

Michael Wilberg and Anabela Brandão

Problem:

SC/O17/AWMP03 showed projection plots for the r t5 percentile and the median of the 1+ population for the baseline evaluation trials for the selected *SLA* for West Greenland bowheadt whales based on 400 simulations. For comparison purposes, the projections for the *SLA* undeht100 simulations were also shown. These show substantial variability between estimates of the r 5 percentile of the distribution of population size (see Figure 1 for an example). It was uncertain what was causing this behaviour and this paper investigates this.

Methods:

Firstly the 400 simulations were split into blocks of 100, and the *SLA* was run for each 100-tsimulation block.

Secondly, we evaluated the percentiles of the results from four 100-trial simulations to determine the potential cause of the issue. We examined the distributions of several variables including carrying capacity and abundance and depletion at different time points. For demonstration in this working paper, we focused on depletion in year 100 as the primary variable of interest. We combined the results of the four 100-trial sets of results and used bootstrapping with 10,000 bootstrap replicates to determine the effect of the number of trials on the precision of the estimate.

Results:

Figure 2 shows the projections for the r 5 percentile and the median for the1+ population for the selected *SLA* based under 400 simulations and for blocks of 100 simulations. This shows the large amount of variability, especially in the r t5 percentile of the 1+ population. The approximate 95% CI for 100 trials was 0.56-0.72. The precision of the estimate was substantially improved with an increase in the number of trials to 400 or 1000, 95% CI 0.61-0.66 and 0.62-0.65, respectively. The r t5 percentile of the distribution is imprecisely estimated with a sample of 100 trials because of the long left hand tail of the distribution (Figure 3).

Conclusion:

Continuing to use 400 trials for the simulations appears to be sufficient to estimate the lower r 5 percentile with a reasonable amount of precision.

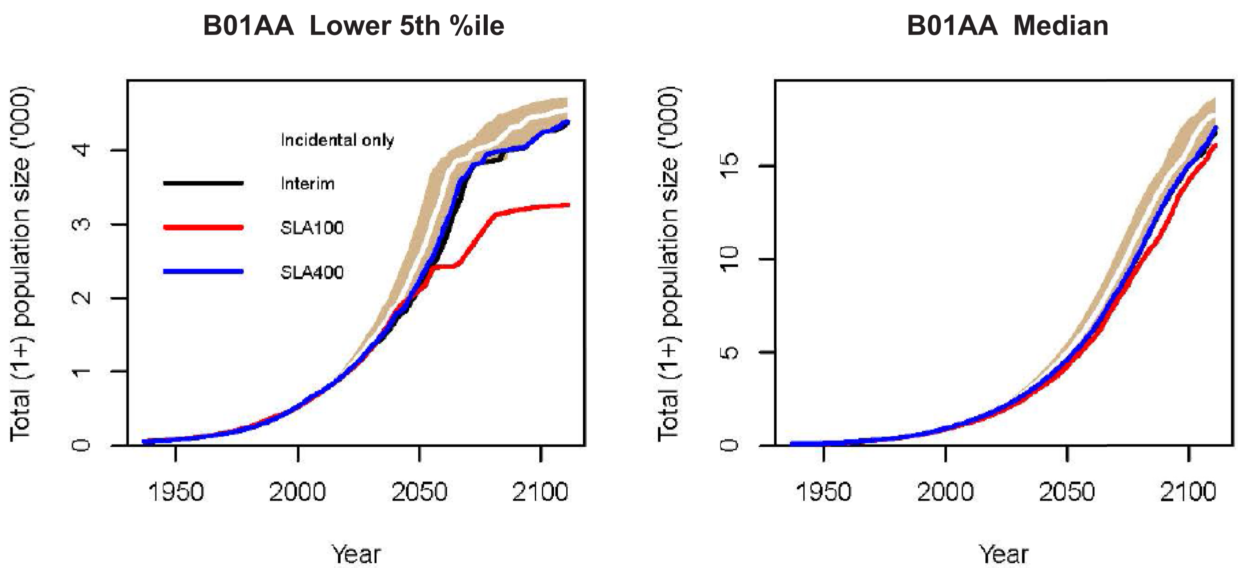

Fig. 1. Projections of the 1+ population for the West Greenland bowhead whales under the selected *SLA* based on trials with 100 and 400 replicates.

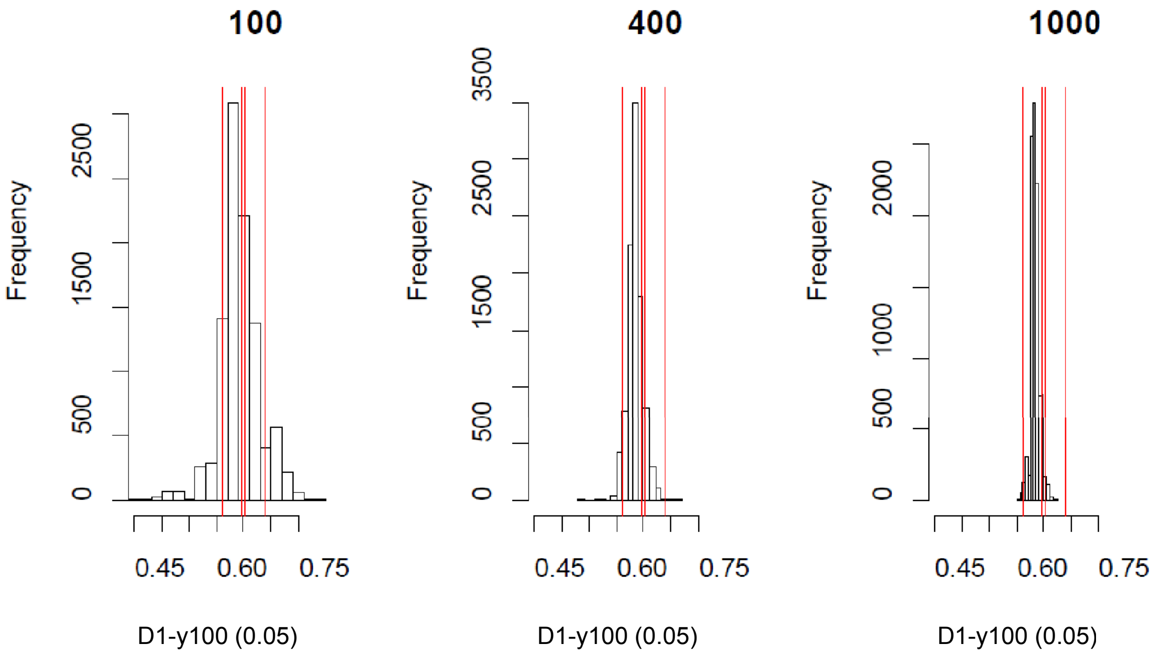

Fig. 2. Distribution of the 5th percentile of depletion in year 100 under three levels of the number of trials (100, 400, and 1,000) for West Greenland bowhead whales. The red lines indicate the estimated 5th percentile from four simulations of 100 trials. Note the wide range of the distribution for 100 trials.

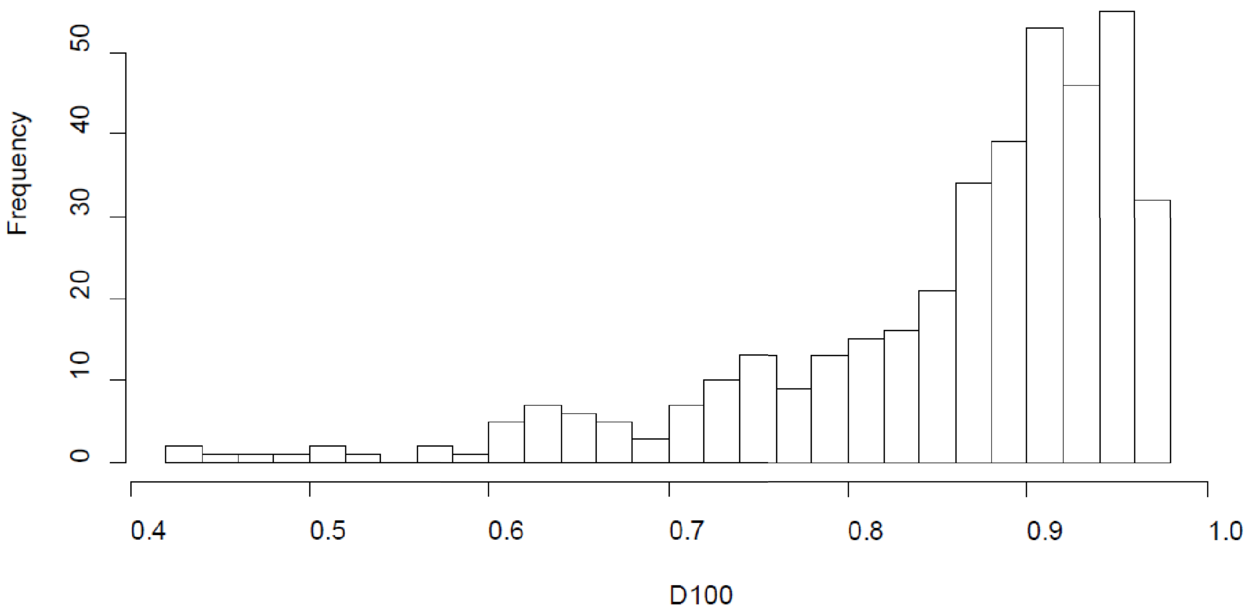

Fig. 3. Distribution of depletion in year 100 from 400 simulations for West Greenland bowhead whales.

Appendix 8

INTERIM RELIEF SCENARIOS

Appendix 9 specifies an interim relief provision for the Aboriginal Whaling Scheme. Under this provision, a survey is required at least every 10 years. If no survey is available after that time and third quota block has begun, the Committee has **endorsed** the use of an 'interim relief', namely a 'grace period' strike limit equal to the limit produced by the applicable Strike Limit Algorithm, without reduction, for a single block.

The 10-year survey interval requirement is complicated by the fact that there will usually be a delay between when the survey is conducted and when the resulting abundance estimate is agreed by the Committee, and because surveys, estimates and quota blocks need not be synchronised. For the sake of counting years, a survey is not considered to have occurred until the resulting abundance estimate is agreed. At that point, the 10-year time window is deemed to have begun in the year during which the survey was conducted. Then, ideally, the next survey would be conducted and the estimate approved within 10 years of the previous survey. However, other scenarios might occur. For example, the next survey might have occurred eight years after the previous one, but the corresponding abundance estimate not agreed until 13

Tables 1 and 2

Example schedules of surveys, block strike limits and so forth. See the text for a detailed explanation.

Yr	A	Clock		B	Clock	
1	SL			SL		
2						
3						
4	Surv	10				
5		9				
6	Est	8		Surv	10	
7	SL	7		Est/SL	9	
8		6			8	
9		5			7	
10		4			6	
11		3			5	
12	Surv	2	10		4	
13	SL	1	9	SL	3	
14	Est	0	8		2	
15			7		1	
16			6	Surv	0	10
17			5	Est	-1	9
18			4			8
19	SL		3	SL		7
20	Surv	10	2			6
21		9	1			5
22	Est	8	0			4
23		7				3
24		6				2
25	SL	5		SL		1
26		4		Surv	10	0

Yr	C	Clock		D	Clock		E	Clock	
1	SL			SL			SL		
2	Surv	10		Surv	10				
3		9			9				
4		8			8		Surv	10	
5	Est	7		Est	7			9	
6		6			6		Est	8	
7	SL	5		SL	5		SL	7	
8		4			4			6	
9		3			3			5	
10		2			2			4	
11		1			1			3	
12	Surv	0	10	Surv	0	10		2	
13	IASL	-1	9	IASL	-1	9	SL	1	
14		-2	8		-2	8		0	
15	Est/USL	-3	7	Est	-3	7		-1	
16			6			6		-2	
17			5			5	Surv	-3	10
18			4			4	Est	-4	9
19	SL		3	SL		3	SL		8
20	Surv	10	2	Surv	10	2			7
21		9	1		9	1			6
22	Est	8	0	Est	8	0			5
23		7			7				4
24		6			6				3
25	SL	5		SL	5		SL		2
26		4			4				1

years after the previous survey was conducted ('the 13th year'). In this case, a survey would be considered overdue during the 11th and 12th years. If the start of a new block occurred during that time, the grace period would be triggered and an interim relief provided. Otherwise, when the abundance estimate is agreed in the 13th year after the last survey was conducted, the fact that the survey actually took place eight years after the last agreed estimate would reset the clock so that the next deadline would be the 18th year, and a grace period would have been averted.

Tables 1 and 2 illustrate several scenarios about how strike limits might evolve with varying survey intervals and grace periods. In these tables, it is assumed for simplicity that the *Strike Limit Algorithm* would output a six-year block strike limit (SL) each time. For the sake of simplicity, carryover is ignored in these tables.

Five different scenarios (A-E) are shown in Tables 1 and 2. These tables cover more than four quota blocks (boxes), with surveys (Surv), abundance estimates (Est) and the establishment of block strike limits (SL) scheduled by year (Yr), The 'Clock' counts the number of years remaining before a survey will thereafter be overdue. Thus, when the clock set by the most recent estimate is negative, a survey is overdue and when a grace period quota is required an interim relief strike limit (IASL) is set.

Scenario A in Table 1 illustrates a situation with regular 8-year survey intervals and estimates two years later. Each strike limit is set using a timely survey; no surveys are overdue and no grace periods are required. Note that in year 13, a block strike limit is set using the survey from year 4. Although the more recent survey (year 12) has occurred, the corresponding abundance estimate has not yet been computed. Scenario B represents an unproblematic case with 10-year survey intervals.

Scenarios C and D illustrate cases where the grace period is invoked in year 13. In Scenario C, immediate revision of the interim relief strike limit (IASL) is assumed and an updated strike limit (USL) is computed. Scenario D presents the same schedule of surveys and estimates, but when the grace period is invoked, the IASL is retained for the entire block, with the year 12 survey first being used in year 19.

Scenario E illustrates that it is possible that surveys could be more than 10 years apart (in this case, 13 years) without triggering the grace period.

Appendix 9

SCIENTIFIC ASPECTS OF AN ABORIGINAL WHALING SCHEME

The Scientific Committee's Aboriginal Whaling Management Procedure (AWMP) applies stock-specific *Strike Limit Algorithms* (*SLA*s) to provide advice on aboriginal subsistence whaling (ASW) strike/catch limits.

ASW management (as part of an AWS, the aboriginal whaling scheme) incorporates several components, several of which have a scientific component:

(a) *Strike Limit Algorithms* (case-specific) used to provide advice on safe catch/strike limits;
(b) operational rules (generic to the extent possible) including carryover provisions, block quotas and interim relief allocations;
(c) Guidelines for *Implementation Reviews*; and
(d) Guidelines for data and analysis (e.g. guidelines for surveys, other data needs)

The scientific components are considered below.

1. CARRYOVER

Carryover is a provision to enable (some) strikes not used in one year to be used in a subsequent year or years, in order to allow for the inevitable fluctuations in the success of hunts (e.g. due to environmental conditions and/or whale availability). Whilst providing flexibility, carryover does not allow hunts to take more than the total number of strikes agreed by the Commission. This flexibility may produce additional benefits for the local management of the hunt. The concept is not new and *ad hoc* provisions incorporating carryover have been included in the Schedule for many years (see the summary provided in IWC, 2018b, p.169-72). As general guidance, the Commission has (in 2001 and 2016), approved examination by the Committee of scenarios incorporating a 50% interannual variation within blocks and 50% allowance to the next block, noting that this did not imply any commitment by the Commission that these values would be used in the Schedule.

1.1 The Committee's role

The Scientific Committee's role is not to recommend a particular carryover approach but rather to provide advice on the conservation and need performance of carryover options when asked by the Commission or ASW countries. Formal evaluation of the performance of options (see Item 1.2) by the Committee will allow a more consistent approach to carryover across hunts. The Committee's evaluation began in the year 2000 as the Committee began to develop its first recommended components of an AWS (IWC, 2001, p.18).

1.2 Examining conservation performance

The Committee examines the conservation performance of options using the same simulation testing approach used to develop *SLA*s. This allows the Committee to provide guidance as to the acceptable limits within which carryover provisions can be developed. In requesting guidance on carryover provisions, at least the following information should be provided by ASW countries or the Commission:

(a) an initial start date for the provision (e.g. 2003, start of new block);
(b) an expiration period (unused strikes cannot be carried over indefinitely); and
(c) limits on use (e.g. the maximum number of strikes allowed in any one year).

1.3 Additional provision

The Committee's *Implementation Review* process (see section 4 below) includes the monitoring of carryover provisions. Should new information (e.g. abundance data) lead an *SLA* to indicate a severe decrease in the quota then this will trigger an appropriate review of the existing carryover provisions and any implications for conservation performance. If necessary, the review may lead the Committee to recommend changes in carryover provisions that may, for example, result in a 'reset' of the starting year or other amendments to carryover provisions.

1.4 Schedule language
The Committee advises that the incorporation of carryover provisions in the Schedule should avoid ambiguity. Rather than try to encode general provisions in the Schedule, the Committee offers to assist the Commission in by providing the actual numbers for each hunt in a new quota block, based upon agreed general provisions.

1.5 Example
A request from the USA and Denmark/Greenland was to

> '…allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit'.

This request was tested using the *Bowhead SLA* (applicable to the Bering-Chukchi-Beaufort Seas stock) and the *WG-Humpback SLA* (applicable to West Greenland) and three types of options were examined:

(1) baseline case – all strikes taken annually (i.e. no need for carryover);
(2) 'frontload' case – strikes taken as quickly as possible within block (+50% limit annually until the block limit is reached); and
(3) two alternative scenarios where carryover strikes are accrued for one or three blocks, followed by a period of carryover usage subject to the +50% limit.

The three-block scenario considered in (3) served as a direct test of the provision described in the request of USA and Denmark/Greenland. The Committee agreed that the Commission's conservation objectives were met for both *SLA*s for all of the options above and would also be met for a proposal carrying forward strikes from the previous two blocks.

2. BLOCK QUOTAS
The Committee has advised the Commission (in the context of moving to biennial meetings) that block quotas of up to 8 years are acceptable (IWC, 2013, p.22), noting the requirement for abundance estimates every ten years (see Item 3).

3. INTERIM RELIEF
A variety of factors, including environmental conditions, beyond the control of the hunters may prevent the completion of a successful whale population abundance estimate. While recognizing such difficulties, the Committee notes that uncurtailed aboriginal whaling quotas cannot be continued indefinitely in the long-term absence of data. Therefore, the AWS must address what should be done in the event that efforts to obtain an agreed abundance estimate are unsuccessful after some time limit. For the purposes of applying AWMP *Strike Limit Algorithms*, the Committee has agreed that this limit is 10 years (IWC, 2016).

A third quota block begun after the 10-year limit has expired is termed a 'grace period' and the Committee has endorsed the use of an 'interim allowance', namely a grace period strike limit equal to the limit produced by the applicable *Strike Limit Algorithm*, without reduction, for a single block. This approach has been simulation tested for B-C-B bowheads and WG humpbacks to confirm that it meets the conservation and need satisfaction goals of the Commission (IWC, 2016, p.190-3, p.471-84; 2017a, p.498) and the results are summarised in IWC (2017b; 2018a, p.159). It will be tested for eastern NP gray whales at the next *Implementation Review* for that stock. Testing for the remaining ASW stocks will be added to the future workplan of the Committee.

The 10-year survey interval requirement is complicated by the fact that (a) there will usually be a delay between when a survey is conducted and when the resulting abundance estimate is agreed by the Committee and (b) because surveys, estimates and quota blocks need not be synchronised, as recognised in IWC (2003). For the sake of counting years between surveys, a survey is not considered to have occurred until the resulting abundance estimate is agreed. At that point, the 10-year time window is deemed to have begun in the year during which the survey was conducted. Further details and examples are given in IWC (2018a).

The Committee recommends that, during the grace period, a new strike limit is established immediately a new abundance estimate is agreed. this approach. However, it notes that if the Commission refrains from updating the strike limit until the grace period expires, this would not pose a conservation risk. If the strike limit is updated during a grace period block, the number of strikes taken to that point of the grace period should be subtracted from the updated quota, with the remainder being the strike limit for the rest of the grace period. Carryover is not affected.

The Committee emphasises that the interim allowance approach is intended to be applied only in the event that exceptional unforeseen circumstances had delayed obtaining an agreed abundance estimate beyond the end of the second quota block. It should not be interpreted as a routine approach for extending quotas for a third block without a concerted effort to obtain a successful survey prior to that time. Furthermore, the Committee would not recommend two consecutive interim allowances.

It is important to consider a scenario in which no acceptable abundance estimate is obtained by the end of the grace period. *SLA*s are not designed or intended to be applied if new abundance data are not forthcoming after such a long period. Given good faith efforts to obtain an abundance estimate, such a situation would probably have arisen from profound and unexpected environmental change (e.g. related to climate or a disaster such as a massive oil spill). Under such circumstances, an immediate *Implementation Review* (see Item 4.1.2) would probably have been initiated, irrespective of the timing of (un)successful surveys and quota blocks. As soon as it becomes apparent that an abundance estimate may not be obtained in time, researchers should immediately begin to develop alternative approaches to obtaining abundance estimates (or at least indices of abundance) that do not depend on the problematic circumstances. Nevertheless, if no abundance estimate is available the year before the end of the grace period, the Scientific Committee should immediately initiate an *Implementation Review*. The approach of the Committee in the absence of positive alternative evidence would be that the Committee could not provide advice on the quota using the *SLA* and the Commission should exercise great caution when agreeing any further strike limits. The level of caution will depend on the specifics of the situation.

4. *IMPLEMENTATION REVIEWS*
The concept of an *Implementation Review* is central to the functioning of the AWMP. 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 a *Strike Limit Algorithm* (*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).

4.1 Timing of *Implementation Reviews*

4.1.1 Regular Implementation Reviews
Implementation Reviews are undertaken regularly, normally every five to six years. This does not have to coincide with the renewal of catch/strike limits in the Commission. For logistical and resource reasons, only one major *Implementation Review* shall be undertaken at a time. The Committee shall begin planning for the *Review* at the Annual Meeting at least two years before the Annual Meeting at which the *Review* is expected to be finished. This is to enable the Committee to schedule additional work or Workshops if it believes that new information or analyses are likely to be presented that will necessitate the development of new simulation trials. Early planning will enhance the likelihood that the Committee will complete an *Implementation Review* on schedule. It is not expected that every *Implementation Review* will entail a large amount of work.

4.1.2 Special Implementation Reviews
In addition to regular *Implementation Reviews*, under exceptional circumstances the Committee may decide to call for special *Implementation Reviews,* should information be presented to suggest that this is necessary and especially if there is a possibility that the Commission's conservation objectives may not be met.

Calling such a *Review* does not necessarily mean revising the Committee's advice to the Commission, although it may do so. The Committee has not tried to compile a formal comprehensive list of what factors might trigger' such an early review, which implies unexpected/unpredictable factors. However, the following list is provided to give examples of some possible factors.

(1) Major mortality events (e.g. suggested by large numbers of stranded animals).
(2) Major changes in whale habitat (e.g. the occurrence of natural or anthropogenic disasters or changes, an oil spill, dramatic change in sea-ice, development of a major oil/gas field, etc.).
(3) Major ecological changes resulting in major long-term changes in habitat or biological parameters.
(4) A dramatically lower abundance estimate (although the *SLA* has been tested and found to be robust to large sudden drops in abundance, the Committee would review the potential causes of unexpected very low estimates).
(5) Information from the harvest and hunters (this might include very poor harvest results, reports of low abundance despite good conditions, reports of large numbers of unhealthy animals).
(6) Changes in biological parameters that may result in changes to management advice (e.g. reproduction, survivorship).
(7) If there are cases when need is not being satisfied, strong information that might narrow the plausibility range and allow an increase in block limits.

4.1.3 Outcomes of Implementation Reviews
There are a number of possible conclusions of *Implementation Reviews*:

(1) there is no need to run additional trials and that the existing *SLA* is acceptable;
(2) the results from the additional trials developed and run reveal that the existing *SLA* is acceptable;
(3) there is no need for any immediate additional trials or changes to management advice but work is identified that is required for consideration at the next *Implementation Review*; or
(4) the results of the additional trials require the development of a new (or modified and then retested) *SLA* in which case management advice will have to be reconsidered until that work is complete.

4.1.4 Data availability
Implementation Reviews fall under the Committee's Data Availability Agreement Procedure A (IWC, 2004). By the time of the Annual Meeting prior to that at which the *Implementation Review* is expected to be completed, the scientists from the country or countries undertaking the hunts, or others intending to submit relevant analyses, shall develop a document or documents that explains the data that will/could be used for the *Implementation Review*. Such a document will:

(a) outline the data that will be available, including by broad data type (e.g. sighting data, catch data, biological data): the years for which the data are available; the fields within the database; and the sample sizes;
(b) provide references to data collection and validation protocols and any associated information needed to understand the datasets or to explain gaps or limitations; and
(c) where available, provide references to documents and publications of previous analyses undertaken of data.

The data themselves shall be available in electronic format one month after the close of that Annual Meeting.

In the case of complex *Implementation Reviews* that may last more than one year and involve one or more workshops, new data can be submitted, provided that the data are described and made available at least nine months before the Annual Meeting at which the *Implementation Review* is expected to be completed.

4.1.5 Computer programs
Programs used in analyses submitted to the *Implementation Review* may be requested by the Committee, who may decide that the programmes need independent validation in accordance with its guidelines at the time. All *SLA* simulation testing and evaluation software shall be undertaken by the Secretariat using validated programmes.

5. GUIDELINES FOR SURVEYS

The Committee's general advice on surveys is applicable. Some more specific considerations are given below.

5.1 Survey/census methodology and design

Plans for undertaking a survey/census should be submitted to the Scientific Committee in advance of their being carried out, although prior approval by the Committee is not required. This should normally be at the Annual Meeting before the survey/census is carried out. Sufficient detail should be provided to allow the Committee to review the field and estimation methodology. Considerably more detail would be expected if novel methods are planned.

5.2 Committee oversight

Should it desire, the Scientific Committee may nominate one of its members to observe the survey/census to assess the scientific integrity of the process.

5.3 Data analysis and availability

Data to be used in the estimation of abundance will be made available to the Committee in accordance with Procedure A of the Data Availability Agreement (IWC, 2004). If new estimation methods are used in the data analysis, the Committee may require that computer programs (including documentation to allow such programs to be validated) be provided to the Secretariat for eventual validation.

5.4 Estimates to use in the *SLA*

The most recent estimate(s) accepted by the Committee for any year(s) should be incorporated in the *SLA* calculations. If there is more than one accepted estimate for a given year and the Committee agrees that the estimates are based on sufficiently independent data, then both estimates should be incorporated in the *SLA* calculations. If a revised estimate is obtained for a particular year, then the old one should be replaced before the *SLA* is next used.

6. GUIDELINES FOR DATA/SAMPLE COLLECTION

The Schedule states that data from each harvested animal should be collected and made available to the IWC. The following information should normally be provided for each harvest or individual whale as appropriate:

(1) species;
(2) number of animals;
(3) sex;
(4) season;
(5) location of catch (at least to the nearest village); and
(6) length of catch (to 0.1m).

The Committee recognises the importance of additional information, especially in the context of *Implementation Reviews* e.g. on reproductive status and health. It highlights the importance of collecting tissue samples for genetic studies in accordance with guidance provided by the Committee (e.g. *https://iwc.int/index.php?cID=60&cType=document*), especially in the context of stock structure issues. It notes that photo-identification data can be valuable for estimating biological parameters, assessing anthropogenic injuries, and encourages such research where possible. The value of traditional knowledge is also noted, and such information can also provide valuable input to conducting *Implementation Reviews*.

6.1 Revisions to the AWS

Revisions or additions to this AWS may be recommended by the Committee at any time, including during *Special Implementation Reviews*.

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Annex F

Report of the Sub-Committee on In Depth Assessment

Members: Palka (Convenor), An, Y-R, Aoki, Baba, Baker, Brownell, Butterworth, Cholewiak, Clapham, Cooke, Donovan, Goto, Hughes, Iñíguez, Inoue, Ivashchenko, Kato, Kitakado, Konishi, Maeda, Matsuoka, Miyashita, Mizroch, Moronuki, Morishita, Morita, Moronuki, Nakamura, Pastene, Punt, Taguchi, Tamura, Terai, Wade, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Introductory remarks
Palka welcomed the participants.

1.2 Election of Chair
Palka was elected Chair for this meeting and encouraged participants to consider becoming a co-chair.

1.3 Appointment of Rapporteurs
Cooke, Clapham and Palka agreed to act as rapporteurs.

1.4 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

1.5 Documents available
The documents considered by the sub-committee were SC/67b/IA01-IA03, Murase *et al*. (2018) and SC/67b/SCSP03.

2. IN-DEPTH ASSESSMENT OF INDO-PACIFIC ANTARCTIC MINKE WHALES

An intersessional correspondence group was tasked to finalise a document synthesising the results of the in-depth assessment of an eastern Indian stock (I-stock) and a western South Pacific stock (P-stock) of Antarctic minke whales distributed between 35°E and 145°W. The assessment, carried out from 2001 to 2014, covered systematics, commercial and research catches, survey methods, stock structure, abundance estimates, spatial distribution patterns, biological information, population dynamics, species interactions, food habits, energetic requirements, pollutants and marine debris interactions. Last year a draft version of the paper was submitted to the Committee where comments were received. During the intersessional period the synthesis paper (Murase *et al.*, 2018) was finalised and submitted to the *Journal of Cetacean Research and Management*.

The sub-committee **commended** the authors for submitting the paper to a journal for publication and acknowledged the great effort that had gone into synthesising the results of this assessment. Because the paper has just started the review process, the sub-committee **agreed** to re-establish the intersessional correspondence group, under Murase (Tables 1 and 2). The terms of reference of the group is to ensure publication of the submitted paper that summarises the in-depth assessment of the Indo-Pacific Antarctic minke whale.

3. IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

3.1 Progress on intersessional work
The intersessional correspondence group convened by Cooke worked during the year to compile input data for the population modelling exercise. The compiled datasets included: a historical catch series by sex and subarea; a table of absolute abundance estimates by sub-area for use in the assessment and model; an array of relative abundances by 10° square and 5-year period during 1965-2015 from Japanese scouting vessel and research cruises; and a data file of Japanese marks and recaptures. These inputs were used for some provisional runs of the assessment model developed by Punt, which were presented in SC/67b/IA01.

The sub-committee expressed its appreciation for the work of the intersessional group. The model structure and most of the model inputs were subject to further discussion and amendment at this meeting, as detailed in Item 3.2.

3.2 Preparation of data for assessment
3.2.1 Stock structure hypotheses
Last year the sub-committee agreed to proceed with two stock structure hypotheses for modelling purposes: (i) a single stock in the entire North Pacific; and (ii) five stocks with some overlap in feeding areas. The sub-committee had not attempted to reach agreement on the plausibility of the two hypotheses. The sub-committee had agreed that the evidence for multiple stocks was weak. However, because virtually all the genetic samples had been obtained in just one of the putative sub-areas (the Pelagic sub-area), the sub-committee was not able to reject the hypothesis of multiple stocks at this stage. The sub-committee emphasised that this decision to proceed does not imply endorsement of either hypothesis at this stage.

At the end of last year's meeting the sub-committee had revised its originally proposed sub-areas to bring them into line with the strata used in the IWC-POWER sightings surveys, to facilitate the extraction of abundance estimates by sub-area (IWC, 2018). However, at this meeting the sub-committee noted that this revision was problematic. Firstly, it did not respect the original oceanographic motivation for the sub-areas (Mizroch *et al.*, 2016); secondly, the revision resulted in a much greater inter-area movement of marked animals. The sub-committee therefore **agreed** to return to the original sub-areas, but with some modification in the western North Pacific. One modification was the line between the Pelagic and Western Coastal sub-areas was shifted westward to respect the original oceanographic motivation. This has the effect that Ogasawara and the pelagic catches are now included in the Pelagic sub-area, and the coastal catches remain within the Western Coastal sub-area. Also, as recommended by the intersessional correspondence group, the other modification was the line between the Eastern Coastal and Eastern North Pacific sub-areas was shifted south from 50°N to 48°N to facilitate the allocation of Canadian catches. A map of the revised sub-areas is given in Appendix 2.

The sub-committee considered that the re-extraction of data according to the sub-areas agreed this year would not be impractical. The catch series and relative abundance series were revised at this meeting, while the revision of the marking data and absolute abundance estimates could be entrusted to an intersessional group.

To ensure that the multi-stock hypothesis could be made consistent with available information, some overlap in feeding sub-areas was allowed between the five putative stocks. For each stock hypothesis, a schematic diagram of the feeding sub-areas and the allowed movements between them is shown in Appendix 3, along with a table of the 'mixing matrix' which links the putative stocks to feeding sub-areas.

The sub-committee once again stressed that these sub-areas have been agreed merely for the purpose of allowing the modelling work to proceed. No decision on the plausibility or otherwise of either hypothesis has been made.

3.2.2 Abundance and trends

A regression analysis of Japanese scouting vessel and dedicated survey data over the years 1965-2015 by 10° square and 5-year period had been prepared for the intersessional group and was reviewed by the sub-committee. The sub-committee noted that the data set is unbalanced; in the later years, there was effort only in the western north Pacific, not counting the areas to the south of 30° where only Bryde's whales were seen (see Appendix 4, Fig. 1). The unbalanced nature of the data is accounted for in principle by using the variance-covariance matrix in the fitting process, but the sub-committee nevertheless deemed it preferable not to use abundance indices that were based on less than 500nm survey effort. The resulting reduced set of abundance indices in given in Appendix 4 along with their correlation matrix.

Building on the work of the intersessional group, the sub-committee agreed in principle to a revised table of absolute abundance estimates (Appendix 5). However, the changes in the sub-areas necessitate some further reallocation of the estimates between sub-areas. The sub-committee **agreed** that this would be relatively straightforward, because nearly all the sightings were in the Pelagic sub-area, and that this task could be accomplished by the intersessional working group (see work plan in Item 5.1.2).

Some of the estimates in the table are annotated as minimum estimates, because they only covered part of the sub-area to which they apply. Some estimates are zero, and should be handled as recommended in the RMP specifications (IWC, 2012). Punt **agreed** to modify the likelihood function in the model to accommodate both minimum estimates and zero estimates.

3.2.3 Marking data

SC/67b/IA02 reported on 11 dedicated whale marking and sightings cruises conducted from 1962 to 1969 along the eastern North Pacific coast from northern California to the southern tip of Baja California and beyond. Most surveys were conducted in winter months and 991 groups of large whales were sighted. Sei whales were seen in all years and most months during which the surveys were conducted. A total of 31 groups of sei whales were seen. A total of 12 were potentially marked (hit or possible hit). Marks were recovered from 2 sei whales.

These mark recovery data were included in the analysis presented to the sub-committee in 2015 (Mizroch *et al.*, 2016) and have been incorporated into the marking data set to be used as input into the assessment.

In the intersessional period Allison and Yoshida prepared a data file on Japanese marks and recoveries of sei and Bryde's whales in the North Pacific during 1949-1981. These data had been used in the preliminary model runs reported in SC/67b/IA01.

The sub-committee discussed a number of issues associated with the marking data. These included marks placed where the species was uncertain, and tags recovered from species different than the one recorded on marking. The effective number of hits was also unclear, with some tags having been recovered from 'possible hits' and presumed misses. It was also not always clear when two tags had been placed in the same whale, when only one was recovered.

There were also some marks recovered at unknown locations: these had been found in the cooker, but it was unclear how long they had been there because the cookers were not cleaned out very often. There was a lot of grime and slime in there. The sub-committee considered that it was better to use these recoveries because they could be assigned to sub-area with little doubt.

Yoshida and Mizroch worked during the meeting to develop criteria for separating genuine marked sei whales from those which were likely Bryde's whales. However, it was not possible to resolve all remaining issues with the marking data set in the time available. These issues are listed in Appendix 6. The sub-committee **agreed** that the proposed intersessional correspondence group (see Item 5.1.2) should resolve these issues after the meeting and produce a final data set for use in the in-depth assessment. The sub-committee also **agreed** that the winter marks be used; Punt confirmed that this could be done through a simple modification to the model.

SC/67b/SCSP03 reported the results of the satellite monitored tagging experiments on North Pacific sei whales conducted during the 2017 NEWREP-NP survey. A total of 44 tagging experiments were conducted using SPOT6 type tags with LKArts system for attachments from Yushin-Maru-type sighting/sampling vessels. A total of 15 tags were deployed on sei whales, of these eight tags transmitted the locations and movement of the whales. Two sei whales were tracked for more than 35 days, and these two whales showed a longitudinal movement. In general, the tagging experiment of penetrate-type tags from sighting/sampling vessels seems to be practical. However, some technical improvements have been identified which could increase the tracking period.

Noting how tag data are valuable in documenting movement patterns which is an important aspect in this assessment, the sub-committee welcomed the results of the tagged North Pacific sei whales, and encouraged the placement of further, improved tags on future cruises throughout the North Pacific.

Attention SC, G:

The movement of the two tagged North Pacific sei whales presented at this meeting remained within the Pelagic sub-area. The sub-committee recommended that when feasible, any researcher working in the North Pacific tag sei whales in one or more of the other sub-areas to assist in quantifying the movement patterns of the animals.

3.2.4 Catch history

Based on the sub-areas agreed last year (IWC, 2018) during the intersessional period Cooke generated a catch series by sub-area and sex from 1907-2017. On the suggestion of Allison, the line between the Eastern Coastal and Eastern North Pacific sub-areas was moved from 50°N to 48°N so that the Canadian coastal catches that lacked position data could be assumed to have been taken within one sub-area, the Eastern North Pacific sub-area. The US coastal catches were assumed to have been taken in the Eastern Coastal sub-area. Of the Japanese coastal whaling catches for which position data were available, almost all sei whales were taken in the Western Coastal sub-area. Therefore, it was assumed that the Japanese coastal whaling catches without positions were also taken in the Western Coastal sub-area.

For those Japanese coastal catches that were not divided between sei and Bryde's whales, the sei/Bryde's split for the summary data followed Allison (2008). For those years and stations where the catches by sex were not divided into sei and Bryde's whales, the Bryde's whales catch by sex was estimated based on the average female proportion (44%) of Bryde's whales taken in the Western Coastal sub-area. This proportion showed little annual variation. The estimated Bryde's whale catches by sex were deducted from the combined catches by sex to yield estimates of sei whale catches by sex.

During this meeting the catch series was further revised to take account of the changes to sub-areas agreed at this meeting. The resulting catch series of sei whales by year, sub-area and sex, and the assumptions made to produce it, are given in Appendix 7.

The month is known for about 75% of the catch. Of the catch with known month, over 99% was taken in summer (May-October). Therefore, it was assumed for modelling purposes that all catches were taken in summer.

3.2.5 Life history parameters

The life history parameters of North Pacific sei whales were last reviewed by the Committee in 1974 (IWC, 1977). The age at sexual maturity (ASM) was estimated to be 10 year in the eastern North Pacific (Rice, 1977). Masaki (1976) estimated the mean age at sexual maturity of both sexes to have decreased with time from about 10 year prior to 1930 to 6 year (females) or 7.5 year (males) in the early 1960s. However, the latter estimates appear to have been based on transition layers without correction for the truncation effect in recent cohorts (IWC, 1984).

The 1974 assessment assumed a value of 0.06 for the natural mortality rate. However, this was based on estimates of total apparent mortality (Z) rates of 0.054 for males and 0.062 for females from catch curve analyses from the catches taken during 1967-1972, when the population could already have been impacted by exploitation, given catches of 35,000 sei whales prior to 1965.

There does not appear to be any more recent information on the age at maturity or mortality rate in North Pacific sei whales, despite the sampling of over 1,350 sei whales under JARPN II.

Taylor *et al.* (2007) estimated an age at first reproduction (AFR) of 9 year and an *M* value of 0.04 for sei whales based on inter-specific regressions. The sub-committee **agreed** to use an ASM of 8 year and an adult natural mortality rate of 0.04 for the in-depth assessment.

3.3 Assessment model

SC/67b/IA01 detailed the provisional model structure for North Pacific sei whales. This had been updated from last year to be able to accommodate the available data types (catches, estimates of absolute abundance, estimates of relative abundance, and mark-recapture data). Preliminary applications of the model based on 1-stock and 3-stock hypotheses indicated some conflicts between the catch and abundance data.

The main conflict arose in the Mixed sub-area, where the abundance was too small to enable all the catches to be taken. In discussion, it was noted that this problem was caused by treating the Mixed sub-area as a discrete feeding group. The sub-committee **agreed** that it should be treated as an area of overlap between multiple adjacent feeding groups, (potentially the Eastern North Pacific, Pelagic and Aleutian sub-areas) such that whaling in the Mixed sub-area could take whales from any of the overlapping feeding groups. This would make it less likely that the whalers would 'run out of whales'. Punt agreed to revise the model accordingly (see work plan in Item 5.1.2).

4. COMPREHENSIVE ASSESSMENT OF NORTH PACIFIC HUMPBACK WHALES

4.1 Progress on intersessional work

Work towards a Comprehensive Assessment of North Pacific humpback whales began in 2016, and included an intersessional workshop held in April 2017 (IWC, 2018). Following SC/67a, an intersessional steering group was formed to oversee additional work. Clapham presented the report of this group (SC/67b/IA03). The main tasks of the group were to prioritise stock structure hypotheses, facilitate further work on abundance estimates, and to prepare for a possible second workshop in 2018. Despite much discussion among members of the Steering Group, progress on these objectives was slow, in part because of uncertainty regarding stock structure hypotheses. Nonetheless, a way forward was agreed, details of which are given below. After consideration, the Steering Group concluded that insufficient progress had been made to justify holding a second workshop in 2018, and agreed that this meeting should be postponed.

4.2 Preparation of data for assessment

4.2.1 Stock structure hypotheses

The sub-committee **agreed** that simplified subdivisions of North Pacific humpback whale feeding habitats as proposed by the Steering Group were largely consistent with existing data, in particular with the results obtained by the SPLASH project. These subdivisions (areas for allocation of catches) are illustrated in Fig. 1 and include (from west to east): (1) the western Bering Sea and Aleutian Islands; (2) the eastern Bering Sea, Aleutian Islands and western Gulf of Alaska; (3) the Central Gulf of Alaska (including Prince William Sound); (4) southeast Alaska and northern British Columbia; (5) southern British Columbia and Washington State; and (6) California and Oregon. There remains an open question of whether area (1) above should include the Commander Islands.

With regard to breeding areas, the sub-committee **agreed** that sub-division of some of the breeding areas used in a former population assessment model (Ivashchenko *et al.*, 2016) was warranted, and the following approach was proposed:

(1) Mexico' should be divided into three distinct sub-areas: the Revillagigedo Archipelago, the Mexican mainland, and Baja California. The former two areas are considered breeding areas and Baja California a migratory route.
(2) The 'Asia' breeding area, which formerly encompassed the Philippines, Okinawa and Ogasawara should be sub-divided into two sub-areas: Okinawa with the Philippines (referred to as OK+PH), and Ogasawara. The latter is now considered a migratory corridor for whales wintering off Asia (but see below).

Four potential modeling scenarios were proposed, and these are illustrated in annex 1 of SC/67b/IA03. The potential usefulness of including an 'unknown' breeding area (which included the Marianas Islands) in at least a few modeling scenarios was also discussed. While there may be difficulties associated with the estimation of model parameters, this idea

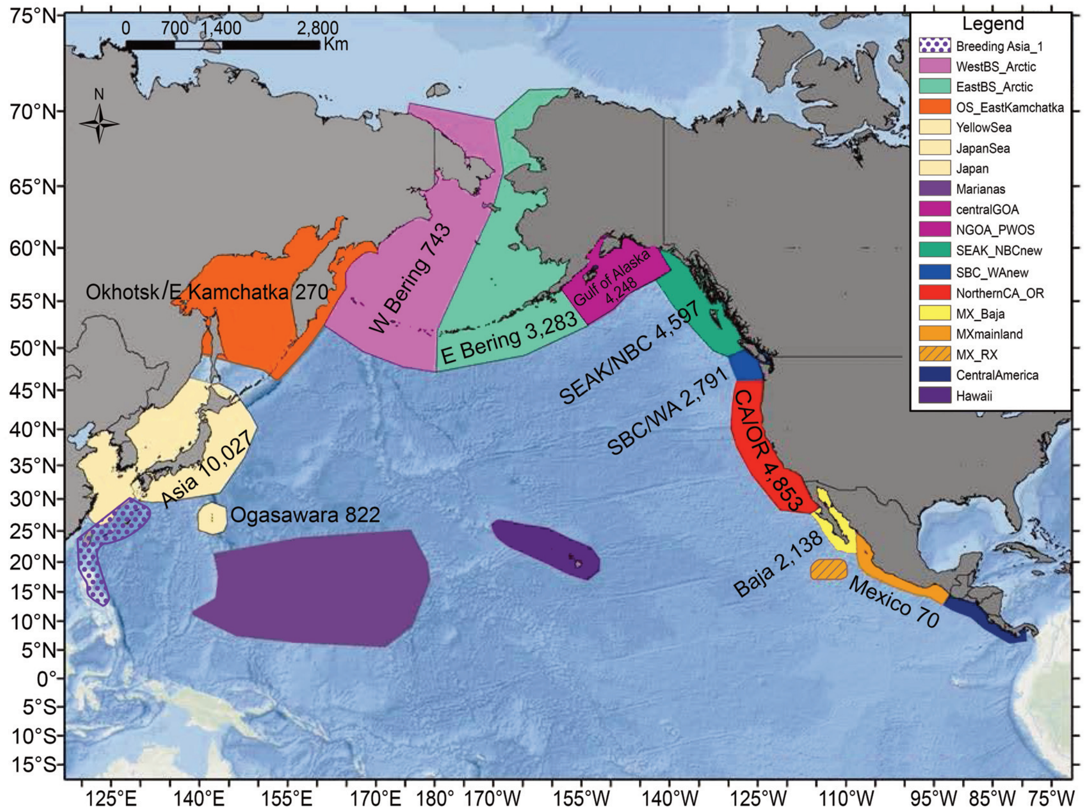

Fig. 1. Stock structure hypothesis scenario 1 that includes 7 feeding and 6 breeding areas (including the 'unknown' breeding area, which includes the Mariana Islands. Note that Japan, Ogasawara (in the west) and Baja California (in the east) are considered migratory routes. Catch numbers are shown.

should be explored further. If the Marianas are included (as part of the 'unknown breeding area') as a breeding ground in the model, consideration should be given to the allocation of catches from Ogasawara to both Asia and to the 'unknown' breeding area.

In addition to Baja California and Ogasawara, the proposed simplified stock structure considers Japan and the Kuril Islands as a migratory corridor that would be associated with the Asian breeding area.

The sub-committee **agreed** that it would be useful to analyse humpback photo-ids taken after the SPLASH project, particularly in some key areas, to help clarify the connections among them. The primary areas of interest include the Philippines, Japan, Russia, the Bering Sea, the Aleutian Islands, the Gulf of Alaska, and Mexico. This analysis involves a large-scale matching effort to collect and compare photo-id data from selected areas of the North Pacific, including those for which the SPLASH sample size was relatively low. If approved by the various catalogue holders involved (some of whom had already expressed tentative interest), the photo-id comparisons would be accomplished using the largely automated *Happywhale* system managed by Ted Cheeseman and discussed in the Working Group on Photo-Identification (see Cheeseman *et al.*, 2017; SC/67b/PH05).

Attention: SC; CG-R, G

*The sub-committee **recommended** that a large-scale matching effort of recent Pacific humpback whale photo-ids taken after SPLASH be conducted to help clarify the connections among the feeding/breeding areas within the North Pacific. In additions, analyses of these matches might also be used to derive new abundance estimates, subject to consideration of potential biases and differential survey effort. To obtain the most robust assessment and thus conservation advice, the sub-committee **encouraged** all catalogue holders to participate in this exercise, after the appropriate data sharing agreements are made.*

4.2.2 Abundance and trends

Previously planned intersessional work to re-compute abundance estimates was not completed and must now be undertaken in the period prior to SC/68a. It was noted that estimates for local areas in Japan might be available by next year. The sub-committee **encouraged** pursuit of these estimates, but the utility of these relative to areas proposed for the models would need to be assessed. Kato stated his belief that the humpback population was expanding and may be recolonising former migratory areas in Japan, notably Okinawa.

Preliminary estimates of humpback whale abundance developed from the IWC-POWER cruise were now available (SC/67b/NH04). The sub-committee **welcomed** these estimates, but noted that they would need to be recomputed relative to the areas proposed for the assessment model, if they are to be used.

4.2.3 Catch history

Catches have been assigned to the four scenarios described above, but may need to be adjusted if additional information requires changing the proposed feeding/breeding areas. Consideration should be given to the time period used in the assessment, and specifically whether historical catches before the modern era should be included.

The sub-committee **agreed** that it was probably unnecessary to consider a factor for struck and lost animals given the efficiency of modern whaling, and the uncertainties regarding incomplete catch series in earlier periods.

4.2.4 Life history parameters
There was no new information on life history parameters, and the model to be used in the assessment does not require age structure. If required for other analyses, the life history parameters summarised in Zerbini *et al.* (2010) may be utilised.

4.3 Assessment model
As previously, the sub-committee **agreed** that a simplified age-aggregated model should be used for the assessment. The model requires abundance estimates for both breeding and feeding areas as well as information on linkages between areas. Sensitivities to be explored include allocating the Commander Islands to either the western or eastern Bering Sea feeding areas (due to uncertainty about the migratory destinations of these whales); and modelling 'Asia' and 'Mexico' as previously defined in Ivashchenko *et al.* (2016).

5. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

5.1 Work plan

5.1.1 In-depth assessment of Indo-Pacific Antarctic minke whales
To ensure the submitted paper that synthesises this in-depth assessment is published, the sub-committee **agreed** that the work plan (Table 1) is to re-establish the steering group convened by Murase (Table 2) to complete the journal's review process and further any needed work to ensure the paper is published. No funds related to this assessment are being requested.

5.1.2 In-depth assessment of North Pacific sei whales
In light of the intersessional work and further progress made during this meeting, the following work plan was **agreed**.

Table 1
Work plan for IA.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting (SC/68b)
In-depth Assessment of Indo-Pacific Antarctic minke whales	Complete review of paper submitted for publication	-	-	-
In-depth Assessment of North Pacific sei whales	Re-establish the ISG (Table 2) to further data preparation and development of the assessment model	Review progress of intersessional work and continue the assessment	Finalise /continue preparation of assessment	Review progress of intersessional work and finalise the assessment
Comprehensive Assessment of North Pacific humpback whales	Re-establish the ISG (Table 2) to further data preparation, development of the assessment model and hold a Workshop	Review progress of intersessional work and continue the assessment	Finalise /continue preparation of assessment	Review progress of intersessional work and continue/finalise the assessment

Table 2
Intersessional e-mail groups for IA (see Annex Y for final list).

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 5.1.1 IA	ICG-1	Antarctic minke whale publication	Continue editing the submitted paper that summarises the In-depth Assessment of the Indo-Pacific Antarctic minke whale to assist in publishing the paper.	Murase (Convenor), Donovan, Kato, Kitakado, Matsuoka, Palka, Pastene, Punt, Suydam. *antminkeass@dist.iwc.int*
Item 5.1.2 IA	SG-1	North Pacific sei whales	Continue progress on developing the in-depth assessment including: (i) Finalise and document the data inputs for the assessment. (ii) Modify the assessment model to incorporate the issues identified. (iii) Conduct runs of the assessment using the updated data and modified model. (iv) Review results of initial runs and specify alternative assumptions if required. (v) Report to next year's meeting on the input data, final model specifications and results.	Cooke (Convenor), Allison, Hakamada, Kitakato, Matsuoka, Mizroch, Palka, Punt, Yoshida. *npseiass@dist.iwc.int*
Item 5.1.3 IA	SG-2	North Pacific humpback whales	Further the preparations for the North Pacific humpback whale comprehensive assessment by: (i) Assess the feasibility of conducting mixed-stock analysis in the feeding grounds. (ii) Re-compute abundance and interchange rate estimates for North Pacific humpback whales for the various stock structure hypotheses agreed above. (iii) Revise the assessment model according to the stock structure hypotheses described above. (iv) Provide a 'dummy' file with input parameters for further model development and collate other information required for the assessment model. (v) Approach photo-id catalogue holders from key areas and conduct a large-scale matching effort to collect and compare photo-id data from selected areas of the North Pacific.	Clapham (Convenor) Baker, Calambokidis, Donovan, Kato, Kitakado, Ivashchenko, Matsuoka, Punt, Zerbini, Urban, Wade and Yoshida *npha@dist.iwc.int*

(i) Finalise and fully document the data inputs for the assessment, including revise the absolute abundance estimates by the revised sub-areas.
(ii) Modify the assessment model structure to incorporate the issues identified, including modify the likelihood to accommodate both minimum and zero estimates of abundance, use winter marks, and treat the Mixed sub-area as an area of overlap not a discrete feeding area.
(iii) Conduct runs of the assessment using the updated data and modified model.
(iv) Review results of initial runs and specify alternative assumptions if required. and
(v) Report to next year's meeting on the input data, final model specifications and results.

To oversee this work plan the sub-committee **agreed** to re-establish the intersessional steering group convened by Cooke (Table 2). It is expected that this work will be completed by the 2020 Committee meeting, if not by the 2019 meeting.

5.1.3 Comprehensive assessment of North Pacific humpback whales
In light of the conclusions regarding stock structure, the following work plan was **agreed** (Table 1):

(i) S. Baker will assess the feasibility of conducting mixed-stock analysis in the feeding grounds to better inform the allocation of catches for the assessment model.
(ii) Wade will re-compute abundance and interchange rate estimates for North Pacific humpback whales using the model described in Wade *et al.* (2016) for the various stock structure hypotheses agreed above.
(iii) Punt will revise the assessment model according to the stock structure hypotheses described above.
(iv) Ivashchenko and Zerbini will provide a 'dummy' file with input parameters to Punt for further model development. They will also collate other information required for the assessment model (in addition to the ones provided by Wade's model), which would be provided to Punt when all information needed for model runs becomes available.
(v) Photo-id catalogue holders from key areas will be approached with a view to conducting an update of SPLASH photo matching, in order to provide new information with which to refine existing stock structure hypotheses.

To oversee this work plan the sub-committee **agreed** to re-establish an intersessional steering group under Clapham (Table 2). To ensure progress of this Comprehensive Assessment, the sub-committee **agreed** that an intersessional workshop was necessary after the intersessional Steering Group decides sufficient progress has been made. Depending upon progress on this work, the intersessional steering group will determine the timing of the intersessional workshop which will be prior to SC/68b.

5.2 Budget request for 2019-20
To ensure progress of the in-depth assessment of North Pacific sei whales, the sub-committee **agreed** to request funds for Punt to modify the assessment model, run the modified model with the updated input data, and produce a report with a description of the model and results (Table 3).

To ensure progress of the Comprehensive Assessment of North Pacific humpback whales, the sub-committee **agreed** to request funds for an intersessional workshop and funds to modify the assessment model, run the modified model with the updated input data, and produce a report with a description of the model and results (Table 3). Details of work to be completed prior to this workshop are in Item 5.1.3.

6. ADOPTION OF REPORT
The report was adopted at 14:17 on 2 May 2018.

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Table 3

Summary of the 2-year budget request for IA.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
1	Intersessional workshop to progress Comprehensive Assessment of North Pacific Humpback Whales (probably in 2019 but might be in 2020)	8000	0
Modelling/Computing			
1	Modelling for the Comprehensive Assessment of the North Pacific humpback whale	3040	0
2	Modelling for the In-depth Assessment of the North Pacific sei whale	0	5000
Total request		**11040**	**5000**

Taylor, B.L., Chivers, S.J., Larese, J. and Perrin, W.F. 2007. Generation length and percent mature estimates for IUCN assessments of cetaceans. 24pp. US NMFS Administrative Report LJ-07-01, Southwest Fisheries Science Center, La Jolla, CA, USA.
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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
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 and trends
     - 3.2.3 Marking data
     - 3.2.4 Catch history
     - 3.2.5 Life history parameters
   - 3.3 Assessment model
4. Comprehensive 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 and trends
     - 4.2.3 Catch history
     - 4.2.4 Life history parameters
   - 4.3 Assessment model
5. Work plan and budget requests for 2019-2020
   - 5.1 Work plan
     - 5.1.1 In-depth assessment of Indo-Pacific Antarctic minke whales
     - 5.1.2 In-depth assessment of North Pacific sei whales
     - 5.1.3 Comprehensive assessment of North Pacific humpback whales
   - 5.2 Budget request for 2019-2020
6. Adoption of report

Appendix 2

LINES FOR DIVIDING DATA INTO SUB-AREAS FOR IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

S. Mizroch and J. Cooke

At the 2015 Committee meeting, it was agreed to proceed with the in-depth assessment of North Pacific sei whales with two alternative stock structure hypotheses (IWC, 2016). The available genetics, mark recovery, sightings, and seasonality evidence for both stock structure hypotheses was summarised in Appendix 4 of Annex G (IWC, 2016). At that time, the Committee was not in a position to specify precise sub-areas for the 5-stock hypothesis.

At the 2016 Committee meeting, with a view to facilitate the assignment of catches and abundance data to stocks, developed tentative simplified sub-areas for the five-stock hypothesis, as shown in Appendix 4 of Annex G (IWC, 2017) and reproduced here as Fig. 1.

At the 2017 Committee meeting, it was tentatively agreed to use the sub-areas in Appendix 2 of Annex F (IWC, 2018), also shown here in Fig. 2, for compiling catch and abundance data for use in the assessment model. It was also agreed that the intersessional correspondence group could modify them, if necessary to facilitate allocation of sightings and other data to the sub-areas. In addition, during 2017 the 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.

Meeting after adoption of the 2017 sub-committee report, the intersessional correspondence group modified the sub-areas to facilitate the assignment of the absolute abundance estimates from the POWER cruises, which used the EEZ as its definition of the survey blocks. The differences between the straight line definitions as defined in 2017 and the EEZ lines are shown in Fig. 3 (from SC/67b/IA01).

At the 2018 sub-committee meeting, it was noted that the revised lines did not respect the original oceanographic motivations for the sub-areas. To return to the original motivations and still facilitate the extraction of data by sub-area two decisions were made. One, the line between the Eastern Coastal and Eastern North Pacific sub-areas was shifted south from 50°N (as suggested in 2017) to 48°N to facilitate the allocation of Canadian catches (Fig. 3). And two, the line between the Pelagic and Western Coastal sub-areas was shifted westward to respect the original oceanographic motivation (Fig. 4).

The resulting sub-areas are shown in Fig. 5. And will be used to divide the data for this assessment. They do not represent agreed stock boundaries.

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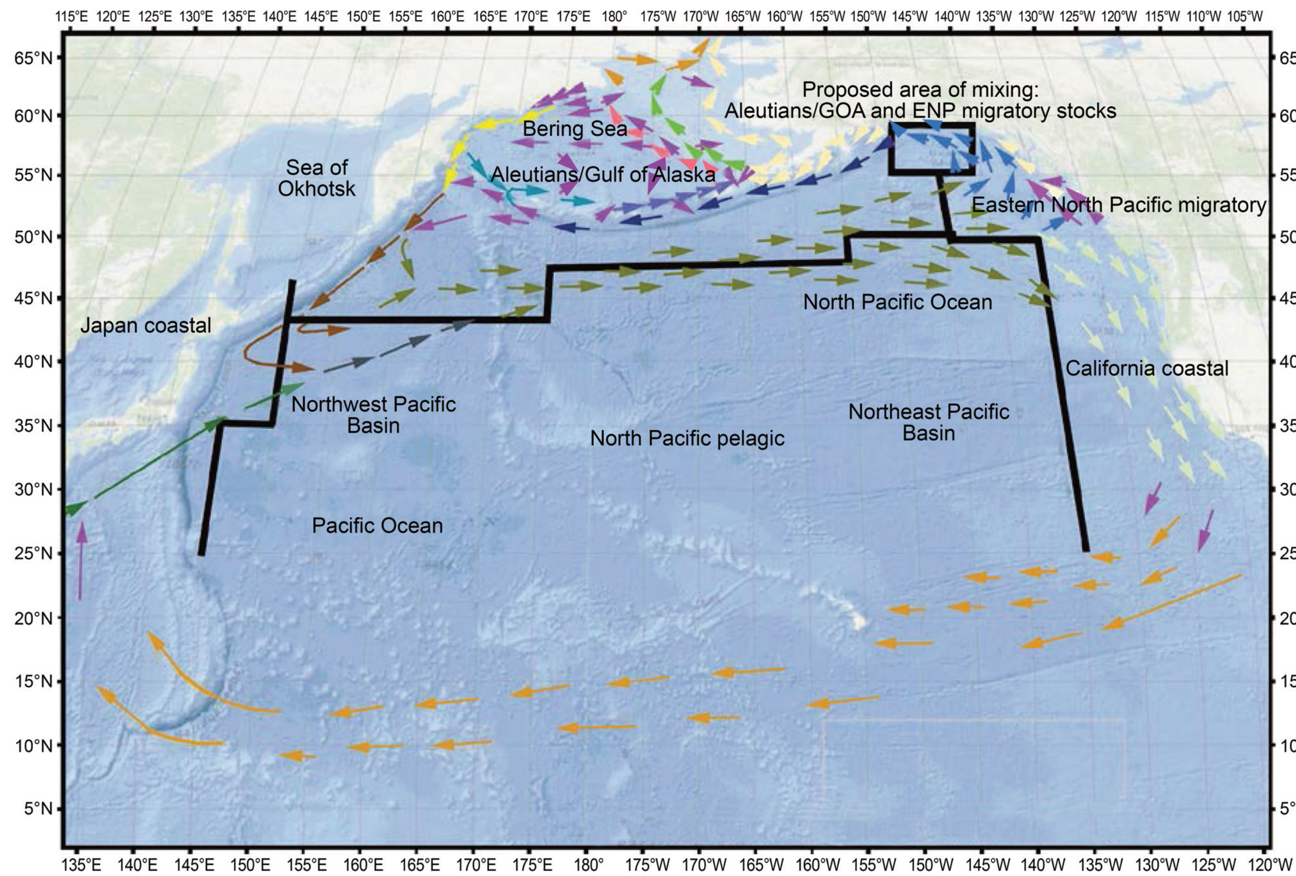

Fig. 1. From the 2016 Committee meeting, the tentative lines for dividing data into sub-areas.

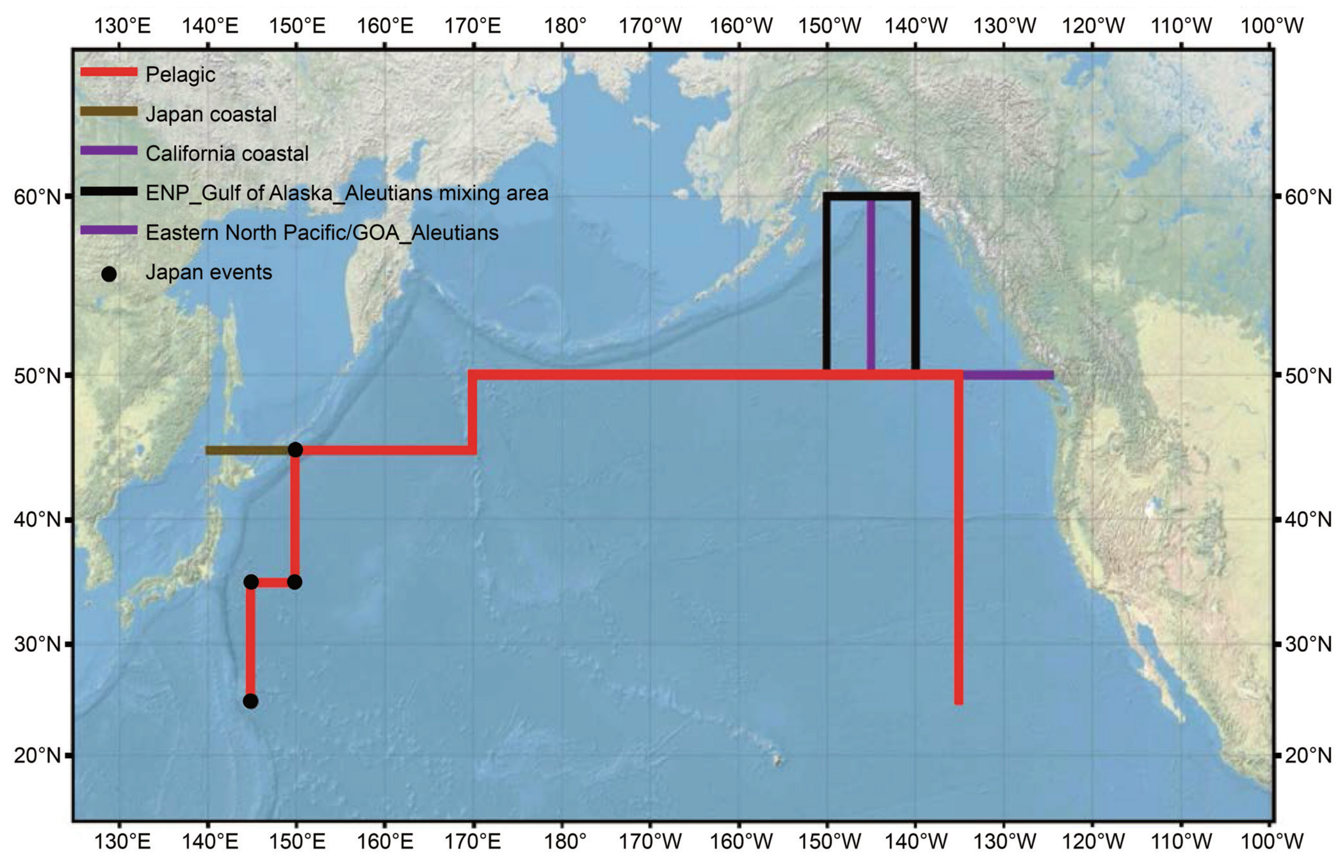

Fig. 2. From the 2017 Committee meeting, the tentative lines for dividing data into sub-areas.

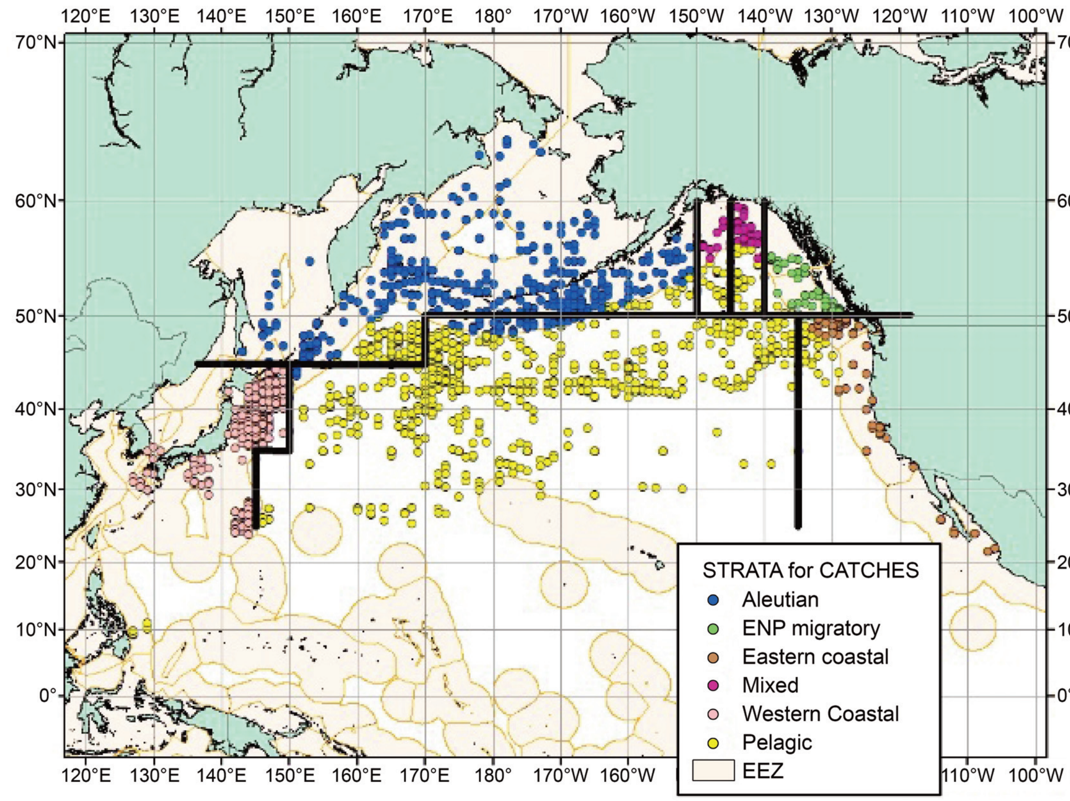

Fig. 3. From the 2017 Committee meeting, the tentative lines (solid bold black lines) and the EEZs (shaded and outlined in yellow) as suggested by the intersessional correspondence group used to divide catches (colored dots).

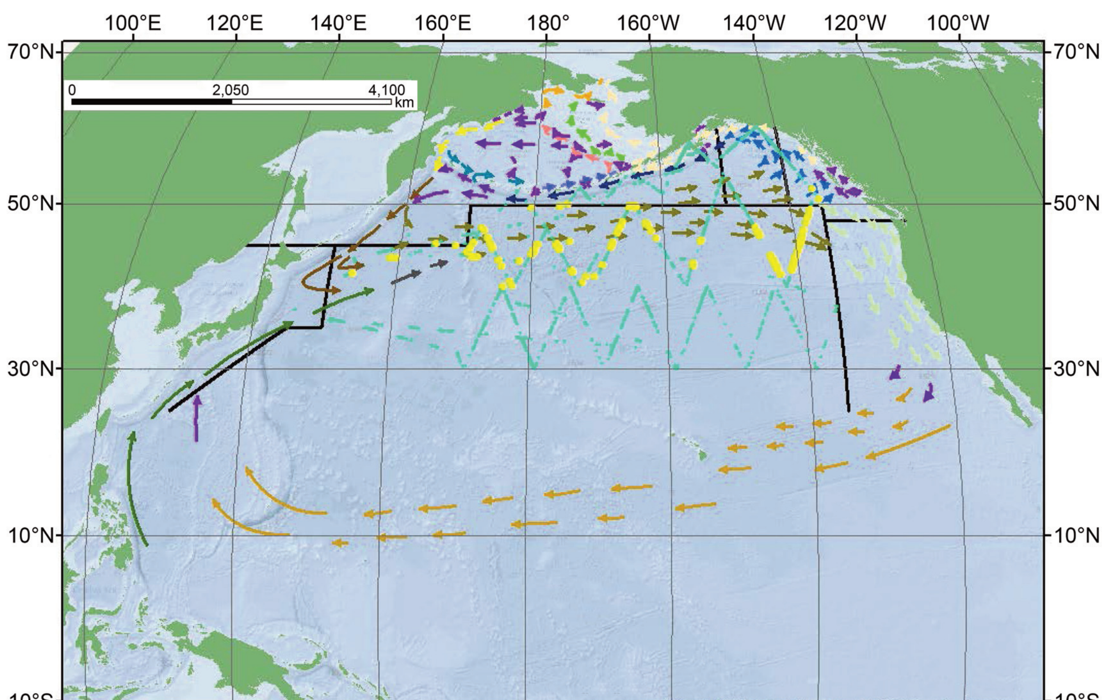

Fig. 4. Oceanographic features (colored arrows) and IWC-POWER cruise Bryde's sightings (yellow dots) and track lines (green lines) overlaying the 2018 lines (black lines) for dividing data into sub-areas.

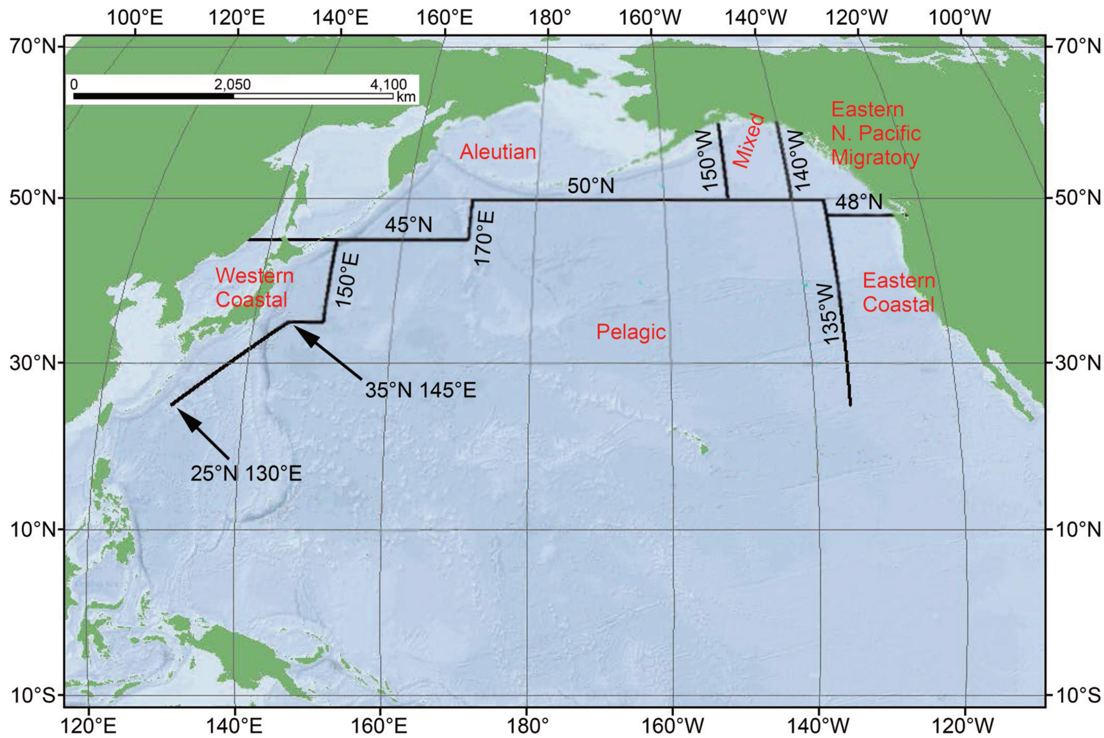

Fig. 5. Lines (black lines) for dividing data into sub-areas for the in-depth assessment of North Pacific sei whales. Red words indicate name of the sub-areas. Numbers indicate locations of the lines.

Appendix 3

MIXING MATRICES BETWEEN SUB-AREAS UNDER THE TWO STOCK STRUCTURE HYPOTHESES

One of pieces of data needed in the in-depth assessment of the North Pacific sei whale is, for each stock structure hypothesis, a 'mixing matrix'. A mixing matrix is a representation of how the animals move between the sub-areas (defined in Appendix 2). The assessment model will model the various types of input data (catches, marking/recoveries, and abundance estimates) to estimate the magnitude of movement that is supported by the data.

Under the 1-stock hypothesis, it is assumed sei whales can move between and within all of the sub-areas (Table 1; Fig. 1).

Under the 5-stock hypothesis, not all putative stocks move between all sub-areas (Table 2; Fig. 2). Thus, a '0' in Table 2 indicates which sub-areas it is assumed that particular stock does not utilise (Table 2). The coloured arrows in Fig. 2 indicate the sub-areas that the stocks in Table 2 move within and between.

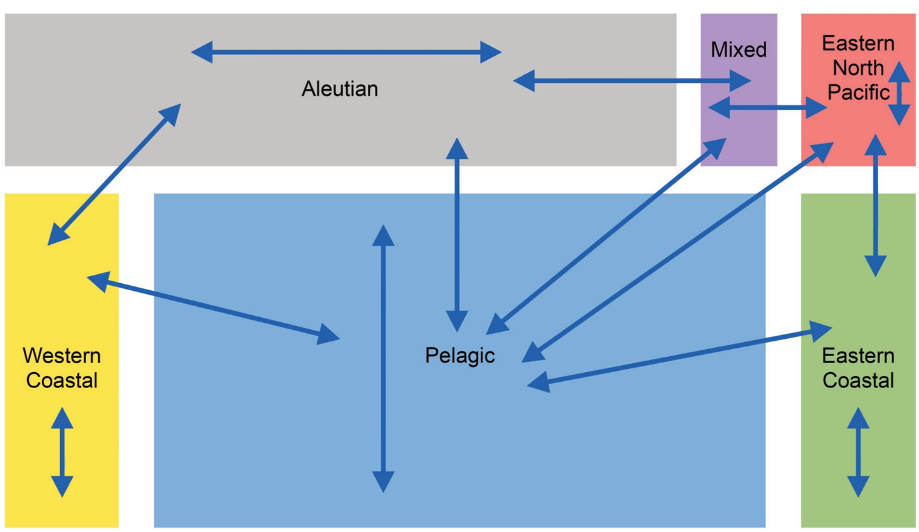

Fig. 1. Schematic representing the mixing matrix for the 1-stock structure hypothesis. Each box represents a sub-area and the arrows represent movements between two sub-areas or within a sub-area.

Table 1

Mixing matrix for the 1-stock hypothesis indicating which sub-areas the proposed stock utilises.

	Sub-areas					
Stocks	Western Coastal	Aleutians	Pelagic	Mixed	Eastern North Pacific	Eastern Coastal
Stock A	γ	γ	1	γ	γ	γ

γ = mixing

Table 2

Mixing matrix for the 5-stock hypothesis indicating which sub-areas the proposed stocks utilise.

	Sub-areas					
Stocks	Western Coastal	Aleutians	Pelagic	Mixed	Eastern North Pacific	Eastern Coastal
Stock A	1	0	0	0	0	0
Stock B	γ	1	0	γ	0	0
Stock C	γ	γ	1	γ	γ	γ
Stock D	0	0	0	γ	1	γ
Stock E	0	0	0	0	0	1

γ = mixing

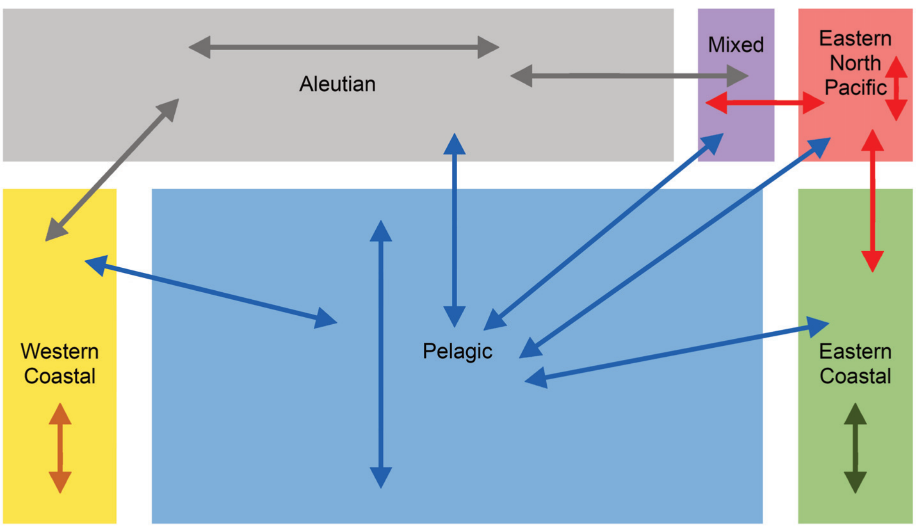

Fig. 2. Schematic representing the mixing matrix for the 5-stock structure hypothesis. Each box represents a sub-area and the arrows represent movements between two sub-areas or within a sub-area. Different coloured arrows represents different stocks as defined in Table 2.

Appendix 4

ANALYSIS OF NORTH PACIFIC SEI WHALE SUMMER DENSITY 1965-2015 FROM JAPANESE SCOUTING AND RESEARCH VESSEL SIGHTINGS

J.G. Cooke

Sightings and effort by Japanese scouting and research vessels in the North Pacific in summer, summarised by 10° square were taken from the following sources:

- seasons 1965-79: Published by Wada in *Rep. int. Whal. Commn* (1975-81).
- seasons 1980-96: Progress Reports Japan published in *Rep. int. Whal. Commn* (1982-98)
- seasons 1997-99: Progress Reports Japan, unpublished SC documents
- seasons 2000-05: Progress Reports Japan, published on-line (*http://iwc.int/scprogress*)
- seasons 2006-15: Supplied by T. Miyashita (by e-mail 24 July 2017).

The sightings of sei whales (animals) and effort (nm of track) are summarised in Table 1. All sightings of sei whales were in series M, N and P (30°-60°N) except for 42 whales in series L (20°-30°N) but the latter were in the early years (up to 1975) and may have been Bryde's whales. There were no sightings on the Okhotsk Sea (OS) or Sea of Japan (JS). This analysis used sei whale sightings and effort in series M, N and P in the North Pacific and Bering Sea, making a total of 7,301 sei whales for 1,167,517nm of track.

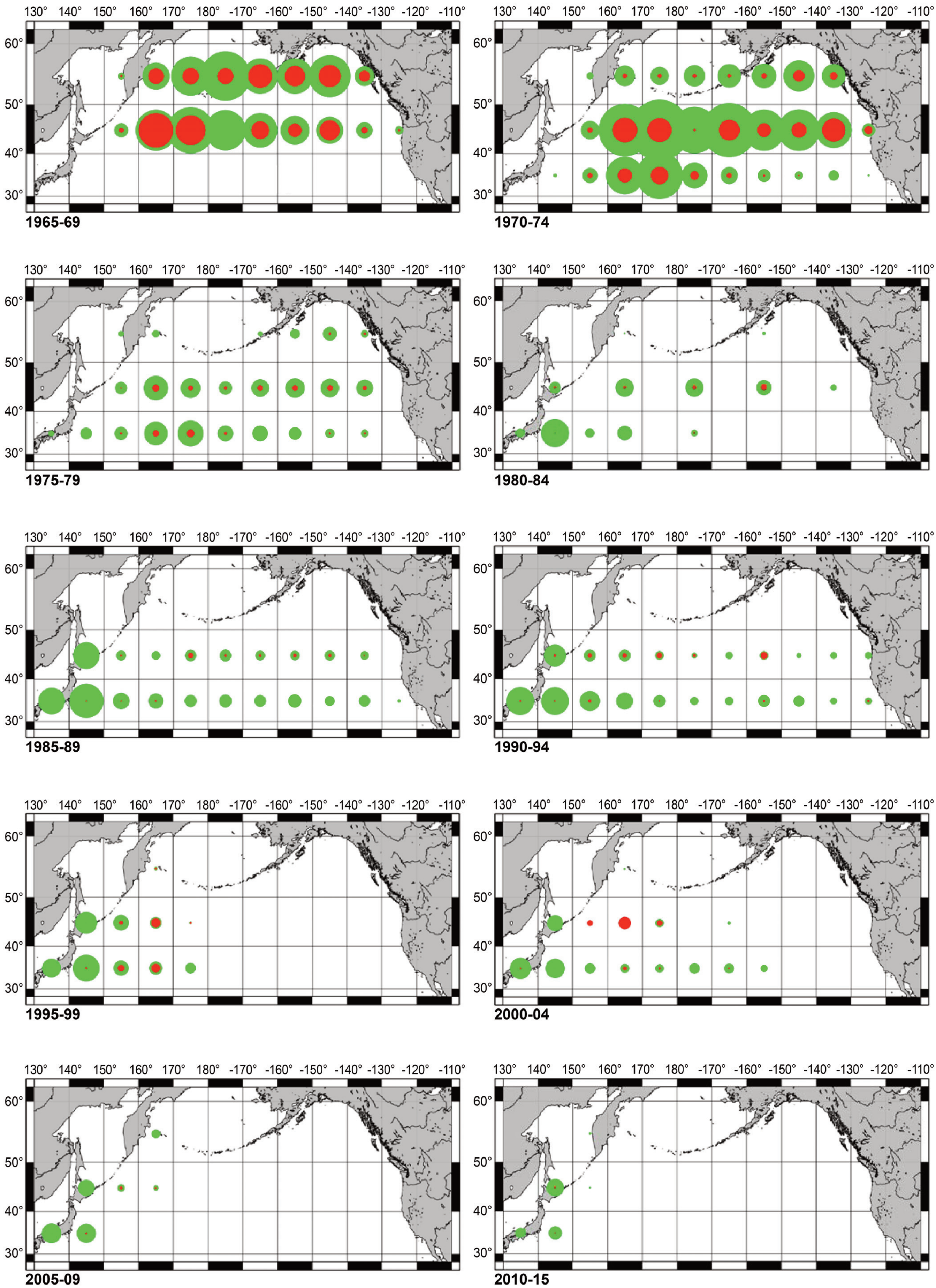

Fig. 1. Distribution of survey effort (nm of track) and sei whale sightings (animals counted) by 10° square by period. The areas of the green circles are proportional to survey effort. The areas of the red circles are proportional to sei whale counts.

Table 1
Summary of effort and sei whale sightings.

Series	Sea	Track (nm)	Sei
J	NP	7,630	0
K	NP	24,608	0
L	NP	92,043	42
L	ECS/NP	16,042	0
M	NP	323,355	665
M	ECS	10,252	0
N	NP	597,189	4,699
N	JS	14,909	0
N	OS	3,065	0
P	NP	183,107	1,838
P	OS	12,669	0
P	BS	63,866	99
Q	OS	240	0
Q	BS	832	0

Table 2
Assignment of 10° squares to nominal stock areas.

Series	Squares	Stock
M	20-21	W.Coastal
M	22-28	Pelagic
M	29-31	E. Coastal
N	21	W.Coastal
N	22-28	Pelagic
N	29-30	E. Coastal
P	22-27	Aleutian
P	28	Mixed
P	29-30	ENP

The nominal stock areas are defined in IWC (2018). Each 10° square was assigned to the nominal stock area with the largest area of overlap with that square (Table 2). The distribution of effort and sightings by period is summarised visually in Figs 1a-j.

The years of data were divided into 10 five-year periods, except that the last period (2010-15) was six years. The fitted model was log-linear with number of sei whale sightings as a negative binomial NB(p,k) dependent variable with constant k and with the offset log(Effort) where Effort is measured in nm of track. The models fitted with their AIC are listed in Table 3. All terms except the intercept were included as random effects. Further terms did not improve the fit. The best-fitting model was model D.

The Abundance Index for each square in a period is the fitted encounter rate for that square multiplied by the area of that square. The Abundance Index represents a relative index of sei whale abundance scaled to a nominal track half-width of 1nm. The calculated Abundance Indices are given in Table 4 by period, summed by nominal stock area and in total. The covariances (expressed as correlations) between Abundance Indices are given in Table 5. All period/sub-area combinations were used in the analysis, but only those period/sub-area combinations with more than 500nm of track were included in the results.

REFERENCE

International Whaling Commission 2018. Report of the Scientific Committee, Annex F: Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 19:174-82.

Table 3
Results of fitting various models.

Case	LogLike	DF	AIC	Model
A	-1550.05	26.15	3152.40	Const + Series*Square
B	-1490.62	53.13	3087.51	Case A + Year
C	-1406.30	108.50	3029.60	Case B + Series*Square*Period
D	-1220.19	260.18	2960.73	Case C + Series*Square*Year

Table 4
Fitted Indices of Abundance (IA) by subarea and period.

Index	Period	SubArea	IA	CV
1	1965-69	Alt	20,295	0.104
2	1965-69	EC	7,204	0.315
3	1965-69	ENP	2,458	0.306
4	1965-69	Mixed	5,054	0.220
5	1965-69	Pel	63,054	0.127
6	1970-74	Alt	3,962	0.169
7	1970-74	EC	8,865	0.229
8	1970-74	ENP	873	0.342
9	1970-74	Mixed	1,340	0.289
10	1970-74	Pel	34,384	0.098
11	1975-79	Alt	3,269	0.336
12	1975-79	EC	4,192	0.315
13	1975-79	ENP	1,083	0.592
14	1975-79	Mixed	729	0.496
15	1975-79	Pel	20,589	0.113
16	1975-79	WC	129	0.593
17	1980-84	EC	3,107	0.439
18	1980-84	Pel	17,178	0.206
19	1980-84	WC	283	0.445
20	1985-89	EC	2,610	0.499
21	1985-89	Pel	16,687	0.211
22	1985-89	WC	71	0.546
23	1990-94	EC	3,119	0.452
24	1990-94	Pel	26,832	0.210
25	1990-94	WC	152	0.449
26	1995-99	Pel	44,470	0.201
27	1995-99	WC	138	0.536

Table 5 - Correlations between Abundance Indices.

	Period	SubArea	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1965-69	Alt	1.000																
2	1965-69	EC	0.048	1.000															
3	1965-69	ENP	0.022	0.017	1.000														
4	1965-69	Mixed	0.016	0.005	0.008	1.000													
5	1965-69	Pel	0.048	0.103	0.010	0.008	1.000												
6	1970-74	Alt	0.042	0.025	0.003	0.002	-0.002	1.000											
7	1970-74	EC	0.024	0.315	0.004	0.005	0.013	0.057	1.000										
8	1970-74	ENP	-0.000	0.001	0.043	-0.001	-0.004	0.018	0.008	1.000									
9	1970-74	Mixed	0.009	-0.001	0.002	0.017	0.003	0.010	0.011	0.001	1.000								
10	1970-74	Pel	0.021	0.011	0.002	0.005	0.060	0.025	0.059	0.006	0.011	1.000							
11	1975-79	Alt	0.056	0.006	-0.000	-0.001	-0.024	0.189	0.012	0.002	-0.001	-0.027	1.000						
12	1975-79	EC	0.020	0.491	0.004	0.001	0.007	0.040	0.343	0.003	0.001	-0.001	0.176	1.000					
13	1975-79	ENP	0.006	-0.001	0.087	0.001	-0.004	0.007	0.002	0.065	0.001	-0.005	0.066	0.042	1.000				
14	1975-79	Mixed	0.001	-0.001		0.031	-0.006	0.005	0.000	0.001	0.042	-0.007	0.061	0.045	0.023	1.000			
15	1975-79	Pel	0.014	0.009	0.003	0.003	0.037	0.008	0.008	-0.000	0.002	0.038	0.107	0.078	0.040	0.040	1.000		
16	1975-79	WC	0.005	0.006	-0.001	-0.001	-0.003	0.013	0.006	-0.001	-0.001	-0.002	0.106	0.073	0.021	0.018	0.042	1.000	
17	1980-84	EC	0.023	0.528	0.007	0.002	0.014	0.048	0.355	0.006	0.003	0.003	0.058	0.579	0.011	0.010	0.012	-0.008	1.000
18	1980-84	Pel	0.018	0.029	0.004	0.003	0.077	0.027	0.014	0.003	0.002	0.059	0.029	0.025	0.006	0.005	0.067	-0.031	0.316
19	1980-84	WC	0.012	0.007	0.003	0.003	0.007	0.009	0.008	0.001	0.003	0.006	0.008	0.007	0.002	0.001	0.004	0.103	0.053
20	1985-89	EC	0.017	0.389	0.005	0.002	0.009	0.035	0.262	0.004	0.002	0.001	0.044	0.428	0.008	0.007	0.009	-0.004	0.470
21	1985-89	Pel	0.015	0.018	0.004	0.003	0.045	0.014	0.011	0.001	0.003	0.034	0.015	0.015	0.004	0.002	0.036	-0.017	0.032
22	1985-89	WC	0.002	0.004	0.001	0.000	-0.001	0.009	0.002	0.001	0.000	-0.001	0.007	0.004	0.001	0.000	-0.002	0.134	-0.002
23	1990-94	EC	0.016	0.334	0.005	0.002	0.009	0.032	0.228	0.004	0.002	0.003	0.036	0.355	0.007	0.006	0.008	-0.004	0.393
24	1990-94	Pel	0.023	0.017	0.005	0.006	0.041	0.014	0.015	0.000	0.005	0.028	0.013	0.015	0.004	0.002	0.033	-0.012	0.026
25	1990-94	WC	0.005	0.001	0.002	0.001	0.002	0.009	0.001	0.001	0.001	0.001	0.008	0.000	0.001	0.001	-0.000	0.138	-0.006
26	1995-99	Pel	0.025	0.019	0.006	0.007	0.057	0.015	0.015	0.001	0.005	0.041	0.014	0.015	0.005	0.002	0.043	-0.019	0.033
27	1995-99	WC	0.004	0.007	0.001	0.001	0.002	0.008	0.005	0.001	0.001	0.001	0.006	0.007	0.001	0.000	0.001	0.120	0.003
28	2000-04	Pel	0.023	0.015	0.005	0.006	0.049	0.016	0.014	0.001	0.005	0.030	0.015	0.014	0.004	0.002	0.036	-0.011	0.029
29	2000-04	WC	0.004	0.010	0.001	0.000	0.002	0.012	0.006	0.001	0.001	0.001	0.010	0.009	0.001	0.001	0.001	0.161	0.004
30	2005-09	Alt	0.081	0.022	0.006	0.002	-0.008	0.212	0.018	0.007	0.003	-0.016	0.529	0.063	0.021	0.017	0.022	-0.009	0.090
31	2005-09	Pel	0.018	0.035	0.005	0.002	0.093	0.028	0.016	0.003	0.002	0.068	0.029	0.027	0.006	0.005	0.071	-0.029	0.062
32	2005-09	WC	0.006	0.007	0.002	0.001	0.005	0.007	0.005	0.001	0.001	0.004	0.005	0.006	0.001	0.000	0.002	0.105	0.003
33	2010-15	WC	0.007	0.011	0.002	0.001	0.006	0.013	0.007	0.001	0.001	0.006	0.011	0.010	0.001	0.001	0.003	0.155	0.006

Table 5 (Cont.) - Correlations between Abundance Indices.

	Period	SubArea	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
18	1980-84	Pel	1.000															
19	1980-84	WC	0.078	1.000														
20	1985-89	EC	0.035	0.002	1.000													
21	1985-89	Pel	0.147	-0.001	0.158	1.000												
22	1985-89	WC	-0.014	0.051	0.037	0.024	1.000											
23	1990-94	EC	0.035	0.002	0.292	0.020	-0.000	1.000										
24	1990-94	Pel	0.110	0.002	0.018	0.064	-0.005	0.140	1.000									
25	1990-94	WC	-0.010	0.060	-0.004	-0.006	0.079	0.037	0.047	1.000								
26	1995-99	Pel	0.186	0.002	0.021	0.090	-0.010	0.023	0.088	-0.006	1.000							
27	1995-99	WC	-0.005	0.045	0.002	-0.003	0.076	0.003	0.000	0.072	0.044	1.000						
28	2000-04	Pel	0.139	0.004	0.019	0.078	-0.004	0.020	0.078	-0.002	0.101	-0.000	1.000					
29	2000-04	WC	-0.007	0.064	0.003	-0.004	0.098	0.004	-0.001	0.096	-0.005	0.091	0.065	1.000				
30	2005-09	Alt	0.088	0.004	0.068	0.046	0.001	0.058	0.041	0.002	0.052	0.002	0.045	0.005	1.000			
31	2005-09	Pel	0.312	-0.002	0.040	0.152	-0.013	0.041	0.136	-0.008	0.198	-0.004	0.161	-0.004	0.480	1.000		
32	2005-09	WC	-0.002	0.038	0.002	-0.001	0.069	0.003	0.002	0.064	0.000	0.066	0.002	0.082	0.070	0.074	1.000	
33	2010-15	WC	0.001	0.059	0.005	0.001	0.098	0.005	0.003	0.093	0.001	0.092	0.005	0.117	0.007	0.004	0.085	1.000

Appendix 5

ABUNDANCE ESTIMATES FOR USE IN THE NORTH PACIFIC SEI WHALE IN-DEPTH ASSESSMENT

The surveys and abundance estimates considered for possible use in the North Pacific sei whale in-depth assessment are listed in Appendix 3 table 1 of last year's IA report (IWC, 2018). The estimates selected at this meeting for use in the assessment, with adjustments for the modified sub-area definitions, are listed in Table 1. The sub-area definitions are given in fig.5 of Appendix 2.

Notes (see IWC, 2018 for supporting information)

(1) There were no sei whale sightings in the Aleutians (Alt) sub-area on the IWC-POWER cruises during 2010-11 and 2017. The western part of Alt (W. of 170°E) was surveyed in 2005 (Miyashita, 2006) without sei whale sightings and treated as making a zero contribution to the abundance in Alt.

(2) The 2012 IWC-POWER cruise covered all the Mixed (Mix) sub-area and part of the Eastern North Pacific (ENP) sub-area. Sei whales were sighted in the ENP but not in Mix sub-areas. Canadian surveys in Mix (IWC 2018) did not venture far enough offshore to encounter sei whales, hence the near absence of sei whale sightings was not informative.

(3) The eastern and western parts of the Pelagic (Pel) sub-area were surveyed by IWC-POWER and JARPN II over a similar range of years, hence the estimates are added together to yield a total estimate for Pel. The abundance in Pel south of 40°N in summer was negligible (IWC 2018).

(4) The two Western Coastal (WC) estimates are considered independent estimates pertaining to different years. The coastal part of JARPN II resulted in zero sei whale sightings.

(5) The zero estimates are to be handled according to annotation 29 to the Revised Management Procedure (IWC, 2012, p.493, annotation 29): the required calculations will be performed intersessionally.

(6) A suitable approach for handling minimum estimates will be developed intersessionally.

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.

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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].

Table 1

Abundance estimates for use in the assessment.

Subarea	Surveys	Reference	Year span	Nominal year	Estimate	CV	Type	Notes
Alt	POWER	SC/66a/IA12, SC67b/IA12	2010-11, 2017	2011	0		Zero	1, 5
Mix	POWER	SC/66a/IA12	2012	2012	0		Zero	2, 5
ENP	POWER	SC/66a/IA12	2012	2012	195	0.754	Minimum	2, 6
Pel (E. of 170°E)	POWER	SC/66a/IA12	2010-12	2011	27,002	0.236		
Pel (W. of 170°E)	JARPNII	SC/F16/JR12	2008-12	2011	3,917	0.208		
Pel	Combined			2011	30,919	0.208	Best	3
WC	JARPNII	SC/J09/JR15	2002-07	2004	162	0.434	Best	4
WC	JARPNII	SC/F16/JR12	2008-12	2010	444	0.561	Best	4
EC	SWFSC	Barlow *et al*. 2016	2008-14	2011	519	0.400	Minimum	6

Appendix 6

REMAINING ISSUES TO RESOLVE WITH RESPECT TO THE SEI WHALE MARKING DATA SET

J.G. Cooke

The marking data set consists of 2,286 marks potentially placed in sei whales in the North Pacific, including 2,265 by Japanese programmes, 18 by US programmes and 3 Canadian. 163 marks were recovered. Not all of these will have been effectively placed, and, especially for marks placed prior to 1962, there is some doubt about the species identification. Some marks placed in 'sei' whales were recovered in fin whales or Bryde's whales, and some were recovered as 'sei' whales in operations whose catch reports did not distinguish between sei and Bryde's whales.

A high fraction of the marks placed were recorded as multiple markings of the same whale, with an average of 1.9 marks per whale. The placement verdict (e.g. hit/miss/possible hit) is not always recorded separately for each mark, and multiple marks were not always recovered together or in the same whale.

The intersessional group will need to choose a consistent method for treating data from supposedly multiply marked whales, taking into account the pattern of recoveries from multiple markings (all or some recovered; recovered in same or different whales). It will also need to estimate the effective number of marks placed, taking into account the relative recovery rates for marks with different placement verdicts, and for multiple and singly-placed marks.

Appendix 7

NORTH PACIFIC SEI WHALE CATCH SERIES

J.G. Cooke

The sub-area adopted at this meeting for the purpose of data division are specified in Appendix 2. The historic catches of sei whales contained in the IWC Catch Database (Allison, 2017) were allocated to sub-areas and divided by sex. Some assumptions had to be made for catches that lacked exact positions or sex information.

Among the coastal whaling catches for which there are individual position data, very few sei whales were taken in the Pelagic sub-area. Hence it is assumed that the coastal whaling sei catches without positions were taken in the coastal sub-area where the whaling station was located. Specifically, this was the Western Coastal sub-area for Japanese and Korean catches, the North Eastern Pacific Migratory sub-area for Canadian catches, and the Eastern Coastal sub-area for US catches.

Catches taken by pelagic whalers in Mexican waters were assumed to be Bryde's whales (Rice, 1974).

The sei/Bryde's whale split for Japanese coastal whaling summary data on catches followed Allison (2008). To obtain catch data by sex, it was also necessary to split the individual data by species. The individual data are divided by sex, but not always by species. From the 1940's to the 1960's, some of the 'sei' individual data include some Bryde's whales, and some of the Bryde's whale individual data includes sei whales. Almost all the mixed-species individual data are in the Western Coastal sub-area. For those years with individual data by species, the Bryde's whales taken in the Western Coastal sub-area were 44% female (*n*=6,543) without much annual variation. This sex ratio was used to subtract presumed catches of Bryde's whales by sex from the combined species catches by sex for those years where the individual data were not divided by species. A net total of 1,632 presumed Bryde's whales were subtracted from the individual data (Table 1).

The resulting sei whale catch series by sub-area, sex and year is shown in Table 1.

REFERENCES

Allison, C. 2008. Catch series for western North Pacific Bryde's whales. *J. Cetacean Res. Manage*. (*Suppl.*) 10:457-467.

Allison, C. 2017. The IWC Catch Database version 6.1; Date: May 2017.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific. pp.170-195 *In*: W.E. Schevill (Ed.) *The Whale Problem: A Status Report*. Harvard University Press, Cambridge, MA.

Table 1

Abundance estimates for use in the assessment.

	Western coastal		Aleutian		Mixing area		Northeastern		Eastern coastal		Pelagic		Total	Brydes
Year	M	F	M	F	M	F	M	F	M	F	M	F	M+F	adjustment*
1906	8	8	0	0	0	0	0	0	0	0	0	0	**16**	
1907	21	22	0	0	0	0	0	0	0	0	0	0	**43**	
1908	49	52	0	0	0	0	0	0	0	0	0	0	**101**	
1909	28	30	0	0	0	0	0	0	0	0	0	0	**58**	
1910	51	54	0	0	0	0	0	0	0	0	0	0	**105**	
1911	106	111	0	0	0	0	0	0	0	0	0	0	**217**	
1912	76	79	0	0	0	0	0	0	0	0	0	0	**155**	
1913	115	121	0	0	0	0	2	1	0	0	0	0	**239**	
1914	89	94	0	0	0	0	11	8	0	0	0	0	**202**	
1915	272	285	0	0	0	0	0	0	0	0	0	0	**557**	
1916	144	151	0	0	0	0	14	11	0	0	0	0	**320**	
1917	195	203	0	0	0	0	85	62	0	0	0	0	**545**	
1918	289	302	0	0	0	0	77	57	0	0	0	0	**725**	
1919	441	461	0	0	0	0	44	32	2	3	0	0	**983**	
1920	147	154	0	0	0	0	97	71	6	7	0	0	**482**	
1921	188	197	0	0	0	0	0	0	0	0	0	0	**385**	
1922	91	96	0	0	0	0	1	1	0	0	0	0	**189**	
1923	204	213	0	0	0	0	31	23	0	0	0	0	**471**	
1924	259	270	0	0	0	0	70	30	1	1	2	1	**634**	
1925	181	190	1	4	0	0	36	32			2	1	**447**	
1926	206	216	3	1	0	0	14	12	9	16	4	3	**484**	
1927	207	216	2	1	0	0	5	2	0	0	2	1	**436**	
1928	112	117	0	1	0	0	8	5	5	7	0	0	**255**	
1929	152	148	0	0	0	0	39	28	4	5	0	1	**377**	-40
1930	166	174	1	1	0	0	51	37	0	0	4	3	**437**	
1931	138	144	1	1	0	0	0	0	0	0	1	1	**286**	
1932	128	133	0	0	0	0	0	0	0	0	2	1	**264**	
1933	122	127	2	1	0	0	1	0	0	0	7	6	**266**	
1934	106	110	1	2	0	0	0	0	0	0	2	1	**222**	
1935	139	146	0	0	0	0	0	0	0	0	6	6	**297**	
1936	119	124	0	0	0	0	0	0	0	0	11	10	**264**	
1937	132	137	1	1	0	0	0	0	0	0	26	25	**322**	
1938	181	190	0	0	0	0	0	0	0	0	11	11	**393**	
1939	223	234	0	0	0	0	0	0	0	0	14	14	**485**	
1940	147	154	2	1	0	0	0	0	0	0	10	9	**323**	
1941	220	230	11	8	0	0	0	0	0	0	14	13	**496**	
1942	105	110	2	2	0	0	0	0	0	1	8	7	**235**	
1943	121	126	11	7	0	0	0	0	1	1	30	28	**325**	
1944	261	273	15	11	0	0	0	0	1	1	62	59	**683**	
1945	30	32	0	0	0	0	0	0	0	0	0	0	**62**	

Table 1 (Cont.)

Abundance estimates for use in the assessment.

	Western coastal		**Aleutian**		**Mixing area**		**Northeastern**		**Eastern coastal**		**Pelagic**		**Total**	Brydes
Year	M	F	M	F	M	F	M	F	M	F	M	F	**M+F**	adjustment*
1946	186	261	0	0	0	0	0	0	0	0	0	0	**447**	-95
1947	180	248	0	0	0	0	0	0	0	3	0	0	**431**	46
1948	247	259	23	16	0	0	1	1	0	0	0	0	**547**	-29
1949	340	336	49	32	0	0	2	1	0	0	0	0	**760**	-56
1950	106	163	38	20	0	0	10	14	0	0	0	0	**351**	-30
1951	200	192	33	32	0	0	5	0	0	0	2	1	**465**	-27
1952	238	348	143	72	0	0	17	5	0	0	0	0	**823**	-79
1953	285	239	114	96	0	0	2	12	0	0	0	0	**748**	-61
1954	307	264	160	109	0	0	74	60	0	0	4	4	**982**	-73
1955	169	223	112	60	0	0	84	55	0	0	4	1	**708**	-66
1956	409	346	134	101	0	0	12	25	0	0	0	0	**1,027**	-24
1957	196	237	141	140	0	0	36	57	0	1	20	11	**839**	-39
1958	207	315	271	332	0	0	15	24	1	1	35	47	**1,248**	-180
1959	586	449	125	127	0	0	116	69	10	27	2	2	**1,513**	-36
1960	188	193	234	130	0	0	0	0	19	28	17	23	**832**	-173
1961	292	309	80	29	0	1	0	0	24	27	8	1	**771**	-41
1962	360	364	312	243	18	18	211	128	5	18	80	64	**1,821**	-269
1963	319	324	73	62	324	268	309	126	34	63	276	262	**2,440**	-199
1964	395	404	614	388	279	175	409	294	4	9	330	310	**3,611**	-65
1965	264	182	595	438	188	122	390	287	7	15	351	349	**3,188**	
1966	70	155	599	464	560	328	179	187	22	38	597	500	**3,699**	-55
1967	202	284	1,150	740	13	5	34	55	2	1	1,431	1,129	**5,046**	-41
1968	403	404	1,257	791	78	37	0	0	5	9	1,070	900	**4,954**	
1969	227	220	850	416	0	0	0	0	4	6	1,562	1,499	**4,784**	
1970	222	254	326	288	32	20	187	132	23	19	1,196	1,117	**3,816**	
1971	126	132	269	212	9	5	35	27	51	33	849	983	**2,731**	
1972	117	85	63	57	9	6	0	0	1	1	962	1,010	**2,311**	
1973	20	11	13	8	4	4	0	0	9	11	938	838	**1,856**	
1974	16	22	35	43	2	5	18	20	16	32	528	543	**1,280**	
1975	16	12	0	0	1	1	2	1	5	13	236	221	**508**	
2001	1	0	0	0	0	0	0	0	0	0	0	0	**1**	
2002	0	0	0	1	0	0	0	0	0	0	16	23	**40**	
2003	3	2	0	0	0	0	0	0	0	0	20	25	**50**	
2004	0	0	15	13	0	0	0	0	0	0	32	40	**100**	
2005	0	0	1	0	0	0	0	0	0	0	50	49	**100**	
2006	2	3	0	0	0	0	0	0	0	0	47	49	**101**	
2007	5	1	0	0	0	0	0	0	0	0	49	45	**100**	
2008	0	0	3	3	0	0	0	0	0	0	41	53	**100**	
2009	0	0	0	0	0	0	0	0	0	0	47	54	**101**	
2010	5	5	0	0	0	0	0	0	0	0	38	52	**100**	
2011	0	0	13	3	0	0	0	0	0	0	42	38	**96**	
2012	0	0	0	0	0	0	0	0	0	0	44	56	**100**	
2013	0	0	6	3	0	0	0	0	0	0	38	53	**100**	
2014	0	0	0	0	0	0	0	0	0	0	38	52	**90**	
2015	0	1	0	0	0	0	0	0	0	0	29	61	**91**	
2016	0	0	0	0	0	0	0	0	0	0	38	52	**90**	
2017	0	0	0	0	0	0	0	0	0	0	63	71	**134**	
Total	12,878	13,481	7,904	5,511	1,517	995	2,734	1,992	271	397	11,348	10,789	**69,817**	-1,632

*Adjustment that had been made for individual catches deemed to be Bryde's whales.

Annex G

Report of the Sub-Committee on Northern Hemisphere Whale Stocks

Members: Brownell (Convenor), Al Harthi, Aoki, Archer, Atkinson, Baba, Baker, Bickham, Bjørge, Branch, Brandon, Brierley, Burkhardt, Buss, Cerchio, Cholewiak, Clapham, Collins, Cooke, Cubaynes, DeMaster, Diallo, Doniol-Valcroze, Double, Fortuna, Goto, Gunnlaugsson, Haug, Irvine, Ivashchenko, Johnson, Kato, Kim, H.W., Lang, Lundquist, Mallette, Matsuoka, Miyashita, Mizroch, Moronuki, Murase, Mwabili, Nakamura, Øien, Olson, Palka, Reeves, R., Robbins, Rodriguez-Fonseca, Scordino, Scott, Simmonds, Širović, Skaug, Slugina, Stachowitsch, Stack, Stimmelmayr, Taguchi, Tamura, Taylor, Thomas, Urban, Vikingsson, Weinrich, Weller, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. CONVENOR'S OPENING REMARKS

Brownell welcomed the participants to the Sub-Committee on Northern Hemisphere Whale Stocks.

2. ELECTION OF CHAIR

Brownell was elected as Chair.

3. APPOINTMENT OF RAPPORTEURS

Cholewiak, Mallette and Weller were appointed as rapporteurs.

4. ADOPTION OF AGENDA

The adopted agenda is given as Appendix 1.

5. REVIEW OF AVAILABLE DOCUMENTS

The documents available to the sub-committee were identified as: SC/67b/NH02-03, SC/67b/NH05, SC/67b/NH06Rev1, SC/67b/NH07-09, SC/67b/ASI01, SC/67b/ASI03, SC/67b/ASI10, SC/67b/ASI12, SC/67b/IA02, SC/67b/HIM09rev1, SC/66a/HIM15, SC/67b/SCSP06-07 and Hansen *et al*. (2018).

6. EVALUATION FOR POTENTIAL NEW IN-DEPTH ASSESSMENTS

6.1 North Pacific blue whales

The intersessional e-mail group on North Pacific Blue whale assessment, convened by Branch, reported back on the data available to conduct an assessment of North Pacific blue whales. Blue whales in the North Pacific consist of at least two distinct populations, the eastern North Pacific and the central and western North Pacific (CWNP), based on widespread call types. In addition, a third call type off Hokkaido may be evidence of a population off Japan. The status of the eastern NP (ENP) population is well known, with catches, abundance estimates, biological parameters, and a stock assessment reviewed and accepted by the IWC in 2016 (Monnahan and Branch, 2015), and there is a catch time series separate for ENP and CWNP (Monnahan *et al.*, 2014), but no abundance estimates are currently available for the CWNP. A limited number of catches were recorded during 19th century whaling; and there are also sightings from the Whaling History database that could be used to characterise their distribution. Shore-based whaling off Japan was presented to the SC in 2016. The remaining catches come from modern whaling. The CWNP whales are 0.8-1.0m longer than ENP blue whales. Ear plugs collected for 18 blue whales off California, resulting in an estimated age of maturity of 9-11yr, a range of ages from 6 to 48 years, and 0.46-0.50 corpora added per year after maturity. Photo-ID data include an extensive catalog by Calambokidis and Gendron, and photos from JARPN and POWER cruises. In addition, Discovery marks include an extensive array of marks, and 15 recaptures with locations showing links between the Gulf of Alaska and Sea of Okhotsk, while marks off Japan were recaptured off Japan. Satellite tag data show links between Costa Rica Dome, Mexico to Gulf of Alaska. Genetic data show that ENP are different to Chilean, although more similar than differences among SH blue whale subspecies. No genetic analyses have been done on a limited number of CWNP samples. Sighting surveys include the SWFSC surveys in the eastern Tropical Pacific, with a gap of 1°N and 6°N which corresponds to genetic and song types suggesting this divides ENP and Chilean blue whales. Other key sightings data are the JSV data from 1965-87 with substantial effort but no sightings off Japan, which has been used to suggest that the Japanese population was extirpated. The more recent JARPN and JARPNII data (1994-2014) shows 72 blue whales sighted off Hokkaido west of 155°E. The POWER surveys cover most of the rest of the CWNP with sightings predominantly in the region north of 40°N. Other sighting surveys include those in Alaska waters. Priorities outlined in this paper are covered later in this report.

The sub-committee welcomed this new information and thanked the intersessional group for their efforts.

The review of data availability for an assessment of North Pacific blue whales (SC/67b/NH03) began with discussion of Northeast Pacific (NEP), Northwest Pacific (NWP) and Japanese (JPN) call types. Širović noted that while a number of calls have been identified in the NWP over the years, they represent only a single song. There is apparent fine-scale structure with the NEP, however. For example, calls from the Gulf of Alaska differ from calls off California. Recordings from the central and western Pacific have been difficult to use to define song type, and a recent analysis of recordings from the Philippine Sea has yet to result in any blue whale detections.

Off Japan, the NWP song and a seasonal JPN song type have been recorded. Detections of the JPN type are louder/clearer than the NWP type and peak in the period of January-September. Detections of the NWP type are more frequent than the JPN type, peaking in about August, but are fainter. While the JPN call is assumed to be attributable to blue whales, it is unusual that it is being detected in only a single location given the high mobility of the species. The sub-committee asked about the detection range of the recorder(s) off Japan and wondered if they were capable of recording blue whales from more distant areas (e.g. the blue whale 'hot spot' south of Kamchatka along the Emperor Seamount Chain). Širović noted that the recorders off Japan were in deep water (i.e. not in the sound channel) and that detections of whales in the aforementioned 'hot spot' were unlikely. Recognising that blue whales off Japan were thought to have been extirpated by whaling, the sub-committee noted that these recent acoustic detections of the JPN song type could represent an extant (albeit small in number) remnant population, a new population or re-colonisation of a historically important habitat by whales from the NWP. Finally, the sub-committee encouraged research teams from Japan (e.g. JARPN/JARPNII) and elsewhere to incorporate acoustic recording into their at-sea-programs in hopes of providing a better understanding of North Pacific blue whale stock structure.

In discussion of the existing morphological data, it was noted that blue whales in the NWP appeared to be longer in length. The sub-committee recognised, however, that this difference may be an artefact of how the whales were measured. These measurements were made by whalers from a number of countries and there was no standardisation between them until the about the 1930s. That being said, if the measurement data from the NWP are older than data from the NEP, it is possible that larger whales still remained and contributed to the longer lengths reported.

With respect to genetic information, it was noted that NEP and southeast Pacific blue whales are not very different and that the potential for genetic exchange across hemisphere exists. Lang noted that genetic differences in the NEP are much lower than what has been reported for blue whales in the southern hemisphere.

The sub-committee also discussed a number of additional papers with respect to their data on blue whales, as summarised below.

SC/67b/IA02 provided historical information on blue whale sightings. Blue whales were commonly seen in winter months in 1965 and 1966 and were also seen in large numbers off Baja California in 1965 during the only spring-summer marking cruise that was conducted. A total of 73 groups of blue whales were seen and at least 113 were approached for marking of which 84 were determined to be a hit or possible hit. No marks were recovered from blue whales. Blue whale marking began in 1965 and catches of blue whales were prohibited the following season.

In consideration of sighting surveys, Ivashchenko summarised progress on completion of a database on catches and sightings of whales from Soviet reports from both the whaling industry and from Soviet scientific surveys and other sources (SC/67b/NH08). It was suggested that these data might be suitable for estimating relative abundance in portions of the NEP where data have previously been spare or unavailable. See Appendix 2.

SC/67b/SCSP06 reported North Pacific blue whale sightings, including results of photo identifications (8 individuals) and biopsies (5 individuals) by the NEWREP-NP offshore component, conducted in the sub-areas 7, 8 and 9, from 16 June to 23 September 2017 with a total of 5,307 n. miles searching. During the survey, a total of 12 schools with 20 individuals of blue whales were sighted. Most of blue whales were distributed in the northern part of sub-area 9 (north of 47^{o}N).

Additional information was received in SC/67b/SCSP07, which describes sightings of two blue whales during the coastal component of the NEWREP-NP survey off Abashiri, conducted from 11 June to 6 July 2017 in the southern Okhotsk Sea. The survey covered 2,500 n. miles, searching mainly within about 40 n. miles from Abashiri port, northeastern Hokkaido. Blue whale sightings were made on 13 July and 18 July, along 1,000m isobath off Abashiri. The distance between the two positions was 7.5 n. miles, and it was thought they could have been duplicate sightings. Biopsy sampling and individual identification was not conducted.

The sub-committee welcomed the new information presented in the additional papers, and thanked the authors for their contributions to the discussion.

In final discussion of stock structure, it was agreed that in the absence of additional data (e.g. acoustic, genetics) the continuous east-west distribution of blue whales in the central and WNP suggests that a single population may exist west of the eastern stock. The past catch records from the Kuril Islands and off NE Japan, in combination with the relatively recent detection of what appears to be a regionally isolated song type off southern eastern Hokkaido (Japan), suggested that the once thought to be extirpated population of blue whales in the far western Pacific may exist as a separate (remnant) population. Therefore, work is still needed to resolve the question of one or two stocks of blue whales in the WNP.

The following priority items were identified in SC/67b/NH03 and were discussed by the sub-committee to form recommendations:

(1) Obtain abundance estimates from the IWC-POWER surveys (Matsuoka and Kitakado).
Matsuoka reported that progress on the analysis to produce abundance estimates is underway.

Attention: SC

*The sub-committee **agreed** that the work on abundance estimation from IWC-POWER cruises continues to be a priority item and looked forward to reviewing results of this work at SC/68a.*

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(2) Obtain abundance estimates from the JARPN and JARPNII surveys (Matsuoka *et al*.).
Matsuoka reported that this analysis is completed using the data through 2014 and that those results were reported at the JARPN II review meeting. An update incorporating data through 2017 is planned.

Attention: SC

*The sub-committee **encouraged** that the work on abundance estimation continues to be a priority item and looked forward to reviewing results of this work at SC/68a.*

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(3) Analyse and compare genetic samples from ENP, IWC-POWER, and ICR biopsy samples to determine stock structure throughout the North Pacific (Lang *et al.*).
Lang reported that the IWC-POWER samples that were collected between 2010-2012 had been processed and the data are ready for analysis and interpretation.

Attention: SC

*The sub-committee **agreed** that the genetic analysis of biopsy samples continues to be a priority item and looks forward to reviewing results of this work at SC/68a. In addition, the sub-committee recognised the importance of samples collected during JARPNII and NEWREP-NP surveys, and **recommended** collection of additional biopsy samples (about 20 if possible) during the NEWREP-NP surveys in the western North Pacific to improve the power to evaluate stock structure. The sub-committee **encouraged** work to produce genetic data from the existing Japanee samples.*

Additional samples from the NEWREP-NP study area, combined with existing samples, will help determine if these western blue whales are distinct from those in the rest of the North Pacific.

(4) Comparison of photo-ID between POWER and other ENP catalogues and JARPN/JARPNII catalogues (no matches between POWER and ENP catalogues).
Mizroch reported that the 2010-2014 POWER blue whale catalog was compared with ENP catalogs managed by Cascadia Research Collective and Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional (CICIMAR-IPN). No matches were found. Branch recommended that photos collected during JARPN and JARPNII be compared to those collected during POWER.

Attention: SC

*The sub-committee **encouraged** that JARPN/JARPNII photographs be compared to POWER photographs and looks forward to reviewing results of this work at SC/68a.*

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(5) Review new acoustic locations and information and conduct fine-scale analysis of song features for central Pacific blue whale calls, with particular focus on calls around Japan.
Širović reported that analyses of additional data collected in the Philippine Sea are currently underway, and may provide further information on distribution of blue whale song types. The sub-committee looks forward to an update on the results of analyses of the Philippine Sea and Northern Mariana Islands dataset, but agreed that detailed analysis of song features in the existing data from the central North Pacific is not feasible given the relatively faint and poor-quality recordings of the WNP/Central call type.

Attention: SC

*Given the new song type recorded off Japan, a reanalysis of recordings from the Northern Mariana Islands (Saipan and Tinian) collected by the Pacific Islands Fisheries Science Center is **recommended** to look for the presence or absence of the Japan song. In addition, the sub-committee also **encouraged** passive acoustic data collection during surveys (e.g. POWER, university/training cruises) from the region of high blue whale density southeast of the Kamchatka Peninsula to determine the song type produced by animals in that region.*

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(6) Obtain better life history parameters from the Cascadia Research Collective, the Mingan Island Cetacean Study Research Station and the CICIMAR-IPN photo-ID dataset.

Attention: G

*The sub-committee **agreed** that the work to obtain life history data on blue whales remained a priority item and **encouraged** the named data holders to begin progress on this initiative.*

It was discussed that the most important data that should be collated are age at sexual maturity and calving interval.

6.2 North Atlantic sei whales
SC/67b/NH07 reported on two separate habitat-based density modeling efforts, utilising visual survey data to produce seasonal abundance estimates for sei whales from the purported 'Nova Scotia' stock, ranging from Nova Scotia to the southeastern US One effort was undertaken by the National Marine Fisheries Service Northeast and Southeast Fisheries Science Centers (NEFSC, SEFSC), as part of a multi-agency (NMFS, BOEM, US Navy, and USFW) funded program to document the spatial-temporal distribution of cetaceans in the US Atlantic waters (Palka *et al.*, 2017). This study utilised systematic line-transect data collected by NMFS shipboard and aerial surveys from 2011-2015. The second study, published by (Roberts *et al.*, 2016a; 2016b), utilised sightings data collected by five different institutions (including NMFS) from 1992-2014. Both methods predict high density in spring and summer months along the Georges Bank region and Scotian shelf. The NEFSC model also predicted sei whale presence south of Cape Hatteras, NC, though at lower densities than on Georges Bank.

The winter distribution and migratory behavior of sei whales in the western North Atlantic continues to be poorly understood. Passive acoustic data collected along the US eastern seaboard and presented in SC/67b/NH07 suggests persistent presence of animals along the Georges Bank region throughout fall, winter and spring, while acoustic data in southeastern US waters is also revealing the wintertime presence of at least some animals in the Blake Plateau region (off Florida), providing preliminary evidence of winter habitat. Strandings data extracted from the US National Strandings database from 2012-present have documented eight putative sei whales distributed along the US east coast and Gulf of Mexico.

In discussion, it was noted that new data were not available from regions around Iceland or Norway, where it was mentioned that abundance estimation is particularly challenging for this species in northern waters, partially due difference in timing between surveys and species' arrival in regional waters.

The sub-committee welcomed the new information on sei whale distribution and abundance, and looked forward to a further update on reanalysis of historical data, particularly related to stock structure and strandings, next year.

6.3 North Atlantic right whales
SC/67b/NH05 summarised the status of the North Atlantic right whale (*Eubalaena glacialis*). This population has been slowly declining since 2010 and the abundance at the end of 2015 was estimated to be 458 individuals with a 95% CI of 444-471 (Pace *et al.*, 2017). Of particular concern is that females showed lower annual survival than male and by 2015, 186 females (95% CI 174-195) remained. Many recent changes including shifts in distribution during summer from the northern Gulf of Maine and Bay of Fundy region to regions further north (i.e. Gulf of St. Lawrence), and during the winter from the Florida-Georgia region to regions further north along the mid-Atlantic coast (i.e. between New York and North Carolina) are being documented (Davis *et al.*, 2017; Mallette *et al.*, 2016; Mallette *et al.*, 2017). In the last two years, there has also been a lack of successful calving. In the 2016/2017 calving season, five calves were known to have been born. To date, there have been no calves observed in the 2017/2018 calving season. The stranding numbers have also been much higher in 2017 than in previous years with the greatest increase being carcasses detected from June to September in the Gulf of St Lawrence (Daoust *et al.*, 2017) and along the US east coast in April, November and December. The 2017 total number of dead whales was 17 whales, with 12 in Canada and 5 in the United States.

Van der Hoop *et al.* (2016) demonstrated that the energetic cost of entanglement can be a significant impediment to reproduction, and both increased number of documented entanglements and decreased calving are being observed.

Due to elevated North Atlantic right whale mortalities, on 24 August 2017, NOAA Fisheries declared a North Atlantic right whale Unusual Mortality Event (UME). For 2018, one dead whale was recovered floating offshore of Virginia entangled in pot gear involved in the snow crab fishery. The 11-year average is 3.8 whales per year. Based on preliminary findings, of the 12 cases examined (7 in Canada, 5 in US) and cause of death determined, five cases were suspected or confirmed for blunt force trauma (vessel-strike) and five cases were suspected or confirmed entanglements (NOAA, 2018b). Nine of the carcasses were females, 8 were males and 1 was undetermined. In addition, there were five live whale entanglements in Canada in 2017, all in the same timeframe in the Gulf of St. Lawrence and three in the US (2 in 2017 and 1 in 2018). The live entanglement sighted off the coast of Massachusetts in 2018 was a chronic entanglement first observed in 2014.

Important to recognise is that these stranding reports represent the minimum number of mortalities for that season. The sub-committee showed great interest in scaling these minimum observed mortalities to an overall estimate. However, it was also realised that there are significant challenges (see HIM report), as some carcasses never make it to shore (floaters at sea), emaciated/thin animals are less likely to float, and detection effort is inconsistent. For example, from 2005 through March 2018, there were 43 confirmed strandings in US waters, of which 28 were detected and reported as floaters by directed aerial survey effort, USCG survey effort, and the public.

Due to the 2017 Canadian interactions in the Gulf of St. Lawrence, on 19 April 2018 the Government of Canada implemented mitigation measures to reduce future interactions (DFO, 2018), including closing a large part of the Gulf of St. Lawrence snow crab fishery on 30 June; creating a dynamic 15-day fishing closure, and a 10 knot speed restriction when a single right whale sighting in any area is detected; putting in place mandatory gear marking and reporting of any lost gear; minimising the allowable amount of floating line at surface; and utilising vessel monitoring systems that reports the boats position every five minutes.

A substantial increase in international collaborations and data sharing between the US and Canada has occurred as a result of these mortalities. For example, Reeves drew attention to the Independent Advisory Committee for Right Whale Recovery (IAC), which was formed in December 2017 with the goal 'to reduce human impacts on right whales to levels that permit the survival and robust recovery of the species using pragmatic approaches.' The impetus for creation of such a committee came from discussions at the annual meeting of the North Atlantic Right Whale Consortium in Halifax, Nova Scotia, in October where it was agreed by many participants that a bi-national, non-government group of experts could play a constructive role in assisting other bodies (e.g. NOAA's Atlantic Large Whale Take Reduction Team, Canada's Departments of Fisheries and Oceans and Marine Transport) in efforts to find ways of reducing entanglement and ship-strike risks to right whales by the summer of 2018 and beyond. The committee's composition is equally balanced in terms of US and Canadian membership, with overall co-chairs (S. Kraus and R. Reeves), co-chairs of the Entanglement working group (M. Baumgartner and S. Brillant) and the Ship Strike working group (M. Brown and A. Knowlton). Each of the working groups consists of 6-7 scientists, 6-7 conservationists associated with NGOs, and 11-13 industry representatives (fishermen and shippers, respectively). There is extensive overlap in membership between the IAC and the various other committees, teams and working groups in both countries tasked with addressing these threats to the whales. The IAC expects to produce recommendations to the relevant authorities in Canada and the US before August 2018.

Attention: SC

The sub-committee welcomed the updated abundance estimate based on Pace et al. 2017. This estimate will be updated in late 2018 and sub-committee looked forward to the results to be presented at the SC/68a meeting. The sub-committee ***encouraged*** *the USA to submit the comprehensive update on North Atlantic right whales to the 2019 meeting of the Scientific Committee. The sub-committee further* ***encouraged*** *updates from the Large Whale Take Reduction Team (ALWTRT), specifically on progress of the Whale Safe Rope and Gear Marking Feasibility Subgroups.*

Attention: SC

The sub-committee ***reiterated*** *its previous* ***recommendation*** *for the submission of a comprehensive update on the status of North Atlantic right whales from the United States. It stressed the importance of this being submitted to the 2019 meeting of the SC to enable an initial review of status. This will allow time for explanations or additional analyses to be undertaken before the proposed 2019 Workshop on the Comparative Biology, Health, Status and Future of North Atlantic Right Whales: Insights from Comparative with other Balaenid Populations (including bowheads). The sub-committee* ***agreed*** *that the Steering Committee should continue its work to plan the workshop which is now scheduled for late 2019.*

Attention: S

At the SC meeting in 2000, the sub-committee expressed serious concern over the status of this stock as it is the only viable population of this species. There were two issues noted at that time: (1) reproductive failure and (2) high anthropogenic mortality mainly from ship collisions but also from bycatch. However, at this and last years' SC meeting the sub-committee noted that the main human related mortality was bycatch and not ship collisions and in high numbers. From 1970 to 2009, mortalities of right whales attributed to vessel interactions was higher (44%) than those resulting from entanglement (35%), while between 2010 and 2015, entanglements accounted for 85% of known mortalities, and 15 % were a result of vessel interactions (Kraus et al.*, 2016).*

Therefore, the sub-committee ***agreed*** *that the Secretary should be asked to write to the US National Marine Fisheries Service (NMFS) and the Canadian Department of Fisheries and Oceans, informing them of the sub-committee's serious concerns over the declining population trend of this species, and as a matter of absolute urgency, that every effort be made to reduce human induced mortality in the population to zero.*

6.4 North Pacific right whales

SC/67b/ASI10 reported a single North Pacific right whale sighting with a photo identification and biopsy sample from this animal by the dedicated sighting survey. The survey was conducted in sub-areas 7CN and 7CS from 28 April to 27 May 2017 with a total of over 2,000 n.miles searching distance. The right whale was sighted in the northern part of 7CN, approximately 60 n.miles off Kushiro port (Hokkaido) at the end of April.

SC/67b/ASI12 reported North Pacific right whale sightings by the IWC-POWER survey conducted in the eastern part of the Bering Sea from 3 July to 25 September 2017. A total of 1,571.0 n.miles was searched on the predetermined trackline. The acoustic survey was introduced for the first time to acoustically monitor for the presence of marine mammals, with particular importance for detecting and locating North Pacific right whales. A total of 240 sonobuoys were deployed, for a total of 841 monitoring hours. During the survey, a total of 9 schools and 18 individuals (including 2 duplicate schools of 3 individuals) of right whales were sighted with photo identifications (12 individuals) and biopsies (3 individuals). The majority of North Pacific right whales were sighted at the western edge of Bristol Bay and in the middle of the critical habitat. Generally, long diving behaviours (from 12 to 18 minutes) were often observed. A total of 5 schools of 9 individuals were detected by acoustics. A school of two was detected approximately 32 n.miles from the trackline by acoustics. The sub-committee welcomed this new information and thanked the authors for their presentation.

Paper SC/67b/NH02 presents the results of an analysis of population structure and historical demography in North Pacific right whales. This work, which represents the first genetic study comparing right whales sampled in the eastern and western North Pacific, identified statistically significant differences in mitochondrial DNA haplotype frequencies between the two groups. These genetic differences are consistent with what is known about the distribution of right whales in the North Pacific. This paper was also discussed by the SD&DNA Working Group; details on that discussion, and a summary of the paper, can be found in Annex I under their agenda item 4.3.

The sub-committee welcomed this new genetic study, as it helps define a western and eastern stock of right whales in the North Pacific, looks forward to the final publication. The sub-committee also noted that SC/67b/NH02 was produced in response to a recommendation made last year (SC/67a), and thanked the authors for their contribution.

In discussion, Brownell noted that a number of the samples in SC/67b/NH/02 came from bycaught and stranded specimens, and then he briefly presented SC/67b/NH/06Rev1, reporting on a right whale taken in large-scale set net in February 2018 off Izu, Japan. It was noted that the last bycatch in a set net in Korean waters was in 2015 (Kim *et al.*, 2015). Bycatches in this population was noted as a possible problem for this population in SC/67b/HIM/09Rev1.

The sub-committee looks forward to a new population estimate in the JARPNII research area next year (western North Pacific).

7. NEW INFORMATION AND WORKPLAN FOR OTHER NORTHERN STOCKS

7.1 North Pacific fin whales

SC/67b/ASI12 reported fin whale sightings by the IWC-POWER survey conducted in the eastern part of the Bering Sea from 3 July to 25 September 2017. Fin whales were the most frequently encountered baleen whale species in the research area and were widely distributed in the southern part of the research area south of 58N, and there were areas of high concentrations to the north and south of St. George Island, as well as north of Unimak Island. A total of 143 schools (195 individuals including 3 calves) of fin whales were observed in the research area. Approximately 50% of fin whales were sighted in shallow waters (depth between 31 and 200m); the rest were in deep water of depths over 1,000m. Biopsy samples were obtained from 28 fin whales, including both individuals in a mother calf pair. In the high density area north of St. George Island, red coloured faeces were observed on a few occasions while photographing sightings on 14 Aug. In the research area, long diving behaviours (from 10 to 18 minutes) were often observed. A total of 79 individuals from 63 schools (combined school size of 88) were photographed, of these 55 were photo-identified.

SC/67b/ASI10 reported North Pacific fin whale sightings with biopsy (one individual) by the dedicated sighting survey, conducted at the sub-areas 7CN and 7CS from 28 April to 27 May 2017, with a total of 2,022.6 n. miles searching distance. During the survey, 2 single schools of fin whale were sighted in the research area, in the northern part of 7CN, approximately 60 n.miles off Kushiro port, and the northern part of 7CS, approximately 20 n.miles off Hachinohe port.

SC/67b/SCSP06 reported 59 schools with 79 individuals of fin whales sightings by the NEWREP-NP offshore component, conducted in the sub-areas 7, 8 and 9 from 16 June to 23 September 2017 with a total of 5,307 n. miles searching distance.

In a genetic analysis aimed at identifying Omura's whales in Korean waters, Kim and colleagues reported three fin whale mitochondrial DNA control region sequences from whales bycaught in fisheries around South Korea between 2002 and 2016 that were deposited in GenBank. Two were from the East Sea and one from the Yellow Sea.

The sub-committee thanked the authors for the presentation of their work and welcomed the new data.

7.2 Omura's whale

SC/67b/NH09 reports new data on Omura's whales from the west coast of Madagascar, supporting the current understanding that the population is resident and non-migratory, and potentially isolated within its regional and global range. Field surveys off Nosy Be, Madagascar were conducted in 2015 and in 2016, involving small boat sighting surveys, passive acoustic monitoring and deployment of satellite tags. Frequent photographic re-sights of individuals were noted within and across seasons, including at least one reproductive female that was sighted in four of six years from 2012 to 2017, once with a calf, suggesting strong site fidelity. Photo-ID work is under way working towards estimation of abundance. Feeding was observed on dense patches of krill identified morphologically as *Pseudeuphasia latifrons*, which seem to appear in response to dense blooms of a cyanobacteria *Trichodesmium* sp. Passive acoustic monitoring (PAM) was conducted at four sites spread across 80km for one year. Omura's whale song was present year-round indicating residency of the Omura's whale population in this region, with evident spatial and temporal heterogeneity among sites. Four individuals were satellite tagged yielding telemetry tracks ranging from 30 to 58 days. Satellite tagged individuals remained in a restricted range of no more than

405km (mean among individuals of 283km) along the northwest coast of Madagascar, with all individuals moving multiple times throughout their individual ranges. Behavioral switching state-space models indicated highly localised movement patterns, involving short periods of transiting between specific areas where the whales would linger for several days displaying primarily localised movements, likely feeding. Habitat suitability modelling indicated favourable conditions for Omura's whale along the west coast of Madagascar, defined primarily by shallow depth and some undefined influence of primary productivity, with little other predicted suitable habitat throughout the Southwest Indian Ocean. Combination of these data sources suggests that this is a resident, non-migratory population whose distribution is likely determined by local shallow water ecological processes and patchy and ephemeral prey resources. Furthermore, this population of Omura's whale may be isolated within a fragmented oceanic/global range for the species. Likely threats to the Madagascar population include entanglement in local fisheries, impacts from oil and gas exploration, and most imminent the risk of coastal water contamination from a recently initiated mining operation for Rare Earth Elements. Future work should include a long-term latitudinal study that incorporates multiple methodologies to investigate all aspects of the species biology and conservation threats to the population. Therefore, the development of sustained or long-term funding sources is currently a critical requirement for the continued investigation of this population and success of the project.

The sub-committee welcomed this substantial new information from northern Madagascar on this poorly known species.

Attention:SC

*The sub-committee **drew attention to** 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. The sub-committee also **recommended** identification of study sites that are suitable for long-term comparative study on Omura's whales in other parts of its range. Possible sites discussed included New Caledonia, Komodo Islands, Indonesia, and the Bohol Sea, Philippines.*

Kim and colleagues reported on the first confirmed documentation of Omura's whale in the waters of South Korea. Between 2002 and 2016, six large baleen whales were bycaught in fisheries along the south and east coasts of South Korea. Using the mitochondrial DNA control region, and reference samples downloaded from GenBank, two of these specimens from the south coast of South Korea at Geoje and Goheung were confirmed to be Omura's whale. The other specimens were identified as fin whale (3) and Bryde's whale (1).

This account reinforces the importance of the Southeast Asian region, including Sea of Japan, the Yellow Sea, the East China Sea, and the South China Sea, as important habitat for Omura's whales, as demonstrated by existing accounts of Omura's whale strandings in Japan, mainland People's Republic of China, Taiwan, Hong Kong and now Korea. It also highlights the vulnerability of this apparently obligate coastal species to anthropogenic impacts such as entanglement in fishing gear.

The sub-committee thanked the author for this valuable information.

7.3 Gulf of Thailand Bryde's whales

SC/67b/HIM09rev01 presents information on the Bight of Bangkok Bryde's whale population, which has not been assessed by the IWC or on the IUCN Red List. The population was estimated to be 63±8 (S.E.) based upon photo-identification data collected between January 2010 and December 2013 (Cherdsukjai *et al.*, 2015). Thongsukdee *et al.* (2014) reported mom calf pairs in this region from April to November. Detection of mother-calf pairs during mark recapture studies suggest this region could serve as an important nursing ground for this population. Mortalities attributed to interactions with fishing gear have been reported and in 1998, a 12m long Bryde's whale was taken in a trawl in Chumphon Province. In September of 2009, a 4.5m calf was severely entangled in a gill net targeting rays off the coast of Trang province (Adulyanukosol *et al.*, 2012). Records of mortality and evidence of scars on the body attributed to fishery interactions (Adulyanukosol *et al.*, 2012) highlight the threat of bycatch on this small population and in potentially important feeding and nursing grounds (Thongsukdee *et al.*, 2014).

The sub-committee thanked the authors for bringing this information to their attention.

7.4 Gulf of Mexico Bryde's whales

The sub-committee received an update from Rosel on activities related to monitoring and new research plans for the Gulf of Mexico Bryde's whale. The search for an appropriate holotype specimen for this subspecies continues, as two specimens from the Gulf of Mexico have proved to be inadequate for use as a holotype. Regarding new data collection, in 2017 the Southeast Fisheries Science Center (SEFSC) undertook a shipboard line-transect cetacean assessment survey in the northern Gulf of Mexico, including known habitat of the Gulf of Mexico Bryde's whale. Passive acoustic data are being collected in historic habitat of the central and western Gulf from June 2016 to June 2017, to evaluate whether the whales' calls are detected in regions beyond their current known northeastern habitat. Data analysis is currently underway. An acoustic suction-cup deployed in 2015 remained on the whale for three days (Soldevilla *et al.*, 2017), and results indicated that the individual whale exhibited diel diving behavior, with deep daytime dives and shallow night time dives. At night, the whale spent 88% of its time near the surface, which is of concern for potential ship strike risk.

The SEFSC received funding from the RESTORE Act to direct dedicated research effort towards the Gulf of Mexico Bryde's whale. The RESTORE Act provides funds to restore and protect ecosystems of the Gulf of Mexico following the Deepwater Horizon oil spill (2010). The SEFSC held a workshop with the following objectives: (1) Review the current state of knowledge on Gulf of Mexico Bryde's whales; (2) Provide an overview of the objectives and research plan for the RESTORE project; (3) Identify information needs related to the conservation and restoration of Gulf of Mexico Bryde's whales; (4) Outline research priorities to address critical information gaps; and (5) Discuss future coordination to facilitate research and conservation planning.

The sub-committee welcomed this report and noted that there are new ongoing research plans.

Attention: SC

*The sub-committee **recommends** that the NOAA scientists working with this subspecies present results from shipboard* *and acoustic data analyses to the IWC at the scientific committee meeting in 2019, and looks forward to receiving a report from the Workshop held in conjunction with the initiation of research associated with the RESTORE Act funds.*

As noted in the Working Group last year, the small population size, restricted range and low genetic diversity place these whales at significant risk of extinction. Furthermore, the northern Gulf of Mexico 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 available evidence clearly demonstrates that this recently identified 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, which is estimated to be about 30 whales.

In 2017, the Gulf of Mexico Bryde's whale was listed as a critically endangered subpopulation on the IUCN Redlist.

Attention: CG-R United States, S

The sub-committee ***reiterated*** *its previous* ***recommendations*** *that US authorities:*

- *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, photoidentification 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 ***reiterated*** *its recommendation 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.*

Attention: G, SC

The sub-committee continued to ***encourage*** *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 passive acoustic data or specimen records from the northern coast of Cuba would be useful to determine potential occurrence of this subspecies in that region.*

7.5 North Atlantic Bryde's whales

SC/67b/ASI01 reviewed recent coastal surveys off Guinea, Sierra Leone and Liberia during March 2018. During these surveys, two groups of five individual Bryde's whales were observed and members of the sub-committee agreed on the species ID based on photographs presented in the report.

The sub-committee welcomed this information and **encouraged** future surveys in this region.

7.6 North Atlantic blue whales

Currently, blue whales in the north Atlantic are considered to be one stock; however, there is little (if any) evidence of interchange between animals in western and eastern North Atlantic waters. Cholewiak presented an update on recent information available for blue whales in western North Atlantic, which included a summary of 31 sightings in US waters since the year 2012. Seventeen serious injuries or mortalities have been documented from 1998 to present through the US eastern seaboard and into the Gulf of St. Lawrence; three of these were due to vessel strikes or entanglement. Preliminary analyses of passive acoustic data collected along the US eastern seaboard has indicated seasonal (fall-winter) presence of blue whales off the Georges Bank region, as well as off Cape Hatteras, NC. Recently published papers have also documented the acoustic presence of blue whales off the New York bight in winter (Muirhead *et al.*, 2018), and movements of two females equipped with satellite tags down through the mid-Atlantic bight and offshore waters (Lesage *et al.*, 2017). A recent Canadian Science Advisory Secretariat Research Document (2016/080; Lesage *et al.*, 2018) provides an extensive summary of recent data collected in Canadian waters.

In discussion, it was noted that multiple new datasets have been recently collected and may provide more information on blue whale distribution in North Atlantic waters. These include ecosystem surveys conducted by Norway, the results of which will be published following presentation at the Joint Norwegian-Russian Symposium entitled 'Influence of ecosystem changes on harvestable resources at high latitudes' which will take place in Murmansk, Russia, 5-7 June 2018, as well as visual surveys off Iceland. Extensive passive acoustic data collection in the western North Atlantic is currently underway, including work by US, Canadian, and German colleagues. These datasets will provide new insights into blue whale distribution throughout the western North Atlantic coast, Labrador Sea, and Fram Strait. Finally, comparison of photo-identification catalogs between the Gulf of St. Lawrence and Iceland have so far yielded no individuals matched between these locations, but additional data from Iceland are available for comparison.

Attention: SC, G

The sub-committee ***drew attention to*** *the lack of data on interchange between blue whales in the eastern and western North Atlantic, and* ***recommended*** *that US and Icelandic colleagues conduct a new comparison of blue whale photo-identification catalogs before the SC/68a meeting. The sub-committee also* ***encouraged*** *Canadian colleagues to generate a new population abundance estimate as soon as feasible, and looks forward to updates on new passive acoustic and visual sightings data SC/68a.*

7.7 North Atlantic humpback whales

Between January 2016 and March 2018, 68 humpback whale mortalities were documented along the western North Atlantic. Either full or partial necropsies were performed on approximately half and evidence of either vessel strikes or entanglement was attributed to 50% of these cases (NOAA, 2018b). An Unusual Mortality Event (UME) was declared for humpback whales in April 2017, and is currently ongoing. In addition, an Unusual Mortality Event was also declared for minke whales in the North Atlantic Atlantic from Maine through South Carolina. Since 1 January 2017, a total of 29 stranded minke whales (10 live; 19 dead) have been documented.

SC/67b/ASI03 reported the intersessional correspondence which reviewed the Icelandic humpback whale abundance estimates, specifically noted was estimates from 2015 for humpback whales around Iceland/Faroe Islands and East and West Greenland, as requested by the ASI sub-committee. The Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises agreed on the abundance estimate for humpback whales around Iceland/Faroe Islands (4,962-20,278, CV=0.36; SC/67b/ASI03 and SC/67b/ASI09), East Greenland (1,845-9,666, CV=0.44) and West Greenland (434-2,272, CV=0.44; Hansen *et al.*, 2018). In discussion, it was mentioned that large numbers of humpback whales have been moving into fjords along Norway. Whales have been documented feeding on herring between the months of November and January in recent years, which is concurrent with an anecdotal shift in herring distribution. It was also noted that photo-identification and tagging efforts were recently conducted around northern Norway.

The sub-committee welcomed this new information on recent work on humpback whales.

7.8 North Atlantic bowhead whales not subject to aboriginal subsistence whaling

No new information was available to the sub-committee.

7.9 North Pacific bowhead whales not subject to aboriginal subsistence whaling

No new information was available to the sub-committee.

7.10 North Pacific sperm whales

SC/67b/ASI10 reported North Pacific sperm sightings by the dedicated sighting survey, conducted at the sub-areas 7CN and 7CS from 28 April to 27 May 2017, with a total of 2,022.6 n. miles searching distance. During the survey, a total of 19 schools with 41 individuals of this species were sighted in the research area.

SC/67b/ASI12 reported the sighting of sperm whales during IWC-POWER survey, conducted in the eastern part of the Bering Sea. Sperm whales were sighted in the southern part of the research area, south of 57°N where the water depth was over 200m. A total of 15 schools (15 individuals) were recorded. Almost all whales were sighted in deep waters over 1,000m. No photographs or biopsy samples were collected from any sperm whales sighted.

SC/67b/SCSP06 reported 215 schools with 365 individuals of North Pacific sperm whales were sighted from the NEWREP-NP offshore component, conducted in the sub-areas 7, 8 and 9 from 16 June to 23 September 2017, with a total of 5,307 n. miles searching distance.

The sub-committee welcomed this new information and thanked the authors for their presentation.

7.11 Other Northern Hemisphere sperm whale stocks, including the Northern Indian Ocean

No new information was available to the sub-committee.

8. WORK PLAN AND BUDGETS REQUESTS FOR 2019-2020

The sub-committee agreed to the two-year work plan in Table 1. A workshop is proposed for North Atlantic right whales that includes a budget request for 2019-2020.

9. ADOPTION OF REPORT

The report was adopted at 17:30h on 2 May 2018.

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Table 1
Work plan for Northern Hemisphere whale stocks

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
North Pacific blue whales	Data collection and review specifically for early catches and stock structure	Review any new information needed for future assessment	Develop proposal for WNP stock structure	Agree to WNP stock structure (1 or 2 stocks)
North Atlantic sei whales	Review distribution based on sightings, strandings and available stock structure	Review any new information needed for future assessment	Develop proposal for WNA stock structure	Consider proposal for WNA stock structure
North Atlantic right whales	-	Review new population status and mortality data	-	Review new population status and mortality data
North Pacific right whale	-	Review any new information needed for future assessment	-	Review any new information needed for future assessment
North Pacific fin whales	-	Review any new information	-	Review any new information
Omura's whales	-	Review any new information	-	Review any new information
Gulf of Thailand Bryde's whales	-	Review any new information	-	Review any new information
Gulf of Mexico Bryde's whale	-	Review any new information on human-induced mortality	-	Review any new information on human-induced mortality
North Atlantic Bryde's whales	-	Review any new information	-	Review any new information
North Atlantic blue whales	-	Review any new information	-	Review any new information
North Atlantic humpback whales	-	Review any new information	-	Review any new information
North Atlantic bowhead whales (not subject to aboriginal subsistence whaling)	-	Review any new information	-	Review any new information
North Pacific bowhead whales (not subject to aboriginal subsistence whaling)	-	Review any new information	-	Review any new information
North Pacific sperm whales	-	Review any new information	-	Review any new information
Other Northern Hemisphere sperm whale stocks (including the Northern Indian Ocean)	-	Review any new information	-	Review any new information

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Appendix 1

AGENDA

1. Convenor's opening remarks
2. Election of chair
3. Appointment of rapporteur(s)
4. Adoption of agenda
5. Review of available documents
6. Evaluation for potential new in-depth assessments
   - 6.1 North Pacific blue whales
   - 6.2 North Atlantic sei whales
   - 6.3 North Atlantic right whales
   - 6.4 North Pacific right whale
7. New information and workplan for other northern stocks
   - 7.1 North Pacific fin whales
   - 7.2 Omura's whale
   - 7.3 Gulf of Thailand Bryde's whales
   - 7.4 Gulf of Mexico Bryde's whales
   - 7.5 North Atlantic Bryde's whales
   - 7.6 North Atlantic blue whales
   - 7.7 North Atlantic humpback whales
   - 7.8 North Atlantic bowhead whales not subject to aboriginal subsistence whaling
   - 7.9 North Pacific bowhead whales not subject to aboriginal subsistence whaling
   - 7.10 North Pacific sperm whales
   - 7.11 Other Northern Hemisphere sperm whale stocks, including the Northern Indian Ocean
8. Work plan and budget requests for 2019-2020

Appendix 2

FURTHER DATA ON NORTH PACIFIC BLUE WHALE DISTRIBUTION

Trevor A. Branch, Yulia Ivashchenko and Koji Matsuoka

JARPN/JARPNII data: Individual locations of blue whale sightings were plotted from the JARPN and JARPNII cruises to assess the extent to which blue whales are now present close to former catches, and close to the acoustic detections of a new song type off Hokkaido. The data include 72 sightings west of 155°E, several close to the location of the acoustic recorder (Fig. 1), in addition to 177 sightings in the hotspot at 45-50°N and 155-165°E. These data were plotted in summarised form in Matsuoka *et al*. (2016).

Soviet sightings and catches: blue whale data were extracted from the digitisation of Soviet sighting surveys and catches (Ivashchenko and Clapham, 2018). These show a much broader distribution of blue whale sightings than was previously known, including some catches in the Bering Sea, and one north of the Bering Strait, in addition to blue whale sightings west of Hokkaido, scattered locations south of the hydrophone location, and catches and sightings around Hawaii and other low latitudes in the western and central North Pacific around 20-25°N. Catches in the Sea of Japan and Sea of Okhotsk are also of interest.

NOTE: Exact locations from the JARPN and JARPNII cruises were supplied by Koji Matsuoka, and data from the Soviet North Pacific sighting voyages and catches came from Yulia Ivashchenko.

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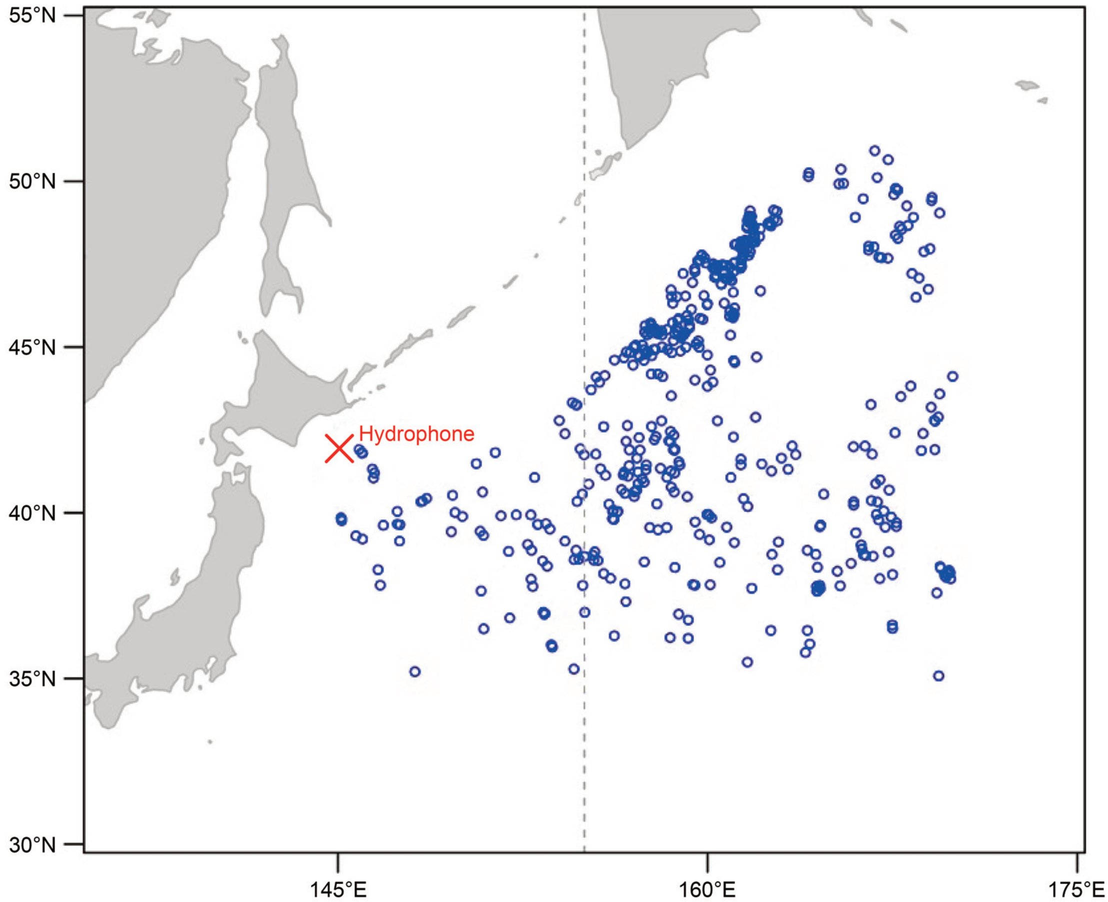

Fig. 1. Sightings of blue whales in the JARPN and JARPNII cruises with a dashed line at 155°E, from Matsuoka et al. (2015).

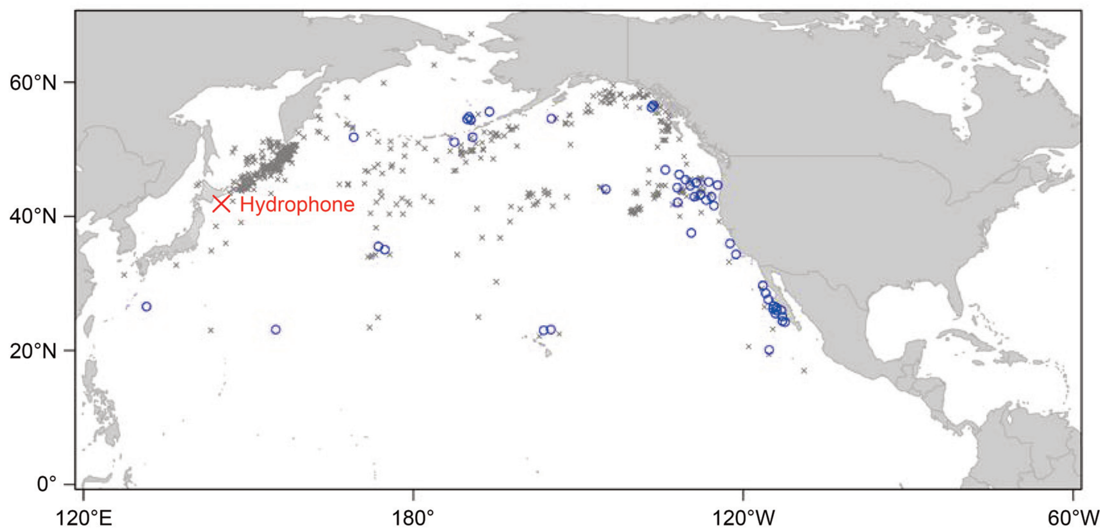

Fig. 2. Locations of sightings (blue circles) and locations recorded as either catches or catches/sightings (grey x) from Soviet surveys. Unpublished data from Ivashchenko and Clapham (2018).

Annex H

Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks

Members: Jackson (Convenor), Andriolo, Archer, Baker, Branch, Brandão, Brierley, Brownell, Burkhardt, Buss, Butterworth, Carroll, Castro, Cerchio, Charlton, Cholewiak, Clapham, Collins, Cooke, Coscarella, Crespo, Cubaynes, Dalla Rosa, de la Mare, Di Tullio, Double, Elwen, Fortuna, Galletti Vernazzani, Iñíguez, Irvine, Ivashchenko, Kato, Lang, Lauriano, Leaper, Lundquist, Mallette, Matsuoka, Minton, Øien, Olson, Pastene, Reyes, Rodriguez-Fonseca, Sironi, Širović, Taguchi, Taylor, Torres, Torres-Florez, Vermuelen, Weinrich, Yoshida, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Jackson welcomed participants.

1.2 Election of Chair

Jackson was elected Chair, with co-chair support from Olson.

1.3 Appointment of Rapporteurs

Carroll, Clapham and Buss undertook the duties of rapporteuring.

1.4 Adoption of Agenda

The adopted agenda is given in Appendix 1.

1.5 Review of documents

Documents identified as containing information relevant to the sub-committee were: SC/67b/SH01-24, SC/67b/PH01-02, SC/67b/PH04, SC/67b/ASI07, SC/67b/SP08, Riekkola *et al.* (2018), Carroll *et al.* (in press), Attard *et al.* (2018), Miller and Miller (2018), Charlton *et al.* (in prep.), Bedriñana-Romano *et al.* (2018).

2. IWC-SOUTHERN OCEAN RESEARCH PARTNERSHIP

SC/67b/SH21 reports on the activity of the Southern Ocean Research Partnership (IWC-SORP) since SC/67a. Progress on the five primary IWC-SORP science themes (SC/67b/SH21, annexes 1-5) is summarised below:

SC/67b/SH21 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.

Analysis of data from the 2015 New Zealand-Australia Antarctic Ecosystems Voyage (Double *et al.,* 2015) was conducted to describe the distribution of Antarctic blue whales in relation to their main prey species, Antarctic krill. Results suggest that Antarctic blue whales are more likely to be present within the vicinity of krill swarms detected at night, those of higher internal density, greater vertical height, and those found shallower in the water column (SC/67b/EM06).

Matching of new photographs of Antarctic blue whales contributed to the Antarctic Blue Whale Catalogue yielded a total of 17 new identifications, bringing the total number of photo-identified Antarctic blue whales up to 458 whales, represented by 342 left sides and 332 right sides (SC/67b/PH02; SC/67b/SH08).

Data from research voyages are augmented with sightings information from ships of opportunity which are contributed to the online reporting system: *https://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/67b/SH02). Further sub-committee discussion of this project is given in Item 3.2.

SC/67b/SH21 annex 2 reviewed progress on the project to identify the 'Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean'. Analysis has been completed on the extensive collection of killer whale photographs from McMurdo Sound and the status of type C killer whales documented (Pitman *et al.,* 2018). Field work around the western Antarctic Peninsula used an unmanned hexacopter 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 B1 and B2 killer whales 2016-2018 revealed individuals in surprisingly poor body condition. The hexacopter was also used to collected vertical images and blow exhalate samples from humpback whales (n=21) and, in a world first, Antarctic minke whales (n=7). Biopsy samples were collected from nine type B2 killer whales, one type B1 killer whale, 11 humpback whales and two Antarctic minke whales.

Analysis of data from Terra Nova Bay, Ross Sea, is underway to assess the local dynamics and role of ecotype C killer whales in this highly productive marine ecosystem.

The project cooperated on a voyage to the western and northern Antarctic Peninsula led by Brazil which generated sightings information and collected 1,903 photographs for individual identification. At least 56 Type A individuals and over 140 individuals of both Type B1 and B2 have been identified to date.

Building on, and set within, the long-term killer whale research at sub-Antarctic Marion Island, research on the movement and foraging ecology of killer whales is ongoing. Genetic analysis of biopsy samples (n=66), in conjunction with photo-identification association data (90,000 images; 63 individuals identified), has shown that Marion Island killer whales form small, fairly stable social units. Over a period of 5 years, 32 satellite tags were deployed and these have revealed seasonal site fidelity as well as rapid, long-distance movements and deep diving over seamounts.

SC/67b/SH21 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 April, 2018, a constant presence and active research were maintained around the Antarctic Peninsula. Effort focused on deploying reusable video-recording suction cup tags on both humpback (10 deployments) and Antarctic minke (10 deployments) whales, measuring prey and sea ice, and using UAS to generate estimates of body condition and animal size.

LIMPET-SPLASH tags were deployed on 13 humpback whales and one Antarctic minke whale. 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 patterns of baleen whales from the west Antarctic Peninsula continue (SC/67b/EM04; SC/67b/07; Riekkola *et al.,* 2018; de la Mare *et al.,* in press). Further Scientific Committee discussion of this project is given under Item 3.2 in Annex L.

IWC-SORP sincerely thanks One Ocean Expeditions, WWF-Australia, the Antarctic and Southern Ocean Coalition (ASOC) and the Hogwarts Running Club for their contributions to fieldwork and financial support of tagging and analyses during the 2017/18 season.

SC/67b/SH21 annex 4 reported progress on the project to 'Determine the distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica'. The focus of the 2017/18 research was five-fold: (1) Opportunistic genetic and photo-identification of whales migrating past the Kermadec Islands on their southern migration (Riekkola *et al.,* 2018); (2) a 2017 pilot trip to Fiordland, southwest New Zealand to identify the breeding ground origins of whales on their southern migration; a 2018 multi-disciplinary voyage to the Ross Sea region feeding grounds to collect photo-identification images and biopsy samples of humpback whales; (3) a voyage to the Chesterfield-Bellona archipelago to genetically identify individuals and determine genetic linkages to assess the origin of the whales (SC/67b/SH17; SC/67b/SH21 annex 6); and (4) two surveys on the Great Barrier Reef breeding ground complex to genetically profile this breeding stock and determine genetic linkages to Oceania (SC/67b/SH18). The outcomes of the research will allow for an improved understanding of the structure and status and migratory paths and feeding grounds of the Oceania humpback whales, will result in an improved assessment of status, and lead to better estimates of pre-whaling abundance and assessment of recovery.

IWC-SORP gratefully acknowledges the South Pacific Whale Research Consortium (SPWRC) for their enormous contribution to and continued collaboration on this project. As well as contributions from Pew Charitable Trusts, the New Zealand Ministry for Business, Innovation and Employment, the New Zealand Department of Conservation, the Australian Antarctic Division, the University of Auckland and the International Fund for Animal Welfare (IFAW), the New Caledonian Government, the Ministère de la Transition Ecologique et Solidaire, the World Wildlife Fund for Nature, and Opération Cétacés.

SC/67b/SH21 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'. In 2017/18 the Acoustic Trends Working Group conducted a high-level review of the project work completed to date and synthesised a three-year work plan focused on continuation and expansion of long-term data collection, and development of novel, efficient, and standardised analysis of acoustic data collected in the Antarctic. Standardised analysis methods include the creation of an Annotated Library that will be completed this year (SC/67b/SH18).

Three autonomous recording devices were deployed in the Southern Ocean at three different recording sites, and two previously deployed autonomous recorders were recovered (data volume of approximately 18,000 hours of underwater sound). A number of autonomous recorders have also been deployed 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). In December 2017, the IWC-SORP Acoustic Trends Working Group became a Capability Working Group of the Southern Ocean Observing System (SOOS) and presented their work to members of the International Quiet Ocean Experiment (IQOE). This marks the first official joint IWC-SORP/SOOS working group.

Overall, IWC-SORP projects have produced 126 peer-reviewed publications to date and 125 IWC-SORP related papers have been submitted to the Scientific Committee, 22 of which have been considered by the IWC Scientific Committee this year. Moreover, a substantial amount of vessel time has been granted to IWC-SORP researchers this year and for 2019.

SC/67b/SH18 provided an update on funds allocated from 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 project progress reports are presented in SC/67b/SH18.

A full financial report of the IWC-SORP Research Fund can be found in SC/67b/01. £641,828 GBP remain unallocated and unspent in the fund. A new Call for Proposals was opened in 2017. Nineteen research applications were received. An independent assessment process, endorsed by the Scientific Committee last year and detailed in appendix 1 of IWC (2018c), was undertaken. The proposed allocation of funds to successful projects will be presented to the Scientific Committee for endorsement. Endorsement of the agreed allocation will then be sought from the IWC Finance and Administration Committee prior to IWC/67. IWC-SORP sincerely thanks all contributors to the IWC-SORP Research Fund for their voluntary contributions.

The sub-committee expressed considerable appreciation to Bell and others administrating IWC-SORP and **commended** the hard work involved in the coordination and execution of the project. It was agreed that the SORP project has continued to be extraordinarily productive in terms of the broad increase in knowledge and the number of refereed publications resulting from the many studies that IWC-SORP has supported. The sub-committee recognised that IWC-SORP's fostering of numerous collaborations across a wide area has become a model for shared scientific endeavours and for a broader scientific vision in the Southern Hemisphere and elsewhere, and **strongly encouraged** that the project be continued.

Several papers arising from projects which have been supported with IWC-SORP funds were available for the sub-committee to review, including Miller and Miller (2018) which was not discussed due to insufficient time.

Riekkola *et al.* (2018) combined innovative analytical tools to assess the distribution and population structure of

Megaptera novaeangliae throughout their migratory range. Using genotype and photo-identification matches, they conducted a genetic mixed-stock analysis to identify the breeding ground origins of humpback whales migrating past the Kermadec Islands, New Zealand. Satellite tracking data and a state-space model were used to identify the migratory paths and behaviour of 18 whales. Additionally, they conducted progesterone assays and epigenetic aging to determine the pregnancy rate and age-profile of the population. Humpback whales passing the Kermadec Islands did not originate from a single breeding ground, but instead came from a range of breeding grounds spanning ~3,500km of ocean. Surveyed whales ranged from calves to adults of up to 67 years of age, and a pregnancy rate of 57% was estimated from 30 adult females. The whales migrated to the Southern Ocean (straight-line distances of up to 7,000km) and spanned ~4,500km across their Antarctic feeding grounds. All fully tracked females with a dependent calf (*n*=4) migrated to the Ross Sea region, while 70% of adults without calves (*n*=7) travelled east to the Amundsen and Bellingshausen Seas region. Their results indicate a population recovering from exploitation, and their feeding ground distribution serves as an indicator of the resources available in these environments.

SC/67b/SH17 presents results from the first large-scale multidisciplinary surveys of the Chesterfield-Bellona archipelago. The Chesterfield-Bellona archipelago is a vast reef complex located halfway between the East Australian coast (BSE1) and New Caledonia (BSE2). It was one of the primary whaling sites in Oceania during the 19th century. Surveys were conducted in 2016 and 2017, combining observations at sea through line-transects and focal-follows, genetics, photo-identification, acoustics and satellite tracking. Humpback whales were observed in both years, showing behaviours typical of a breeding/nursing area, and in densities similar to those found in the neighbouring breeding ground of the New Caledonia South Lagoon. Surprisingly, the sex-ratio was skewed towards females and many females with a calf were encountered. Genetic analysis and photo-identification suggest a connection to the New Caledonian population, whereas satellite tracking indicates movements towards the East Australian migratory corridor. The genetic comparison between whales sampled in Chesterfield-Bellona and the Great Barrier Reef should bring light to the large-scale connectivity between these South Pacific stocks.

The sub-committee noted that this is an impressive array of data collected in an area of the Southern Hemisphere where humpback whale breeding stocks are complex and boundaries are still poorly understood.

3. PRE-ASSESSMENT OF SOUTHERN HEMISPHERE BLUE WHALES

At SC/66a, the sub-committee began the process of identifying and summarising datasets (acoustic and genetic) relevant for assessing population structure among non-Antarctic Southern Hemisphere blue whales (Item 5.1, IWC 2016). Initial results of this assessment were presented at SC/67a (Item 3.1, IWC, 2017).

3.1 Southern Hemisphere population structure and catch allocation

SC/67b/SH11 presents an update to the blue whale song biography for Southern Hemisphere (see Fig.1). This is the continuation of the review started in 2016 (IWC, 2017), and over this time new information has been acquired on published records allowing consolidation of the total number of songs present in the SH. There were three main changes to the previous analysis. The data from the Solomon Sea were obtained from the authors of the original paper and after evaluating characteristics of the signals, it was decided that this was not likely a blue whale song. Likewise, following further review of the SWI2/9B song ('Diego Garcia' signal by McDonald *et al.,* 2006) these are now not considered to be blue whales. In both cases, the more likely source of these signals would be Omura's whale or Bryde's whale. Finally, the song recorded in South Atlantic (near the islands at 54°26'00"S/36°33'00"W) was identified as a faint version of the SEP2 song commonly recorded off Chile. Similar signal has also been recorded off Ascension Island, indicating this occurrence of SEP2 song in the South Atlantic may be a regular occurrence. This brings the total number of 'pygmy' blue whale songs in the Southern Hemisphere to six. An additional song regularly heard both at low and high latitudes in the Southern Hemisphere is Antarctic blue whale song. It has been recorded both circumpolarly and in all of the Southern Hemisphere ocean basins, with peak singing in the Southern Ocean in late austral summer and during

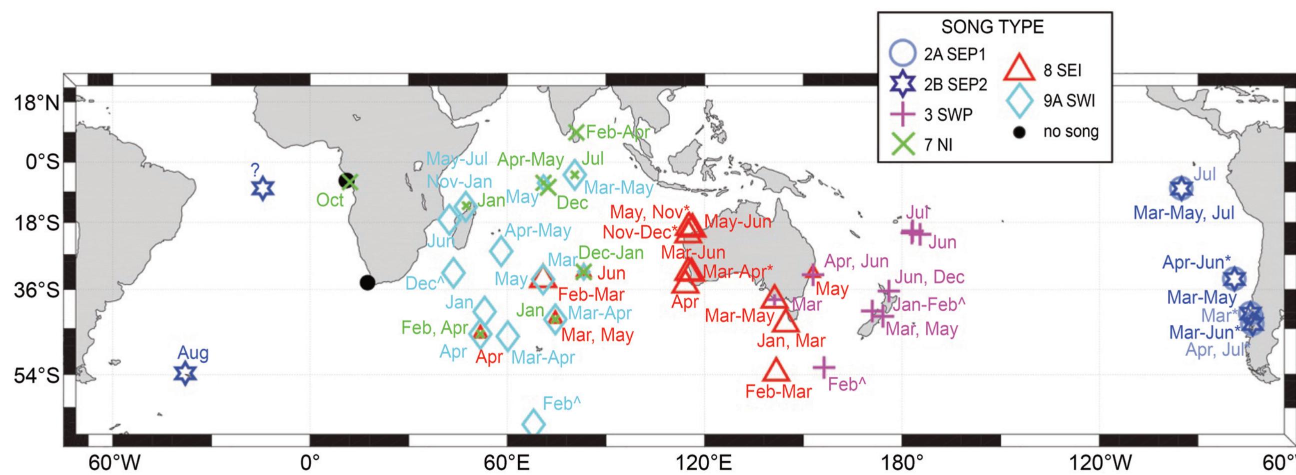

Fig. 1. Locations of non-Antarctic blue whale songs reported for the Southern Hemisphere (between the equator and 60°S) in the literature, summarised in SC/67b/SH11. Each symbol and colour denote a song type. Months included for each site indicate peak months of detection. In most cases year-round recordings were available. If three or more months of recording were missing per year, those peak months are marked with *. At locations marked with ^, recordings were collected with sonobuoys or dipping hydrophones and generally data were only available during indicated month(s). The black dot marks a location where full year of recording exists and no non-Antarctic blue whale songs were recorded.

autumn, while peak singing at lower latitudes typically occurs during the austral winter.

In discussion, it was questioned how detection distance of the calls varied geographically, and whether some areas had more distant call propagation than others. In response, it was noted that call detection distance can be affected by the depth of the hydrophone in or near to deep water channels, where sound propagation distances are greatest. In particular, the apparent overlap of different call types in the central southern Indian Ocean may reflect the fact that sound recorders in this region have been deployed in deep water channels, and may therefore be receiving very distant calls. This has implications for catch allocation, as discussed below.

The detection of Chilean blue whales in the southwest Atlantic was discussed, and it was questioned whether there is evidence that Chilean blue whales were included in the historical catch records. The sub-committee was informed that the Grytviken historical catches contain an over-abundance of 70-80 foot blue whales, which are short relative to mature Antarctic blue whales but long relative to pygmy blue whales and could possibly be the Chilean form (see SC/67b/SH23). It was also noted that occasional sightings of putative pygmy blue whales are made in the vicinity of 54°26'S; 36°33'W (some are held in the Antarctic blue whale catalogue), and that there is at least one haplotype in the bone collection from former whaling stations that is associated with the pygmy blue whale form (see SC/67b/SH02). Catch allocations explored to date in SC/67b/SH23 have assumed all catches from this region to be from Antarctic blue whales. This may still be a reasonable assumption, because oceanographic conditions have varied substantially over the 20th century and blue whale feeding distributions are strongly tied to areas of primary productivity rather than fixed locations (e.g. Fiedler *et al.*, 1998; Gill, 2002). Further analysis of the blue whale bones may be helpful to better establish the past distribution of these stocks. It was noted that Chilean blue whale song detection in the vicinity of 54°26'S, 36°33'W was made during the austral winter (August), while historical whaling there was particularly intense during the summer months, so detections of these occurrences within the catch record might be limited. The sub-committee were informed that the British Antarctic Survey have deployed an acoustic mooring in waters west of 54°26'S, 36°33'W during the 2016/17 season, and will be analysing the acoustic data received from this over the next two years.

SC/67b/SH23 examined historical catches of blue whales in the Southern Hemisphere and northern Indian Ocean to identify pygmy blue whale catches, and separate these into individual populations (see Fig. 2). Antarctic blue whales are found circumpolar-wide especially south of 60°S, while Chilean blue whales are caught off Chile and Peru through to the Galapagos. Shore station catches off south-western Africa and at Durban are assigned to Antarctic blue whales based on substantial numbers greater than 24.2m in length, reductions of around 99% in catch numbers, and winter timing of catches. Durban is the most ambiguous with at least four pygmy blue whale catches evidenced by pregnant females of lengths typical of pygmy blue whales. Pygmy catches are separated into northern Indian Ocean (NIO), south-west Indian Ocean (SWIO), south-east Indian Ocean (SEIO), and south-west Pacific Ocean (SWPO) populations based largely on acoustic records of distinctive call types made by each population. Off Somalia, foetal lengths with a southern conception date suggest SWIO blue whales occur up to 2°N, while pygmy blue whales north of 9°N there have aseasonal reproduction and are assigned to the NIO population. Pelagic catches were divided between Antarctic and pygmy blue whales based on very distinct separation in catch length frequencies, with the southern boundary of 52°S or 53°S and longitudinal boundaries of 20°E eastwards to 180°. Within these boundaries there were virtually no mature females longer than 24.2 m, while south of this boundary more than 90% of mature females were longer than 24.2m. Catches off western Australia were SEIO; those between eastern Australia and New Zealand were SWPO. The vast majority of pygmy blue whale catches (97%) came from pelagic Japanese expeditions in 1959/60-1963/64 (21% of the total) and Soviet expeditions in 1962/63-1971/72 (76% of the total). A GAM model was fitted to geographic occurrence of blue whale song type (and the fetal length data) to estimate the probability that a pygmy blue whale belonged to each of the four populations. A major area of overlap was identified in the southern Indian Ocean where

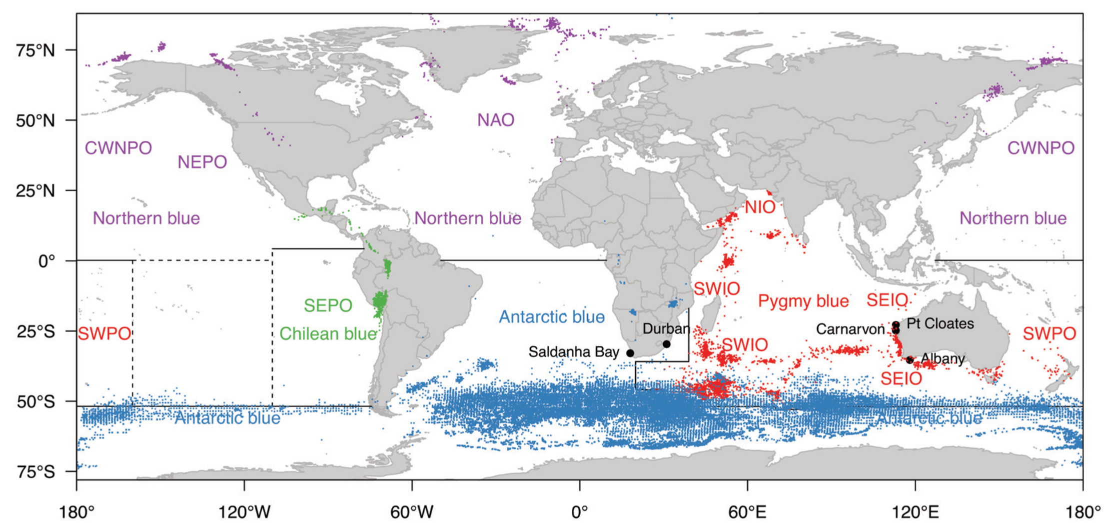

Fig. 2. Global blue whale catches of each of the four generally accepted subspecies (northern blue, Chilean blue, Antarctic blue, and pygmy blue), showing assumed boundaries in black used to enclose catches of each. Dashed boundaries enclose an area in the South Pacific with no known blue whale data. Individual populations are shown by acronyms for pygmy blue whales: northern Indian Ocean (NIO, Sri Lanka), south-west IO (SWIO, Madagascar), south-east IO (SEIO, Australia/Indonesia), south-west Pacific Ocean (SWPO, New Zealand); Chilean blue whales (SEPO); northern blue whales: north-east PO (NEPO, California/Mexico), central and western north PO (CWNPO, Japan to Gulf of Alaska), north Atlantic Ocean (NAO). Selected land stations are labelled.

NIO, SWIO, and SEIO blue whales all had some probability of occurrence; another area of overlap was north and east of Tasmania between SEIO and SWPO blue whales. Catch time series were developed from these analyses, with total pygmy blue whale catches of 12,184 and totals for each population of 1,228 (NIO), 6,889 (SWIO), 3,646 (SEIO), and 421 (SWPO).

The sub-committee commended the authors for this comprehensive and useful paper, which arises from IWC Scientific Committee funding support awarded during SC/66b (see item 10.2.2, IWC, 2017).

In discussion, the latitudinal band of offshore catches west of Australia (Fig. 2) was highlighted, and the reasons for allocation of this catch to the Australian population (as shown in Fig. 3) were queried. It was noted that there are few acoustic recordings from this area to inform the population model, but the small number of Australian calls recorded out to 40°E have influenced the model fitting. Several other call types have been recorded in the central southern Indian Ocean (Fig. 1) so the allocation of these catches is rather uncertain, especially considering the deployment of recorders in deep sound channels. It was queried whether it would be possible to incorporate data on the acoustic propagation levels of each recorder into the inferences being made here about blue whale distribution. In response, it was commented that call propagation modelling would be required as well as full access to primary data from all locations; this would be technically challenging to implement, and is further complicated by changing propagation distances over depth and latitudes. A general review of the sound propagation patterns in the south central Indian Ocean could however be useful for better establishing the likely range of these calls. At present the catch allocation in this region is challenging because a large number of catches were made but few sound recorders have been deployed to monitor these calls. The sub-committee **encouraged** the deployment of more recorders in the south central Indian Ocean region to help resolve these ambiguities.

The catch boundaries applied to the area south of Durban (South Africa, Fig. 2) was discussed, as they are extended slightly into the Indian Ocean. The author noted that this was a challenging area for catch allocation because data were not reliably recorded and very few measurements of mature females exist in the catch record. Considering that the catch patterns from Salandha Bay are similar to those off Durban, he has assumed similar occurrences of Antarctic blue whales in the two areas.

The sub-committee considered the assumption of this assessment that recent (acoustically-inferred) blue whale distribution is similar to blue whale distribution during the whaling period. They noted that blue whales are often strongly associated with oceanographic features rather than occurring in static locations (e.g., Calambokidis *et al.,* 2009), and highlighted that this spatial flexibility must be considered in the process of developing an assessment. In this regard, the best approach for developing a 'high case' catch scenario for each putative population was discussed, and how best that could take into account this distributional uncertainty. The authors also noted that they plan to use a bootstrapping approach to better accommodate the distributional uncertainty inherent in the use of an assemblage of acoustic recordings. It was also cautioned that the use of relative strength of acoustic signals to weight catch allocations in overlap areas is problematic as relative frequencies of whales in those areas may reflect different levels of past exploitation, rather than a long-term, stable dynamic. It was suggested that oceanographic data could be informative about changes in local conditions and could improve model inference.

Some minimum and maximum catch allocations were suggested for pygmy blue whales (see Appendix 2), to bound the catch uncertainty in the context of population assessments. It was highlighted that the maximum

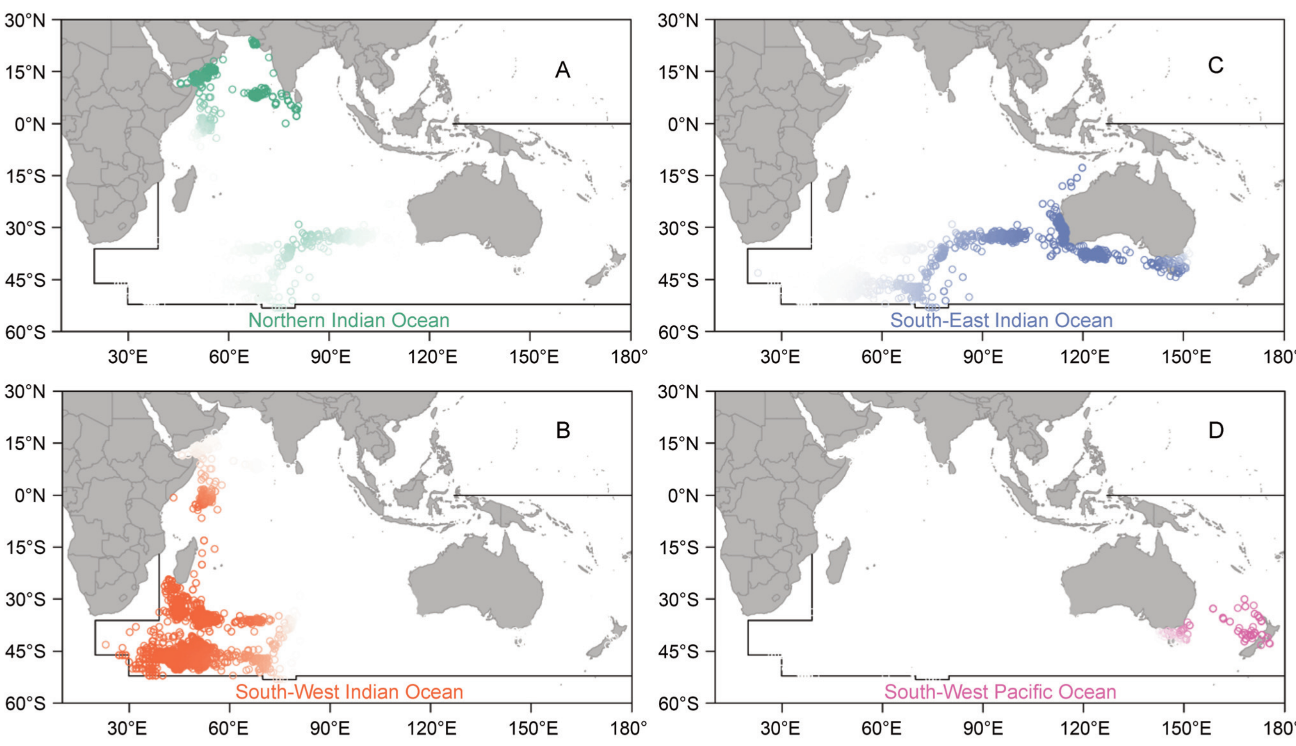

Fig. 3A-D. The probability that each pelagic catch is assigned to one of the four pygmy blue whale populations. High color intensities represent high probabilities that each catch was assigned to that particular population, while catches in colors fading to white represent low to near-zero probabilities.

population boundaries define very broad ranges for the NIO, SEIO and SWIO populations and that the data guiding the maximum range for each population is based on contemporary data. For example, the allocation of catches at Bass Strait could be explored as the current model shares catches between the South-East Indian Ocean and South-West Pacific Ocean populations (Fig. 3d), reflecting the co-occurrence of the two call types in this area (although the South-East Indian Ocean call type appears predominant). The sub-committee **agreed** that further discussion on catch allocation scenarios was needed in order to agree some cases, to be facilitated via an intersessional correspondence group convened under Branch (see Item 7.1.1). The sub-committee also **agreed** that regional population modelling should be commenced with these catch series in order to explore assessment parameters and population recovery levels for pygmy blue whales.

Torres-Florez summarised intersessional efforts to identify and standardise microsatellite loci used in Southern Hemisphere blue whale research across labs. Only four loci were used in common across labs, and data summarising these were presented.

The group was thanked for this important work. Sample depletion remains a concern given the speed of technological change and repeated analyses from the same samples. Many participants highlighted that the IWC Antarctic blue whale samples are very valuable, and proposals should be carefully considered to reduce duplication. There was discussion amongst the group on the best genomic applications of the remaining samples. Further discussion, including the idea of whole genome sequencing of remaining blue whale samples, was held in the SD-DNA Working Group and is summarised under item 4.4.2 of Annex I. The sub-committee **strongly encouraged** that the different groups that make use of the same samples (e.g. IWC) make their associated metadata available including the voucher number of the sample (e.g. Southwest Fisheries Science Center).

3.2 Antarctic blue whales

SC/67b/SH02 summarises progress on a project to investigate potential loss in genetic diversity and change in stock structure of Antarctic blue whales. This project builds on previous analyses of bones from former whaling stations at Grytviken and the Antarctic Peninsula (e.g., Sremba *et al.,* 2015). The authors report on efforts to use next-generation sequencing to reconstruct the whole mitogenome from 30 bones previously identified as originating from blue whale. Whole-genome, shotgun sequencing with an Illumina HiSeq 3000 was used to generate an average of 24 million paired-end reads of 150bp in length for each sample. Sequences of the mitogenome were extracted computationally from the whole genome sequences and proved sufficient for high-quality reconstruction of near-complete mitogenomes from 20 of the bones. From these 20 full sequences, the authors identified 18 unique mitogenomes, and compared these to 53 unique mitogenomes from 73 contemporary samples. From this alignment and comparison, only 2 of the mitogenome haplotypes were shared between the contemporary and historical samples. The authors suggest that the low level of sharing of mitogenomes between the contemporary and historical samples suggests a loss of maternal lineages as a result of the severe population bottleneck due to 20th century whaling. Further analysis is underway to test for this loss of diversity or change in population structure and to evaluate the potential for investigating loss in diversity of the nuclear genome.

This progress report was welcomed, with the Chair noting that these analyses have been funded by IWC-SORP. In discussion, it was suggested that the population genetic survey of these whales might usefully be expanded to include samples from southeast Pacific, considering that Chilean blue whale calls have been detected off the islands at 54°26’00”S, 36°33’00”W (see Item 3.1). In this regard, the presence of haplotype ‘q’ (a haplotype often seen in the eastern Pacific, LeDuc *et al.,* 2007) was also noted. This reinforces the idea that Chilean blue whales may occur in the waters at 54°26’00”S, 36°33’00”W, although it was also cautioned that haplotypes shared at the control region level may turn out to be distinct when whole mitogenomes are sequenced. The authors noted that they are conducting genomic analysis of this sample to better establish its population origins.

Three apparently divergent, basal lineages shown in the phylogenetic tree (Fig. 1 of SC/67b/SH02) were discussed; the authors clarified that these samples definitely represent blue whales and that the tree was rooted with fin whale sequences which are not shown in the phylogeny. Branch lengths are relatively short across this phylogeny (e.g. compared with those of the fin whales presented in SC/67b/SH13), so it is hard to interpret whether these lineages have any taxonomic significance with the current data.

There was discussion about how to determine whether the results showed substantive loss of genetic diversity due to whaling. This is not simple to measure because there are two dimensions to consider: temporal differences and spatial differences or stock structure, which confounds analyses in one dimension. The exact methodology to test for changes in diversity and structure in both time and space has not yet been identified, but the authors noted that the low level of shared haplotypes suggests a loss of diversity or change in population structure since the whaling era (e.g. see Sremba *et al.,* 2012). Whilst current Antarctic blue whale diversity is relatively high (Sremba *et al.,* 2012), modelling of the population trajectory for this subspecies still suggests that many haplotypes were lost, with current haplotype diversity levels consistent with the number of whales (~360) that survived the exploitation bottleneck (Branch and Jackson, 2008; Sremba *et al.,* 2012).

Recognising the immense value of these historical datasets, the sub-committee highlighted the importance of utilising bone collections for documenting the loss of genetic diversity and shifts in population structure, and **encouraged** these and related collection efforts to continue in order to inform stock structure and assessment.

Brownell summarised ongoing work at the Smithsonian Natural History Museum on baleen whale plates that were shipped to the USA from Japan in the 1940s. After some initial work to curate and catalogue these samples, it was established that there are baleen plates from 1,626 individual baleen whales (likely 50:50 blue: fin whales). Lang advised that preliminary results from a pilot study on 11 blue and 1 fin whales showed that DNA extraction and mtDNA sequencing can be successfully conducted on these baleen whale plates. The sub-committee were informed that additional analyses, including stable isotope and hormone analysis, are planned for these samples. The researchers were also **encouraged** to measure the lengths of these baleen plates, because Antarctic blue whales are currently lacking such a reference set, for comparison with pygmy blue whale baleen samples and to assist with sub-specific characterisation of unknown baleen samples.

3.2.1 Cruise reports

SC/67b/SH07 described an IWC-SORP 49-day research voyage that will be conducted from 17 January to 6 March 2019. The voyage's objective is to describe the density, distribution, and fine-scale 3D structure of krill swarms relative to predator density and distribution estimated through visual surveys and passive acoustics. In addition, through measurements of the abundance and speciation of whale faecal iron the voyage will assess the new hypothesis of iron-fertilisation by whales and determine whether iron concentrations are higher within aggregations of feeding whales than within krill-only aggregations or than in adjacent areas. The data collected on this voyage will develop further the research described in SC/67b/EM06 that indicates krill swarm characteristics can predict the occurrence of Antarctic blue whales.

SC/67b/ASI07 reports the results of the systematic whale sighting survey conducted by two vessels in the Antarctic Areas VE (south of 60°S, 165°E-170°W including the Ross Sea) and VIW (170°W-145°W) under the NEWREP-A in 2017/18 austral summer. The survey was conducted under two survey modes based on IWC IDCR/SOWER survey procedures (Normal Passing mode (NSP), and an Independent Observer mode (IO)) from 10 December 2017 to 20 February 2018. The total searching distance in the research area was 5,196.6 n.miles, including 2,441.2 n.miles covered in NSP and 2,755.4 n.miles in IO modes. A total of 13 schools (23 individuals) of blue whales were sighted in the research area. They were mainly distributed in Area V. Several blue whales were sighted in the Ross Sea (south of 69°S). Four biopsy samples (skin and blubber) were collected.

SC/67b/SP08 reports the sightings of fin whales by the sighting and sampling vessels during the NEWREP-A conducted in Area VI (south of 60°S, 170°W-120°W) during 2017/18 austral summer. The total searching distance was 4,164 n.miles, and a total of 8 schools (13 individuals) of blue whales were sighted. Two individuals were photographed and one biopsy sample was collected. Results of these data including multi-year data will be analysed and submitted to the NEWREP-A review meeting in the future.

The sub-committee thanked the authors for this new information. In discussion, it was commented that one of the aims of the work presented in SC/67b/SH07 is to describe the distribution of blue whales and how strongly they are aggregated in space and time. The aggregations shown in Area V (figure 3a, SC/67b/ASI07) were noted in this context, and it was queried whether there was scope to do finer scale sightings survey to study blue whale aggregations in more depth. The response was that based on previous cruises, the whales appear to be broadly (rather than tightly) distributed across Areas II-VI south of 60°S.

3.2.2 Progress toward population assessment

SC/67b/SH08 used photo-identification data of Antarctic blue whales from 1990/91 to 2014/15 in a capture-recapture analysis to produce estimates of super-population abundance for the circumpolar Antarctic. Population estimates were made separately based on the left and right-side photos. The R package RMark version 2.1.12 was used as an interface to the program MARK version 8.0; the POPAN is an open-population model. The circumpolar estimates of Antarctic blue whales were 4,629 (95% CI 2,563 to 8,558) using left side photographs and 4,485 (95% CI 2,514 to 8,192) using right side photographs.

The sub-committee thanked the authors for this work which represents important new information for measuring abundance of Antarctic blue whales. During review during the ASI Standing Working Group (Annex Q, item 3.1.1.9), the authors were **encouraged** to re-run the models exploring suggestions made by the Working Group. It was cautioned that super-population estimates produced from re-sight data spanning 25 years may be biased high since no mortality is assumed, and recommended that point estimates of abundance be produced, and these results presented to SC/68a.

In discussion, it was noted that the estimates produced by this work are similar in magnitude to the 1997 IDCR-SOWER estimate of abundance (Branch, 2007). Considering the morphological similarities of the two sub-species it was queried whether some of the photographs contributed to this catalogue might potentially be from pygmy blue whales. The author responded that she has thoroughly reviewed each photograph and is confident that only the Antarctic type has been used in the mark recapture study. The sub-committee **strongly encouraged** the continuance of this work and looked forward to receiving an updated abundance estimate at SC/68b.

3.3 Non-Antarctic Southern Hemisphere blue whales

SC/67b/SH16 reports on preliminary results of recent comparisons among Southern Hemisphere Blue Whale Catalogues off Australia, New Zealand and Sri Lanka regions. Until 2017, this regional sub-catalogue included photographs of 698 individuals comprising 510 left side IDs, 493 right side IDs, and 60 photo-IDs from flukes. Comparisons of left sides were fully completed, and comparisons of right sides are underway. Fourteen matches were found between the areas in Australia. Photo-identified Australian whales were found within all three sub-areas: Geographe Bay, the Perth Canyon and the Bonney Upwelling, representing a high level of connectivity between these areas, and thus strengthening the hypothesis of one distinct population of Australian whales. Two whales were seen in three different years. The longest re-sighting period was 12 years and corresponds to a whale that was first seen in 2003 in the Perth Canyon and re-sighted in 2015 in the Bonney Upwelling. Two matches were found in the whales photographed off New Zealand. Matches off New Zealand have been found between the northwest coast and the northeast coast of the South Island. No match was found between whales off Australia and New Zealand, or between whales off Sri Lanka and Australia or New Zealand. These results also support the hypothesis of an isolated New Zealand blue whale population from the Australian population.

In discussion, it was commented that the New Zealand matches described here have been reported in SC/67b/SH05, and support the idea that the New Zealand population is relatively small. The Chair commented that the movements shown by these data are concordant with what is known about these populations from genetics and acoustics, and highlighted the importance of collecting photo-ID data for measuring population connectivity and abundance. The sub-committee thanked the authors for this update and **agreed** that the Southern Hemisphere blue whale catalogue should continue to be compiled. This is an item that has financial implications for the Scientific Committee. Further details are given in Item 7.1.1.

SC/67b/SH12 presented a progress update on the development of the blue whale song library, which was funded intersessionally by the IWC following a recommendation at SC/66b. The team (Miller, Samaran, and

Širović) have worked out the definitions of the terms for the library: definition of song and variant, naming structure, and ways of submitting new samples. They have also developed metadata requirements for submissions. An important feature will be inclusion of 'perfect' examples of the song, but also 'average' (i.e. most commonly recorded) examples to illustrate effects of propagation and facilitate identification. Currently underway is the process of migration of the library to the IWC web server with the IWC Secretariat IT staff. Once the library is ready, it will be announced to colleagues through listserves such as MARMAM and bioacoustics. Addition to the library will occur after peer-review acceptance of new songs and will be reviewed by a committee that will be selected to maintain quality control on the submissions.

In discussion, the recent application of these acoustic data to infer blue whale stock structure was highlighted (see SC/67b/SH11 and Fig. 1). Considering the limited availability of genetic samples to infer stock structure, the utility of this alternative measure was acknowledged, and the sub-committee **encouraged** further work to develop this initiative. The sub-committee were made aware that there will be ongoing maintenance costs of server hosting for the IWC Secretariat, which are currently being calculated and will need to be explicitly accounted for in Scientific Committee budgets going forward (see work plan in Item 7.1.1).

3.3.1 Southeast Pacific blue whales

SC/67b/SH03 presented the results of a morphometric analysis on Chilean blue whales. The taxonomic status of pygmy blue whales is in flux, with debate about whether northern Indian Ocean blue whales (pygmy) and Chilean blue whales should each be listed as separate subspecies. Length frequencies of sexually mature female blue whales from several regions of the Southern Hemisphere, call type, and genetics, have been used to propose that Chilean whales are a separate subspecies from pygmy blue whales throughout the Indian Ocean. This interpretation has been accepted by the Society for Marine Mammalogy's List of Marine Mammal Species and Subspecies. SC/67b/SH03 provided crucial morphometric data to directly address this taxonomic question that were obtained in a biological survey during the 1965/66 Chilean whaling season by a Japanese whaling company. The data for this season consist of sex, total body length, length from tip of snout to center of eye, and length from notch of flukes to anus for 60 blue whales ranging from 21.2 to 24.9m in total length. The data provide strong evidence that maximum body length, fluke-anus measurement, as well as the ratio of fluke-anus to total body length, are different among Antarctic, pygmy and Chilean blue whales, with the values of the Chilean blue whales being intermediate between pygmy and Antarctic blue whales. These results are similar to those obtained for the distribution of total body length of sexually mature females, and they are also consistent with the available genetic data and differences in song types among regions, and strongly support the suggestion that Chilean blue whales should be considered a separate subspecies.

The authors were thanked for this contribution which responds to a recommendation made in 2016 (item 3.1, IWC, 2017). In discussion, the authors were asked if it would be possible to compare these length data with measurements from the northeast Pacific, to assess any length differentiation between Chilean and northeast Pacific whales (as genetic data suggest they are closely related, e.g., LeDuc *et al.,* 2017). It was noted that these two populations appear to be similar in length although a formal comparison has not been done. No information on the sources of measurement data in the northeast Pacific was available for the sub-committee. Therefore, the sub-committee **encouraged** Pastene, Brownell and Branch to work intersessionally to compile this information. See Work Plan, Item 7.1.1.

Bedriñana-Romano *et al.* (2018) evaluated the use of different data types within a hierarchical Bayesian framework to model the abundance and distribution of a small and highly migratory population of blue whales summering in Chilean Northern Patagonia (CNP). Analyses showed that distance to areas of high chlorophyll-*a* concentration during spring (AHCC-s) was the most important and consistent explanatory variable for assessing blue whale abundance and distribution in CNP. Despite the limited and heterogeneous data, the hierarchical species distribution model showed good capacity to integrate the different data types. Results indicate that AHCCs, and possibly thermal fronts, could modulate blue whale abundance and distribution patterns in CNP. Preliminary model-based delimitations of possible priority conservation areas for blue whales in CNP overlap with highly used vessel navigation routes and areas allocated for aquaculture.

The authors were thanked for presenting this work. The fluctuations in abundance of blue whales in CNP shown here are also seen in the local mark recapture data (Galletti Vernazzani *et al.,* 2017). Potential use of the local abundance estimate presented in this paper was discussed, but it was cautioned that this area is unlikely to represent the whole Chilean blue whale population. In this regard, the collection and matching of regional photo-IDs was discussed, and the sub-committee welcomed news that the next priority for the Southern Hemisphere blue whale catalogue is to match all newly contributed photos from the southeast Pacific. This may help to improve understanding of population connections. Following recent discussions in the ASI Standing Group, it was highlighted that new methodologies now exist (e.g. McClintock, 2015) whereby data from multiple mark sources can be incorporated in a mark recapture framework; this may be particularly useful for blue whales where left and right side photos are used for photo-ID. The usefulness of other methodologies to investigate distribution and abundance were discussed, and the sub-committee **encouraged** more satellite tracking and surveys to do photo-ID and assess the distribution and abundance of blue whales in Chile.

3.3.2 Madagascar blue whales

SC/67b/SH14 reported on passive acoustic monitoring for baleen whales off the northwest coast of Madagascar at approximately 13.3°S latitude, monitoring in the Mozambique Channel. Three passive acoustic recorders were deployed during four 4-month deployments starting in December 2016 and ending in April 2018, anchored off the shelf break at depths ranging from 225-275m. Review of data from December 2016 to November 2017 revealed extensive documentation of both SWIO (Madagascar) pygmy and Antarctic blue whale song-types, fin whales and Antarctic minke whales. SWIO pygmy blue whale song was present bi-modally with peaks of singing activity during May-July and October-January, suggesting a previously unrecognised migratory corridor between summer feeding and winter breeding grounds south and north of Madagascar respectively. Antarctic blue whale song was present throughout the austral winter from June to September, suggesting a previously unrecognised breeding season aggregation area. NIO (Sri Lanka) blue whale song, as well as a potentially new and previously undescribed blue whale song, were detected for short periods between January and May. Fin whale song was present during the late austral winter, from early August to mid-September. The 20Hz pulses included a single secondary frequency peak at 94-96Hz; this appears to be distinct from the different types previously reported from the Southern Ocean, however further analysis and direct comparisons are necessary. The timing of fin whale song suggests a later arrival than Antarctic blue whales and a lower rate of occurrence and occupancy, potentially representing the northern extent of breeding habitat. Antarctic minke whale pulse trains representing three distinct song types were found to be very common in the higher bandwidth, although a systematic browse above 100Hz has not yet been completed. Antarctic minke whales were present from at least early July to early November, so remaining later in the season than Antarctic blue or fin whales. In addition, the monitoring has also documented the expected seasonal presence of humpback whales and year-round presence of Omura's whales. These new discoveries highlight the importance of the northern Mozambique channel as wintering habitat for several Southern Hemisphere migratory baleen whales, and emphasises the need for continued and more in-depth research and monitoring.

The authors were thanked for this work, which was carried out with financial support from the Scientific Committee following a recommendation during SC/66b (IWC, 2017). These data are particularly welcome because they provide new information on the migratory movements and distribution of poorly understood blue whale stocks in the Indian Ocean. The sub-committee **agreed** that the work presented in SC/67b/SH23 should be updated intersessionally to include this new information.

It was noted that fin whale song was also recorded during surveys, which could be contributed to the fin whale acoustic analysis proposed in Item 7.1.1. In discussion, it was clarified that the lack of reports of fin whale calls at lower latitudes than 13°S may be due to the focus on blue whale detection rather than an absence of fin whales, to these may also be present further north than this location.

SC/67b/SH24 reports on a baleen whale song type that, to the best of available knowledge, has not been previously described. The song was recorded at two disparate locations in the western Indian Ocean separated by approximately 3,500km, off Oman in the western Arabian Sea and off northwest Madagascar in the Southwest Indian Ocean, during independent efforts of long-term (one complete year) passive acoustic monitoring. The acoustic and temporal characteristics of the song were described to allow comparison with existing records throughout the Indian Ocean and assess whether it has been recorded in other areas or confused with a previously reported type. The song was relatively scarce on deep water recorders off Madagascar, whereas it was much more prominent off Oman given a temporal distribution of detections between November and June, a relatively high number of hours with detections, and the incidence of multiple singers. Although it is impossible to definitively attribute this song to a species, we suspect it is almost certainly a new blue whale (*Balaenoptera musculus ssp.*) song type, based upon its acoustic structure and temporal characteristics, along with supporting circumstantial evidence of blue whale sightings off Oman during days when songs were detected. If this species attribution is correct, this song would represent that of a previously undefined population of blue whales in the western Indian Ocean, that may be more associated with the North Indian Ocean and the Arabian Sea, and only an occasional visitor in the Southwest Indian Ocean and the Mozambique Channel. Given that this song type has not been previously reported in studies that documented the Sri Lanka song type, and that no Sri Lanka song types were detected in data off Oman, then there may be a longitudinal division of these populations between: (a) the Western Arabian Sea and western Indian Ocean in general; and (b) the eastern Arabian Sea / Bay of Bengal and central Indian Ocean in general. The presence of this population off the coast of Oman during the boreal winter is congruent with the timing of Soviet catches in the region (Mikhalev, 1997) and observations off Oman; thus the large numbers of blue whales caught in Soviet whaling operations in the Gulf of Aden and Arabian Sea may represent a population of blue whales that is distinct from that represented by the Sri Lanka song type, or a combination of two distinct populations. Continued work is recommended including: deep water acoustic monitoring in combination with boat-based surveys off the coast of Oman to validate these observations and allow definitive attribution to species; evaluation of existing acoustic datasets throughout the Indian Ocean for the presence of this song type; and reconsideration of current data and discussions on Northern Indian Ocean pygmy blues (e.g. SC/67b/SH23) in light of the possibility of two distinct populations in the Northern Indian Ocean.

In discussion, the authors confirmed that no Sri Lanka call types have ever been detected in recordings from Oman, suggesting that they have a more easterly distribution. Since this call has not been recorded at moorings further south or east, it was hypothesised that the 'Oman' call type may represent a non-migrating population of blue whales inhabiting the western Arabian Sea. The authors were thanked for this new information, which has implications for the current catch allocations proposed for assessment (see SC/67b/SH23) that are currently based on a single blue whale 'stock' in the Northern Indian Ocean. It was observed that a number of catches were made by Soviet whalers in the local vicinity of these calls, while few catches were made in the northeastern Indian Ocean suggesting that this unknown population may have been the more exploited of the two hypothetical Northern Indian Ocean stocks.

The sub-committee **strongly encouraged** further acoustic work in the region, in deeper water in order to obtain high quality recordings and further information about the distribution, seasonality and overlap of these calls in the western Indian Ocean and Arabian Sea. It was noted that deployment of acoustic recorders in the Gulf of Aden, Somalia and Yemen would be particularly useful and that collection of full propagations in close proximity would be helpful for fully characterising these calls.

The sub-committee also discussed the availability of genetic data from surveys and strandings in the Indian Ocean in order to better establish the population connectivity between blue whales using the west and eastern latitudes of this ocean. Some Sri Lankan samples are now available from strandings and collection of faecal samples during surveys, while offshore of Oman sloughed skin samples have been collected and 3-4 tissue samples from strandings have been obtained. The sub-committee **strongly encouraged** the collection and analysis of available samples for analysis of genetic population structure, including whale sloughed skin and faecal samples, which are not subject to CITES restrictions.

3.3.3 Indonesia/Australia blue whales

Attard *et al.* (2018) used a genomic dataset of 8,294 single nucleotide polymorphisms (SNPs) to assess population structure in pygmy blue whales from the Bonney Upwelling and Perth Canyon feeding aggregations in Australia. The study built upon Attard *et al.* (2010), which found no evidence of population structure within or between these aggregations using 10 microsatellites and the mtDNA control region. This lack of evidence could be due to no population structure or insufficient power to detect low levels of population structure. To determine this, 8,294 SNPs were developed using a standard double-digest restriction-site associated DNA sequencing (ddRAD) protocol (Peterson *et al.,* 2012). Power analyses showed that the SNP dataset was able to detect genetic differentiation (F_{ST}) as little as 0.001, whereas the microsatellite dataset could only detect a F_{ST} as low as 0.015. So, F_{ST} as well as analyses that do not require *a priori* putative population groupings were conducted on the SNP dataset. The latter included FASTSTRUCTURE (Raj *et al.,* 2014), Discriminant Analysis of Principal Components (DAPC) (Jombart *et al.,* 2010), and Principal Components Analysis (PCA). All analyses on the SNPs found no evidence of population structure. This is corroborated by growing photo-ID matches between the two feeding aggregations (see SC/67B/SH16 for Southern Hemisphere Blue Whale Catalogue update). Of additional interest, related individuals were detected using the SNP dataset with much greater power than the microsatellite dataset (see Attard *et al.* 2018, which uses these datasets as a case study). The SNP dataset also allowed Attard *et al.* (2018) to investigate the potential for adaptive differences between the feeding aggregations, but found no such evidence. In summary, the powerful 8,294 SNP dataset confirms previous inferences from a smaller 10 microsatellite and mtDNA dataset that the pygmy blue whales feeding in Australia are one population. For a similar study on Antarctic blue whales, see the IWC-SORP report (SC/67b/SH21).

In discussion, it was highlighted that these data are concordant with the photo-ID results reported in SC/67b/SH16. It was noted that the uncertain stock allocation (to New Zealand or Australia) of blue whale catches which occurred between Tasmania and mainland Australia is not resolved by these data, since no genetic samples are included from this region.

In 2008, a mark recapture estimate of blue whale abundance in Perth Canyon was presented to the Scientific Committee (Jenner *et al.,* 2008). Further work on this estimate was recommended (IWC, 2009; p.237), but has not yet been received. There are now plans underway to reanalyse these data and provide a new mark recapture abundance estimate for Perth Canyon at SC/68a. The sub-committee **encouraged** the authors to present an update of this work.

3.3.4 New Zealand blue whales

SC/67b/SH09 provides preliminary results from a voyage undertaken this summer to attach satellite tags to pygmy blue whales in the Taranaki region of New Zealand. The aim of this voyage was to examine the movement and habitat utilisation of pygmy blue whales in New Zealand waters. In total, the research team spent 72.51 hours (1,637.54km) actively searching for blue whales over eight survey days. Eleven blue whale sighting events were made of a total of 16 animals and 14 unique individuals. Overall, blue whales were found further south than anticipated, in lower numbers, and were not observed surface feeding, likely due to the La Niña anomalous oceanographic conditions, which resulted in sea surface temperatures 4-6°C higher than average, reduced west wind flows, and consequent reduction in upwelling, significantly impacting the high productivity characteristic of the Taranaki region. Photo-identification data were collected for 11 individual blue whales. All photo- identification data will be provided to the Southern Hemisphere Blue Whale Catalogue, and collaborations have been established with other researchers to share and compare data. Six skin/blubber samples were collected from four blue whales, and will be used to confirm the sub-species of the whales. Two satellite tags were successfully deployed and the preliminary track data are shown in Fig. 5. One of the two animals circumnavigated the South Island over the subsequent ~6 weeks. Due to the small sample size and La Niña conditions, it is uncertain how representative these movements are for blue whales in New Zealand waters.

This report was welcomed as it provides useful movement data for blue whales in a region currently being considered for population assessment. In discussion, it was noted that some of these whales went into the South Taranaki Bight area, an area which appears to be important habitat for blue whales (see SC/67b/SH05). The satellite telemetry also suggested that an area west of Westport (on the northwest coast of the South Island) was visited, supporting previous opportunistic and anecdotal sightings which suggest this area may also be a habitat that blue whales visit regularly. This area is not too distant from the South Taranaki Bight, suggesting possible continuity of habitat use between these areas within the broader Taranaki Bight ecosystem. Broader movement patterns made by two whales suggest that blue whales may use other habitats around New Zealand and supports the notion that whales surveyed in the South Taranaki Bight may be relatively representative of the population using the New Zealand ecosystem more broadly. However, it was cautioned that La Niña created unusual oceanographic conditions in this region during the 2017/18 austral summer, and habitat use patterns may consequently have been perturbed.

Papers SC/67b/SH04 and SC/67b/SH05 are from the same research group and focus on the South Taranaki Bight region of New Zealand. These papers were presented together.

SC/67b/SH05 reports on a multidisciplinary assessment of blue whales in New Zealand using survey data in the South Taranaki Bight (STB) region, photo-ID, genetic tissue analysis, and acoustic data from an array of five hydrophones. Results indicate a genetically differentiated blue whale population that occurs in New Zealand waters year-round, with a conservative abundance estimate of 718 individuals (95% CI 279-1926), and multiple individual re-sightings within New Zealand waters across multiple years and a lack of photo-ID matches with blue whales from neighboring regions. These results support the hypothesis of Torres *et al.* (2013) that this newly documented blue whale population is largely resident to New Zealand, although excursions beyond New Zealand waters may occur. The authors conclude that the STB region is an important area for New Zealand blue whales, particularly for foraging, which has important management implications given the high level of industrial presence in this area.

With the documentation of a New Zealand blue whale population (SC/67b/SH05), including an important foraging ground in the industrial region of the South Taranaki Bight (STB) region, comes the need for improved ecological data to inform conservation management action. As the New

Zealand government moves forward with the establishment of a marine mammal sanctuary in the STB region to protect blue whales from industrial activity, there is a need for robust information on blue whale distribution patterns and response to noise disturbance. SC/67b/SH04 reports two projects underway to fill these knowledge gaps and inform management decisions.

(1) Describe the fine-scale blue whale habitat use patterns during summer months in the STB region. They plan to develop predictive species distribution models of blue whales using *in-situ* oceanographic data, echosounder prey availability data, blue whale survey data, and remotely sensed SST and chl-*a* images.
(2) Large-scale blue whale distribution patterns in the STB region and response to acoustic disturbance. Using two years of acoustic data from an array of five hydrophones the spatial and temporal distribution of blue whale calls will be described over an annual cycle relative to remotely sensed environmental conditions and vessel traffic patterns, and the distributional response of blue whales to seismic airgun noise will be assessed.

The authors were commended for the range of work presented, which includes abundance and stock structure data useful for population assessment of New Zealand blue whales. The ASI Standing Group discussed this abundance estimate during SC/67b (see Annex Q, item 3.1.1.9) and will conclude their categorisation of this assessment during SC/68a. In discussion, it was noted that further New Zealand photo-identifications have been submitted to the Southern Hemisphere blue whale catalogue and could be informative for measuring population abundance at the regional scale. The sub-committee **agreed** to form a small intersessional group to progress photo-identification upload to the SHBWC (see Work Plan Item 7.1.1), for informing a broader mark recapture estimate of abundance which can be compared with the South Taranaki Bight estimate presented in SC/67b/SH05.

It was noted that one of the sightings included in this dataset was made at Raoul Island in the Kermadec Islands. There were no photo-IDs collected of this animal so the sub-species identity of this sighting is unknown.

4. PRE-ASSESSMENT OF SOUTHERN HEMISPHERE FIN WHALES

The Scientific Committee is currently encouraging the submission of new information on fin whale population structure, movements, abundance and habitat use, with a view to possible assessment of population recovery in the next ten years.

4.1 Southern Hemisphere population structure

SC/67b/SH15 summarised available data pertaining to fin whale stock structuring around the Southern Hemisphere. This comprised mostly sightings, catch, acoustic and genetic data, with a little movement information provided by satellite tracking off Chile and southeast Pacific Discovery mark deployments. The small amount of available genetic data shows no evidence of population structuring across the Southern Hemisphere, but acoustic data suggests more than one call type is present. Given the limited data currently available, the following work was proposed: (i) a comprehensive review of fin whale calls from Antarctica as well as lower latitudes to investigate fin whale call variation across the Southern Hemisphere; (ii) a focus on collecting genetic samples alongside good quality photo-ID (and ideally photogrammetry analysis of length), in order to co-identify individuals morphologically and genetically; (iii) a review of catch length statistics, particularly for catches taken at lower latitudes by the Japanese in the 1960s compared to earlier catches from the Antarctic, (iv) isotope analyses to investigate trophic differences in feeding; (v) a global review of museum holdings of Southern Hemisphere bone/baleen and corresponding external morphs, including genetic sampling from the fin whale subspecies holotypes, particularly *patachonica.*

In discussion, it was noted that IWC Management Areas I-V were originally delineated based on the distributions of fin and blue whale catches from Norwegian whalers, suggesting distinct aggregations across the high latitudes of the Southern Hemisphere (reviewed in Donovan, 1991). The sub-committee **encouraged** the provision of an updated fin whale distribution using all available catches. This will be completed intersessionally by De la Mare, using the method he has developed using catch per unit effort (CPUE) data to provide an index of relative abundance that is reasonably related to true density (de la Mare, 2014). The sub-committee also **encouraged** construction of a histogram of catches by longitude, to help identify high latitude aggregations.

Prospects for additional genetic studies of fin whale stock structure were discussed. Pastene highlighted the work on Antarctic fin whale structure reported by Goto *et al.* (2014) which included 55 high latitude samples and showed some significant differentiation between Antarctic Areas IV and V using microsatellites (see SDWG review p.229 in IWC, 2015). New analyses of these data are being conducted. It was also noted that a new study of fin whale population structure expanding on the geographic sampling in Archer *et al.* (2013) is also close to completion. The sub-committee **encouraged** the presentation of these two stock structure analyses for review next year during SC/68a.

Širović noted that fin whale songs are a potential tool for distinguishing populations. Distinguishing fin whale song features in the North Pacific include spectral structure of individual pulses, their patterning, and the inter-pulse interval (Širović *et al.,* 2017). In the Southern Ocean and the Mediterranean Sea, an additional distinguishing feature is a higher frequency component of the pulses (Gedamke, 2007; Širović *et al.,* 2009; Castellote *et al.,* 2012). In 2004, the calls in eastern Antarctica contained a higher frequency component at 99 Hz whereas the calls in the vicinity of the Western Antarctic Peninsula contained that same component at 89 Hz, possibly indicating two distinct populations in the Southern Ocean (Širović *et al.,* 2009). High frequency components of fin whale song have also been reported at mid-latitude monitoring stations in the Southern Hemisphere (Gedamke, 2007). Baleen whale songs are known to undergo both gradual and abrupt shifts; a recent example has been reported from the North Pacific (Širović *et al.,* 2017). Therefore, Širović noted that a study to analyse fin whale acoustic structuring should focus on the same year of recording from multiple locations, in order to minimise confounding due to song shifts. Such data has recently become available through the work of the IWC-SORP Acoustic Trends Working Group, which has concurrent data collection from several sites between 2014 and 2016.

The sub-committee welcomed this news and **agreed** that analyses of concurrently collected acoustic recordings should be carried out in order to assess fin whale song variation around the Southern Hemisphere. This recommendation has financial implications for the sub-committee (see Item 7.1.2 for more details).

SC/67b/SH13 reports the results of a study using genetic data from the southeast Pacific, specifically from a feeding area in the north-central coast of Chile (*ca.* 29°02'S, 71°36'W), to measure fin whale genetic differentiation between the southeast Pacific and southeast Atlantic. Currently, three sub-species of fin whales are considered valid, *Balaenoptera physalus physalus* in the Northern Hemisphere, *B. physalus quoyi* and *B. physalus patachonica* in the Southern Hemisphere. The latter is described as a pygmy-type sub-species and proposed to be located mainly in low to mid latitudes in the Southern Hemisphere (Clarke, 2004). Recently, Archer *et al.,* (2013) detected a strong genetic differentiation between North Pacific and North Atlantic fin whales, suggesting a taxonomic subdivision at the sub-species level. Little information was available, however, for the South Pacific and South Atlantic oceans, impeding a global taxonomic revision of this taxon. Mitochondrial control region DNA analysis (D-loop) of 19 biopsy samples collected in north-central Chile recovered 17 different haplotypes, with only two shared between individuals. A haplotype diversity (h) of 0.97 and nucleotide diversity (π) of 0.8% were estimated at a local level. At a global scale, phylogeographic analyses, including different ocean populations (*sensu* Archer *et al.,* 2013), showed a clear genetic differentiation between Southern and Northern Hemispheres as has been previously reported, as well as between North Pacific and North Atlantic Oceans. However, a low and unidirectional direction of gene flow from the South to North Pacific was detected. In contrast, no significant genetic structure was detected when comparing populations from the Southern Hemisphere (South East Pacific with that from the Atlantic Southern Ocean; F_{ST}=0.01539, p=0.1333), even considering samples that would represent the putative pygmy fin whale sub-species (*B. physalus patachonica*), suggesting the existence of a single evolutionary unit in this area. Therefore, these results might challenge the validity of the proposed pygmy fin whale sub-species and propose the existence of three taxonomic units (two for the Northern Hemisphere and one for the Southern Hemisphere).

The authors were thanked for their contribution. The sub-committee noted the very limited work carried out to date to examine fin whale stock structure in the Southern Hemisphere. The authors plan to sequence 20 further samples and present their analyses to SC/68a. Interpretation of the f_{ST} results presented in this paper was cautioned given the high diversity seen in the dataset, which can obscure low levels of population structure. The sub-committee recommended that a network diagram would be a more appropriate descriptor of the diversity, and that for such diverse data, unsupervised clustering methods (e.g., Rodriguez and Laio, 2014) may be better able to detect distinct haplotype clusters than standard F-statistic approaches. It was also noted that the phylogenetic tree showed very weak resolution with low bootstrap scores, perhaps reflecting the low power of control region sequences to resolve deeper nodes within the phylogeny. The possibility of replicate samples was raised, but it was noted that diversity was so high (17 haplotypes in 21 samples) that duplicates were unlikely. The Working Group **encouraged** collection of more samples and sequencing of more loci to improve the chances of detecting subtle geographic influences on population structure.

The population and demographic identity of the coastal fin whales was discussed. Fin whale calls recorded off the coast of Chile match those recorded in the Antarctic (Buchan, pers. comm.). Coastal recordings would be helpful to ascertain if those calls match those heard offshore and at high latitudes. Cooke highlighted that body length measurements of past catches off the coast of Chile (Appendix 3) showed that fin whales taken in these waters were particularly short, corresponding to one-year-old juvenile Antarctic fin whales in terms of body length. The fin whales biopsied in the current study may therefore be a juvenile cohort of the Southern Hemisphere fin whale population. A similar pattern can be seen off the west coast of South Africa, where predominantly juvenile Antarctic blue whales were caught (see Item 3.3, SC/67b/SH23; Mackintosh and Wheeler, 1929). Co-collection of photo-IDs along with genetic samples and use of hexacopters to measure body length was **strongly encouraged**, to help better understand the identity of these coastal whales.

In discussing the conclusions of the paper that there is no genetic differentiation between the eastern Pacific and eastern Atlantic, it was noted that despite the apparent lack of large-scale structure, recent satellite telemetry work off Isla Chañaral suggested a degree of site fidelity, with five of the six tagged animals remaining in Chañaral during the summer (Sepulveda *et al.,* 2017). In some areas fin whales are also seen aggregating year-round, possibly indicating residency (Toro *et al.,* 2016). However, long-distance movements from these grounds have also been reported; of 11 Discovery marks deployed off Chile, four were recovered in Antarctic Area II (South Atlantic), revealing fin whale movements from the Pacific to the Atlantic (Clarke, 1962). This may be concordant with the idea elaborated in Appendix 3 that the Chilean ground is mostly inhabited by juveniles who may travel south when they mature. In contrast to the Pacific, Discovery mark deployments in the Atlantic showed more traditionally longitudinal movements of fin whales to high latitudes (Brown, 1962). The sub-committee **agreed** to conduct a review of all Discovery mark data published on fin whales to assess population connectivity patterns, although they note that contemporary linkages may differ from those seen historically due to various factors, including changing oceanographic conditions and disruption of regular behaviours due to intense exploitation.

Evidence for the existence of a distinct subspecies *B. physalus patachonica* (see Clarke, 2004 for a review) was discussed and considered to be weak. However, *B. p. patachonica* is currently recognised as a subspecies (Committee on Taxonomy, 2017), so the veracity of this identification must be addressed. The sub-committee **reiterated** its previous recommendation that the Secretariat provide a letter of support to assist Archer in gaining approval to sample the *B. p. patachonica* holotype in the Buenos Aires museum, to establish the genetic identity of this specimen. They were also informed that another possible *B. p. patachonica* type specimen is held in Vienna Museum. Plans are underway for genetic sampling of this specimen. The sub-committee further noted that the size distribution of fin whales taken by whaling in the Antarctic and Subantarctic did not appear to support the notion of a smaller form of fin whales at lower latitudes (Table 1).

While the sub-committee generally felt that the evidence for *B. p. patachonica* being a distinct subspecies is weak, some members noted that there may be some latitudinal population structuring within Southern Hemisphere fin whales. Such latitudinal structuring might still suggest two distinct forms, including a poorly known high latitude type which may have been heavily exploited at higher latitudes early in the whaling period. The chief line of evidence for

Table 1
Size (m) of fin whales taken in Southern Hemisphere (pelagic whaling and (sub-)Antarctic land stations)

Latitude	Mean (m)	SD	*N*
North of 60°S	20.3	1.7	297,493
South of 60°S	20.4	1.6	311,443

Source: IWC Catch Data Base v6.1

this comes from the distribution of past catches: ~300,000 catches were made south of 60°S, inconsistent with the contemporary hypothesis that fin whales are mainly concentrated north of 60°S. Plots generated by de la Mare using his relative density model were reviewed in 2017 (see Appendix 3, IWC, 2018a) and show a shift from high latitude fin whale catches before 1935, to a high-density band of lower latitude catches in the 1970s. However, it was highlighted that this pattern also reflects the effort foci of the whale fishery, which initially targeted Antarctic blue whales at the ice edge, only later shifting focus to fin whales.

The sub-committee **agreed** that Southern Hemisphere fin whale stock structure is currently inconclusive, and **encouraged** further work using satellite telemetry, photo-identification, acoustics, biopsy sampling and length measurements to better understand fin whale population structure, movements and habitat use.

4.2 Southern Hemisphere distribution

SC/67b/SH10 reports the first confirmed stranding of a fin whale in Tierra del Fuego, Argentina, and provides information about the possible cause of death. No superficial lesions were found but the subcutaneous and visceral fat deposits were in bad condition and the stomach was empty. Histological sections of lungs and respiratory tract showed characteristics compatible with an initial stage of acute pneumonia. Although none of the pathological findings can convincingly explain the stranding, the pneumonia in combination with a bad physical condition, may have contributed to its death.

The authors were thanked for this information, which is from an area where fin whales are rarely seen. In discussion, it was noted that since this report there has been another fin whale stranding in Patagonia, and tissue samples from both strandings will be genetically analysed.

SC/67b/SH09 provided an update on meta-data collections for Southern Hemisphere fin whales. During the intersessional period (2017/18) nine new datasets have been added, 12 updated and two corrections have been made to existing datasets with one dataset being deleted. In total, 69 datasets have been identified, of which, 32 are from the West Antarctic Peninsula and Scotia Sea, whilst 37 are from other Southern Hemisphere regions. These datasets include a broad range of surveying methods, including visual and acoustic surveys, biopsies, stranded specimens, photo identification and telemetry. The table presented in SC/67b/SH09 is the most recent overview of available data sets on Southern Hemisphere fin whales.

The sub-committee welcomed this update to work previously presented last year at SC/67a (Appendix 2, IWC 2018a). The sub-committee **encouraged** the next phase of this work, a meta-analysis of the Western Antarctic Peninsula and Scotia Sea sightings data to measure recent fin whale distribution, density and habitat use. This information will be helpful for understanding current fin whale distribution patterns in relation to environmental features, and for comparison with past distributions inferred from whaling data (e.g. Appendix 3; IWC, 2018a).

Dalla Rosa informed the sub-committee about the recent work of the cetacean team of the Brazilian Antarctic Programme (PROANTAR), who have been conducting research in the Antarctic Peninsula region since 1997. Dedicated fin whale research has been conducted since 2013, including collection of sightings data, photo-identifications, biopsy samples, and satellite telemetry deployments. A total of 27 biopsy samples have been collected for studies on genetics, contaminants and stable isotopes. Six satellite tags have been deployed, providing new information on movements and dive behavior of fin whales around the Antarctic Peninsula. They currently hold a fin whale photo-ID catalogue for the Antarctic Peninsula, which numbers ~80-100 individuals. All these data have been collected with the main aim of helping to assess the population structure of Southern Hemisphere fin whales. He noted however that the current PROANTAR project will end at the end of the year, with no ship time or funding secured for 2019 onwards.

The sub-committee welcomed this update on the work of PROANTAR and **strongly encouraged** the continuance of this research program for the purpose of understanding fin whale population structure, movements and habitat use.

Fin whale song was also detected in the Northern Mozambique Channel during the late austral winter (see SC/67b/SH14) and discussed in Item 3.3.2.

4.3 Southern Hemisphere abundance

During SC/67a, the sub-committee requested a review of data from the post-CPIII IDCR/SOWER surveys to determine whether the data are of any use for informing on whale trend or abundance. They have since been informed that a regional abundance estimate has been generated for fin whales by Matsuoka and colleagues using CPIII data which is in the process of being published. The sub-committee **recommended** that this estimate be reviewed at SC/68a to determine suitability for use in population assessment.

SC/67b/PH01 reported on the compilation of a new photo-identification catalogue of Antarctic fin whales. A total of 30 identifications were obtained; 28 from Areas III, IV, and V during SOWER cruises and 2 from 2018 during a Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) fisheries research voyage at the South Orkney Islands. There were no matches between any of the identified individuals from different dates. Photographs were scored categorically in order to assess the suitability of Antarctic fin whales for photo-ID. Results of the scoring analyses confirmed that Antarctic fin whales are marked well enough to serve as subjects for photo-ID projects. Another 20-24 identifications are expected from SOWER 2006/07 photographs that are currently missing from the IWC archives. The catalogue serves as a foundation for future photo-ID studies.

The sub-committee welcomed this update which indicated that Southern Hemisphere fin whale photo-identifications could potentially be useful to measure abundance using mark-recapture methodologies and **encouraged** further photo-ID data collection. It was noted that the largest quantity of fin whale photographs is likely being collected in the Antarctic Peninsula, and that encouragement of tourists and naturalists to collect good quality photo-identifications during their Antarctic expeditions could be very helpful with developing this dataset. It was noted that fin whales are extremely difficult from which to collect good photo-identification images. In this regard, the sub-committee was informed that a matching protocol is currently under development for Omura's whales which may also be of assistance for fin whale matching. This option will be explored intersessionally.

4.4 Cruise reports

SC/67b/ASI07 reports the results of the systematic whale sighting survey conducted by two vessels in the Antarctic Areas VE (south of 60°S, 165°E-170°W including the Ross Sea) and VIW (170°W-145°W) under the NEWREP-A in the 2017/18 austral summer. The survey was conducted under two survey modes (Normal Passing mode (NSP), and an Independent Observer mode (IO)) based on IWC IDCR/SOWER survey procedures from 10 December 2017 to 20 February 2018. The total searching distance in the research area was 5,196.6 n.miles, including 2,441.2 n.miles covered in NSP and 2,755.4 n.miles in IO mode. A total of 66 schools (106 individuals) of fin whales were sighted in the research area. They were widely distributed in the western sector of Area VI. A biopsy sample (skin and blubber) was collected in Area VIW from one animal. Results of these data including multi-year data will be analysed and submitted to the NEWREP-A review meeting in the future.

SC/67b/SP08 reports the sightings of fin whales from the sighting and sampling vessels operating in Area VI (south of 60°S, 170°W-120°W) under the NEWREP-A, during the 2017/18 austral summer. The total search distance was 4,164 n.miles, and a total of 115 schools (272 individuals) of fin whales were sighted. No biopsy samples were collected. Results of these data including multi-year data will be analysed and submitted to the NEWREP-A review meeting in the future.

The sub-committee thanked the authors for this new information.

5. SOUTHERN HEMISPHERE RIGHT WHALES NOT SUBJECT TO CMP

Last year the Scientific Committee conducted a prioritisation exercise and decided that population assessment of southern right whales from southwest and southeast Australia was a top work priority for completion in the next 2-5 years (see item 9 of IWC, 2018a). In order to progress towards regional southern right whale assessments, a summary of abundance and trend data reported from across the range of the species was compiled (Table 2). These data have not yet been reviewed by the Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises (ASI), so are not yet officially endorsed by the Scientific Committee. Review of these estimates is proposed to occur during SC/68a.

5.1 Southern Hemisphere population structure

The 1998 Workshop on the Comprehensive Assessment of Right Whales: A Worldwide Comparison (IWC, 2001) agreed to divide the Southern Hemisphere into 11 management units for southern right whales based on the distribution pattern and locations of breeding aggregations. These units were: (1) sub-Antarctic New Zealand, (2) mainland New Zealand/Kermadec, (3) Australia, (4) Central Indian Ocean, (5) Mozambique, (6) South Africa, (7) Namibia, (8) Tristan da Cunha, (9) Brazil, (10) Argentina, and (11) Chile/Peru (IWC 2001). The 2011 southern right whale workshop (IWC, 2013) **agreed** to the hierarchy of stocks/habitats summarised in table 1 of that report.

With this background, the sub-committee reviewed currently available information on population structure in southern right whales, aided by a genetic study summarised in Carroll *et al.* (in press). The authors of this paper noted that in southern right whales, patterns of genetic diversity are likely influenced by the glacial climate cycle and recent history of whaling. The study used a dataset of mitochondrial DNA (mtDNA) sequences (*n*=1,327) and nuclear markers (17 microsatellite loci, *n*=222) from major wintering grounds to investigate circumpolar population structure and historical demography. Analyses of nuclear genetic variation identified two population clusters that correspond to the South Atlantic (Argentina and South Africa) and Indo-Pacific (New Zealand and Australia) ocean basins that have similar effective breeder estimates. In contrast, there was significant differentiation among wintering grounds for mtDNA, and to a lesser extent, microsatellite loci, but no sex-biased dispersal was detected using the microsatellite genotypes. An approximate Bayesian computation (ABC) approach with microsatellite markers compared scenarios with gene flow through time, or isolation and secondary contact between ocean basins, while modeling declines in abundance linked to whaling. Secondary-contact scenarios yielded the highest posterior probabilities, implying that populations in different ocean basins were largely isolated and came into secondary contact within the last 25,000 years, However, the role of whaling in changes in genetic diversity and gene flow over recent generations could not be resolved. The authors hypothesised that these findings were driven by factors that promote isolation, such as female philopatry, and factors that could promote dispersal, such as oceanographic changes. These findings highlight the application of ABC approaches to infer connectivity in mobile species with complex population histories and currently low levels of differentiation.

The Chair complimented the authors on the range of data and analyses presented in this paper. In discussion, it was noted that the mitochondrial haplotype network pattern (Fig 3d; Carroll *et al.,* in press) suggests that the South Pacific and South Indo-Pacific haplotypes originated from the South Atlantic (i.e. a 'founder' effect), with the South Atlantic appearing more ancestral and more diverse than the South Pacific, but historical and bottleneck ABC estimates of effective size are similar for both populations. This may point to further population complexity, and further ABC analyses to explore founder population hypotheses could be useful. In response, the author highlighted that this was noted in the manuscript and that comparisons of more complex population hypotheses are poorly distinguished using the available microsatellite loci, but upcoming genomic work on these populations should provide more capacity for such testing.

Levels of population differentiation and migration between calving grounds can provide useful information for regional population assessments. It was noted that the whales in southeast Australia were not significantly differentiated from those in New Zealand but were differentiated from

Table 2

Southern right whale abundance and trend data

	Method	Time series	Demographic parameters	Notes	Citation
New Zealand	Boat based photo-ID and genotype mark recapture estimates using POPAN and lambda-POPAN models	1995-1998 and 2006-2009	Super-population size for 1995-2009: 2169 (95% CI: 1836, 2563); 2009 abundance for females: 1074 (95% CL 812, 1339); Annual growth rate 1995-2009: 7% per annum (95% CI; 5%, 9%)	Includes NZ sub-Antarctic, Mainland NZ	Carroll *et al.*, (2011; 2013)
Southeast Australia	(1) Aerial survey and population size estimated as correction to the number of reproductive females, assuming (a) consistent number of females per year and (b) correction factor of 3.94 (IWC 2001) and (c) correcting for availability bias derived from proportion of time spent diving.	2013-2014	250-300 whales; 257 (CV 0.367)	Results were extrapolated from two years of survey	Watson *et al.*, (2015)
Southwest Australia	Aerial survey with trend estimated as simple exponential regression and total population size estimated as correction (x3.94) to the number of reproductive females in last three cohorts (IWC 2001)	1993- 2016	Total population size for 2016: 2195 (No CIs available); Annual growth rate for all animals of 5.55% (95% CI 3.78, 7.36%)		Bannister (2017)
Head of Bight sub-area of Southwest Australia	Cliff-based counts with trends estimated using compound annual growth rate (CAGR) and linear regression analysis (LR)	1992-2016	Trend over time series: CAGR: 5.5% (SD 2.5%); LR: 3.2% (CI +/- 1.3%)		Charlton *et al.*, (In prep)
South Africa	Photo-ID from aerial survey integrated into population demographic model that estimates population parameters using female reproductive cycle; total population size found by adding estimated numbers of mature and juvenile females and then using a 50:50 ratio to include males	1979-2017	Total population size for 2017: 6116 whales (SE 446); Annual growth rate 6.5% (SE 0.3%);	Estimate relates to southern Cape coast breeding ground with linkages to Namibia, and possibly Mozambique, but does not account for whales historically seen around Tristan da Cunha	SC/67b/SH22
Argentina – Península Valdés	Photo-ID from aerial survey integrated into population demographic model that includes the female reproductive cycle and estimates population parameters and total population size	1970-2010;	Annual growth rate 2000-2010: 6.5% (SE 0.2%); Mature females in 2010 1,578 (SE 72); aged 1+ population size in 2010 4,765 (SE 243)		Cooke *et al.*, (2015)
	Aerial survey count	1999-2016	Number of calves in survey area, rate of increase: 0.5%		SC/67b/CMP05
Brazil	Photo-ID from aerial survey with trend estimated as linear regression of the natural log number of females with calves identified each year; population parameters using female reproductive cycle	(1) 1987-2003; (2) 1987-2011;	(1) Annual growth rate: 14% per year (95% CL 7.1, 20.9) for time series 1 (2) Annual growth rate for time series 2: 12.0% (CI 8.514.2%); Population size in 2010: 197 mature females (CI 146-234).		(1) Groch *et al.*, (2005); (2) IWC (2013)

[A] Note that there is no new information available for Chile/Peru or the Central Indian Ocean.

those in southwest Australia. It was queried whether the small sample size available from southeast Australia might limit stock discernment. However, the authors responded that the 12 samples collected were from Warrnambool, the only regular calving ground in southeast Australia. The samples represent perhaps a third of the total breeding females (Watson *et al.,* 2015), so are likely to be relatively representative of this stock. They also highlighted the different abundance trajectories observed in the two regions of Australia (see Table 1), which also suggest a degree of demographic isolation.

The broad confidence intervals on some ABC parameter estimates were noted, although the authors highlighted that confidence intervals on the inter-ocean migration rates were relatively precise, and that precision of these estimates is likely to be improved when genomic analyses of the samples are conducted.

5.1.1 New Zealand right whales
Carroll informed the sub-committee of a plan to conduct surveys in the Auckland Islands in 2020/21 to estimate abundance (updating the last estimate from 2009), to assess trend and population age structure, as well as changes in genetic diversity. The project will use a close-kin mark-recapture approach (Bravington *et al.,* 2016). It was cautioned that implementation of this approach is challenging, and the assumptions of the method have to be very well understood and accounted for (see Item 6.2.1, IWC 2018b). Carroll responded that they recognise this issue and are undertaking a feasibility study and power analysis, including epigenetic work in collaboration with Jarman.

5.1.2 Australian right whales
Double reported the latest results from John Bannister's long-term monitoring program (1993 to 2017) of Australia's western population of southern right whales. The 2017 aerial survey from Cape Leeuwin (Western Australia) and Ceduna (South Australia) recorded 847 individuals, of which 303 were cows accompanied by calves of the year. The 2017 counts were the highest yet in the series. Application of a simple multiplication factor to the total count of cow/calf pairs seen over the last three years of survey produces an estimate of the total population size of approximately 2,474 individuals. Although the counts are highly variable between years an exponential increase of approximately 6% per year remains the best description of the data. The Australian Government has agreed to fund this survey for a further three years through its National Environmental Science Program.

The sub-committee recognised the value of these long-term monitoring programs and the value of these datasets for the work of the Scientific Committee and for conservation management and **recommended** that this monitoring continue.

Charlton *et al.* (in prep.) examined demographic parameters for southern right whales off South Australia using 26 years of photo identification (ID) mark recapture data and 25 years of count data. An annual cliff-based photo-ID and count study was completed at the Head of the Great Australian Bight, South Australia from 1991 to 2016. Annual aerial photo-ID and count surveys were completed for the 'western' sub-population of right whales from 1993 to 2016. At Head of the Bight, the estimated mean rate of increase for all right whales was 3.17% per annum (R^2=0.54, ±1.3, 95% CI), and for females with calves was 4.6% (R^2=0.57, ± 1.7, 95% CI) (1992-2016). Owing to cohort structure and pulses in calf production, the annual maximum count was highly variable among years (mean=39, SD=17.8). The Head of the Bight photo-ID database includes 1,186 non-calf individuals, of which 459 are reproductive females with 471 recorded inter-annual calving intervals. Southern right whales sighted at Head of the Bight represent 21-48% of the 'western' sub-population in Australia, where this fraction decreased over the study period. Mean photo-ID success of 92% and a mark recapture rate of 70% was recorded for females with a calf. The estimated apparent mean calving interval was 3.3 years (SD=0.8, ± 0.3, 95% CI), although this changed to 4 years in the latter part of the study. The mean observed age at first parturition was 9.3 years (*n*=22, SD=2.1, ± 0.9, 95% CI), with the minimum at 6 years. The oldest whale was approximately 50 and the oldest female with a calf 41, indicating that females continue to reproduce at least into their 40's. Natal site fidelity was recorded for 33% of known-age individuals. These SRW demographics data provide information for monitoring recovery, population status, species conservation management and global comparative studies.

In discussion, it was noted that the number of unaccompanied adults was not growing at a rate that would be expected from an increasing population; this might be due to habitat specialisation, with mothers and calves preferentially occupying the Head of the Bight area and other adults spending less time there. The rate of increase in Head of the Bight is lower than reported from South Africa and Argentina; this may reflect density dependence operating at the Head of the Bight and suggests that this is an open population.

The issue of why calving intervals appear to have lengthened to a mean of four years was also discussed; further analysis might examine correlations between oceanographic indices and calving intervals, as has been shown for the North Atlantic (Greene *et al.,* 2001) and Southwest Atlantic (Leaper *et al.,* 2006; Seyboth *et al.,* 2016). During 2014-16 there was a similar increase in calving interval in this region and in South Africa (see SC/67b/SH01 and SC/67b/SH22), suggesting a phenomenon that may affect much of the Southern Hemisphere. The sub-committee were informed that a workshop is planned to study calving intervals and body condition in right whales and other balaenids in November 2018 at the New England Aquarium which could prove informative (see Annex G). There was considerable discussion regarding factors affecting or potentially biasing apparent calving intervals. Previous entanglement has also been shown to be a factor in diminished reproductive success in the North Atlantic, but there is no evidence that this is a problem for whales in Australian waters. It was noted that as calving intervals increase, the practice of excluding apparent calving intervals of >6 years from analysis might be problematic as it could downwardly bias the calving interval estimate. The sub-committee **agreed** that these calving data would most usefully be analysed in a modelling framework which can accommodate this uncertainty, and that the model implemented by Cooke (e.g. appendix 1 of SC/67b/ASI02) would be the best approach for analysing population trends across all calving grounds.

Carroll reported that an aerial survey was conducted in south-eastern Australia that covered the area from Ceduna to Sydney including Tasmania, updating the earlier survey reported in Watson *et al.* (2015). The 2013 survey found that 91.5% of the 59 individually identified whales recorded during the survey were not previously known. While the study provided an abundance estimate of 200 animals, the authors acknowledged the limitation of just two years of survey effort and that they could not fully address issues related to the detectability of whales within the surveyed region.

The sub-committee **encouraged** further work on these data in order to measure abundance of this population. It was noted that most survey work to date has been concentrated in the vicinity of Warnambool, and that survey effort in other areas of Australia would be useful to establish whether the high recapture rates seen in this region are also found elsewhere. Opportunistic photographs collected from the region may help to establish whether this local population estimate is representative of the wider southeast Australia region.

Double informed the sub-committee that the Australian Government has recently allocated funds, through its National Environmental Science Program, to a two-year project that will provide an abundance estimate for Australia's two southern right whale populations. It will also investigate life history characteristics and levels of connectivity between breeding areas on the eastern, southern and western coasts of Australia. Information on population abundance and movements will allow an assessment of the status of right whales in Australian waters and determine if conservation and management efforts are effectively coordinated between regions. This is a highly collaborative project that is made possible through the cooperation of many photo-identification catalogue holders and engagement with leading analysts.

5.1.3 South Africa right whales

SC/67b/SH01 reported the results of the 2017 photo-ID aerial survey of southern right whales, flown across the southern Cape coast of South Africa. The survey, which has been operated with a photo-ID component since 1979, has in recent years shown a marked decline in the presence of unaccompanied adults (since 2010) and cow-calf pairs (since 2015), for unknown reasons. To continue monitoring and investigate the trend, aerial surveys were conducted in the whale calving and nursing season (June to December) of 2017. The annual photo-identification aerial survey was flown as usual on 2-10 October with the aim of counting all southern right whales and photographing all females with calves and individuals with a brindle or grey blaze colouration between the area of Nature's Valley and Muizenberg. In total, 182 groups comprising 183 cow-calf pairs (366 animals) and 82 groups comprising 161 unaccompanied adults were observed. The number of cow-calf pairs represents the second-to-lowest count in the last 17 years of survey. The 2017 count of unaccompanied adults represents the highest presence since 2010, although levels remain significantly lower than those observed pre-2010. Additional aerial surveys to count cow-calf pairs were flown in July, September and November, covering the main calving areas. Results suggest a peak presence of cow-calf pairs along this stretch of coastline in early September, opposed to the previously assumed peak in October (when the annual photo-identification survey is conducted). Analysis of photo-ID data indicated an increasing occurrence of 4- and 5-year calving intervals post-2014. Current data suggest two working hypotheses to explain the continued low presence of southern right whales on the South African calving ground: (1) a temporal shift in seasonal presence, and (2) a decreased calving success. The authors stressed the importance of continuing the aerial survey series and an in-depth assessment of the resulting demographic parameters to monitor the status of this population.

SC/67b/SH22 extended the analyses of Brandão *et al.* (2013) that applied the three-mature-stages (receptive, calving and resting) model of Cooke *et al.* (2003) to photo-identification data available from 1979 to 2012 for southern right whales in South African waters, by taking five additional years of data into account. The lower counts of calving females over 2015 to 2017 are indicated to be a reflection of time variability in the probability that a resting whale rests another year, rather than of any mass mortality. The 2017 number of parous females is estimated to be 1,765, the total population (including males and calves) 6,116, and the annual population growth rate 6.5%. This reflects a small decrease from the 6.6% increase rate estimated previously; this is the case even given the lower numbers of whales observed in recent years compared to previously. Information from re-sightings of grey-blazed calves as adults with calves allows estimation of the first-year survival rate at 0.852, a slight increase from the previous estimate of 0.850, compared to a subsequent annual rate of 0.988. It appears that 2009 was the year when a decrease in the calving rate commenced, for unknown reasons. The variation in calving rate in South Africa is broadly similar to that observed in Australia, with similar timing for high and low values, reinforcing the idea that examining broad-scale environmental correlates might prove to be a productive approach.

In discussion, it was noted that addition of the time-varying b parameter (probability that a resting mature whale rests for a further year) has an improved fit to the data, but the b parameter varies substantially between years and may be better fitted using environmental correlates to inform this value. The substantial change in this value after 2009 was highlighted, suggesting a significant shift in the dynamics of this population. The sub-committee noted the common features of this population trend when compared with those presented in Charlton *et al.* (in prep.). The sub-committee **recommended** those responsible for the different southern right whale studies consider using an integrated dataset and (as far as possible) a common modelling framework to explore broader-scale analyses, including incorporation of environmental correlates (see Item 5.2).

5.1.4 Feeding grounds

In paper SC/67b/SH06, genetic markers ('tags') were employed to identify individual southern right whales to assess their site-fidelity and sex-specific ranges in Antarctic Area IV. In total, 157 biopsy samples were collected from whales during fourteen summer surveys. Each sample was sexed, genotyped at fourteen microsatellite loci, and sequenced for 430 bp of the mtDNA control region. The overall probability of identity was estimated at 1.95×10^{-10}. After removal of duplicate samples, the number of individuals was reduced to 153. Eight 'mark-recapture' incidences were detected (four males and four females). Individual matching by multi-locus genotypes was supported by mtDNA, sex determination, and in two cases by photo-identification. These eight recaptures suggested that individual whales tended to return to the same location in the Antarctic in subsequent years. The average longitudinal dispersal ranges were 13°06' and 7°15' in males and females, respectively. The time span between the 'mark' and the 'recapture' ranged from 3 to 13 years, with an average of 7.3 years. Preliminary application of a mark-recapture method based on an open population model, resulted in abundance estimates in Area IV similar to those obtained using line-transect-based sighting survey data. For example, the estimate of abundance by the genetic 'mark-recapture' method was 1,619 (95% CI: 868-3,151) individuals for 2015/16, similar to the most recent (2007/08) sighting survey abundance estimate of 1,557 (95% CI: 871-2,783) in the same area. The authors emphasised that these estimates correspond to a fraction of the total population migrating into the Antarctic feeding ground of Area IV.

The authors were thanked for bringing forward this information and **encouraged** to conduct further mark recapture analyses and present estimates of abundance to SC/68a, noting that southwest Australia is currently a priority area for population assessment (item 9 of IWC, 2018a). In discussion, it was noted that this inter-annual feeding ground fidelity is consistent with regional stable isotope and genetic analyses (including in southwest Australia) which show that whales feeding in similar areas are more closely related to each other (Carroll *et al.,* 2015). In this context, it was queried whether the current microsatellite data are able to discern sibling relationships and whether genotypic error rates have been calculated, given that probability of identity for siblings should also be considered when judging the certainty in the genotype matches. The authors responded that genotypic error rates were ~0.1 and that work to assess relationships between individuals is now underway. It was also suggested that permutation tests could help establish whether the resighted whales were geographically closer to each other than one might expect from a random pair of sightings. The authors informed the sub-committee that photo-identifications have also been collected from this area and will also be analysed in a mark recapture framework.

The southern right whale distribution in Antarctic Area IV was discussed. IDCR-SOWER surveys suggest their distribution is concentrated between 90-130°E and south of 60°S (Matsuoka and Hakamada, in press), similar to the feeding area for humpback whales associated with west Australia breeding stock D (Branch, 2011). In discussion of the preliminary abundance estimate presented, it was noted that the most recent estimate of abundance for western Australia (~2,500 whales, see Item 5.1.2) was substantially higher, supporting the stable isotope-driven hypothesis that different components of the calving ground population feed in different places (Carroll *et al.,* 2015). In this regard, it was suggested that these high latitude data be compared with mtDNA haplotype frequencies and sequences associated with the western Australia stock to investigate what component of that population is using this high latitude area.

SC/67b/SH20 reported the results of a visual and acoustic survey of southern right whales off the islands in the South Atlantic at 54°26'S, 36°33'W, in January/February 2018. During 19 days of expedition time in these waters (totalling 76 hours where weather conditions were suitable for survey), right whales were sighted 15 times (an estimated 31 whales), yielding 21 right whale photo-identifications (left and right sides). Three right whale biopsy samples were collected. Work is now underway to assess the body condition of the whales sighted during the cruise. Analysis of right whale sightings data in relation to oceanographic features is also in progress. During the survey, 27 sonobuoys were deployed and right whales were detected by 19 of these, the most commonly heard call types being upcalls <200 Hz, as well as some gunshots. A second right whale research expedition to 54°26'S, 36°33'W is planned for January/February 2019.

5.2 Progress towards population assessment

Jackson summarised recent increases in knowledge of southern right whale catches, including newly available information from projects analysing historical whaling logbook data, notably from American and British whaleships (e.g., Smith *et al.,* 2012; Carroll *et al.,* 2014; Roux *et al.,* 2015) and work on numbers of whales struck-but-lost by the different fisheries (e.g. Carroll *et al.,* 2014), which is important for upwardly correcting landed catches to account for whales lost at sea. She suggested that it would be timely and valuable to hold a workshop bringing together (among others) individuals involved in these data recovery efforts, in order to better assess the situation with regard to catches and discuss ways to fill gaps in the record.

The sub-committee **supported** the proposal for this workshop. They also agreed that this should focus on collation of catch data, and subsequently consider how to utilise this information within the context of an assessment. This proposal has financial implications for the Scientific Committee. Further details are provided in Item 7.1.3.

Following the discussions in Item 5.1.2, Charlton introduced a proposal to complete a comparative study of demographic data using common models generated by Cooke *et al.* (2015) and SC/67b/SH22, for Southern Hemisphere right whale populations. Specifically, demographic parameters include: abundance trend, calving intervals, age of first parturition, survival and mortality. The project would also investigate correlations between SRW abundance trends/calving intervals and environmental variables in the Southern Ocean. The sub-committee **agreed** that this work proceed. This proposal has financial implications for the Scientific Committee. Further details are provided in Item 7.1.3.

6. SOUTHERN HEMISPHERE HUMPBACK WHALES

6.1 Progress towards assessment of Breeding Stock D

Last year, the sub-committee encouraged a survey of humpback whales off Western Australia for the purpose of producing a new abundance estimate, although it remains unclear if this is feasible either financially or logistically. The sub-committee hoped that such a survey would occur at some point and **reiterates** their recommendation from SC/67a that a re-analysis of the pilot study conducted by duFresne *et al.* (2014) be carried out to assess the feasibility of future surveys.

7. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

The sub-committee assessed and prioritised funding requests for the biennial period, 2018/19 and 2019/20, against Scientific Committee criteria and sub-committee priorities identified during the course of this meeting. Sub-Committee recommendations for funding are detailed in the following Work plan (unless otherwise indicated). A summary of the Work plan is in Table 3.

7.1 Work plan for 2019-20

The sub-committee **recommended** development of photo-ID outreach material to circulate amongst IAATO operators, naturalists and citizen scientists, to enhance citizen-contributed photo-ID for key catalogues including the Antarctic blue whale, Southern Hemisphere fin whales, Southern Hemisphere blue whale catalogues and regional southern right whale catalogues. This is relevant for all high latitude Southern Hemisphere species (details of this discussion are in Annex S, Item 4.1 and 8). The cost for the Scientific Committee would be £1,000 in 2018/19 for the creation of this guide, as well as provision of Powerpoint materials and guidance notes for naturalists.

7.1.1 Blue whales

7.1.1.1 ANTARCTIC BLUE WHALES

Work on the Antarctic Blue Whale Catalogue is ongoing. During the upcoming year photographs contributed from various sources will be examined and quality coded, including ~45 individual Antarctic blue whales photo-identified during ICR cruises 2014-2017. The sub-committee **agreed** to support continued work on this catalogue, to be conducted by Olson, with a budget allocation of £3,000 for 2018/19 and £800 for 2019/20.

The sub-committee **encouraged** further mark-recapture modelling by Olson using resight data from the Antarctic blue whale catalogue in order to address the suggestions made by the ASI Standing Group (Annex Q, Item 3.1.1.9).

An intersessional email group formed under Brownell and Kato in SC/66a is still in progress in order to progress work on the baleen plates from whales caught during the 1946/47 Antarctic season and currently stored at the Smithsonian with the Japanese whaling logs. Details are given in appendix 4 of IWC (2016).

Attention: SC, G, CG-A

*The Committee **welcomes** the progress being made towards being able to undertake a new population assessment of Antarctic blue whales. The Committee:*

*(1) **encourages** further work to update the abundance estimate for Antarctic blue whales following Committee recommendations;*
*(2) **strongly encourages** continued opportunistic photo-ID data collection in the Antarctic to assist with developing estimates of population abundance for this subspecies; and*
*(3) **encourages** continued collection and analysis of bone and baleen from historical Antarctic commercial whaling samples and sites to evaluate loss of genetic diversity and shifts in population structure.*

7.1.1.2 NON-ANTARCTIC SOUTHERN HEMISPHERE BLUE WHALES

Preparation for Southern Hemisphere pygmy blue whale assessments is still underway. The sub-committee **encouraged** a number of intersessional initiatives in support of this.

(1) Further work on the allocation of catches to acoustically distinct putative pygmy blue whale populations, including; (i) incorporating the new data presented in SC/67b/SH25 into the catch allocation model; (ii) bootstrapping of acoustic recordings to better account for distributional uncertainty; (iii) development of high case catch allocations for all stocks; (iv) modelling of regional population exploitation trajectories where sufficient abundance and trend data are available to allow preliminary population assessment; (v) Alternative assessments based on extrapolation of abundance estimates using: (1) ratio of the area surveyed to geographic range; and (2) ratio of catch in area surveyed to catch in geographic range of each population. This work would require a budget allocation of £6,185 GBP in 2018/19 and £12,865 GBP in 2019/20.
(2) Discussion on catch allocation scenarios to inform pygmy blue whale population modelling, to be held intersessionally in an email group convened under Branch and composed of Jackson, Brownell, Širović, Buss, Olson and Cerchio.
(3) Work to continue on the Southern Hemisphere Blue Whale Catalogue. Work to be conducted by Galletti and associated researchers with a budget allocation of £16,810 GBP for 2018/19 and £3,000 GBP for 2019/20. The following work is planned: (i) conduct matching with new photos from the Eastern Tropical Pacific and southeast Pacific; (ii) integrate new IWC database requirements into SHBWC software; and (iii) update the User Manual. If further photographs are submitted to the catalogue intersessionally from Australia, New Zealand and Sri Lanka, funds calculated based on matching costs (likely range within £5,000-£10,000) will be requested at SC/68a in order to continue within-region matching efforts, if funds are available. Hosting of the catalogue on the IWC servers has an ongoing cost of £900 per year in 2018/19 and 2019/20 to cover web and database hosting, other infrastructure, back-up storage and software licensing.
(4) Complete development of the blue whale song library, to be hosted on IWC servers. This completes a project funded by the IWC during SC/66b (item 10.2.2, IWC, 2017). This development also has an associated cost of £450 per year in 2018/19 and 2019/20 for the Secretariat to cover web and database hosting, other infrastructure, back-up storage and software licensing.
(5) Re-analysis by Jenner of the Perth Canyon mark recapture estimate of blue whale abundance presented to the IWC in 2009 (Jenner *et al.,* 2008), with assistance from Double and Jackson.
(6) Intersessional email group (shared with the Photo-Identification Working Group) to progress the upload of photo-IDs collected around New Zealand to the Southern Hemisphere blue whale catalogue for the purpose of mark recapture abundance estimation (composed of Galletti, Torres and Olson, convened under Olson). See Annex S,work plan.
(7) Intersessional e-mail group to investigate the different morphometric measurements made for pygmy, Chilean and North Pacific blue whales during the whaling period, assess comparability of these measurements and address whether the Chilean blue whales are most similar in length to the northeast Pacific blue whales. This group is composed of Pastene, Brownell and Branch (convened under Brownell).

Attention: SC, G

In order to progress its work towards an assessment of pygmy blue whales, the Committee:

*(1) **agrees** that further work is needed to identify high and base case catch scenarios for pygmy blue whales;*
*(2) **encourages** deployment of more acoustic recorders in the southern Indian Ocean;*
*(3) **agrees** that further population modelling is needed to assess pygmy blue whale populations;*
*(4) **strongly encourages** blue whale research groups to publish the metadata associated with their sequences in order that levels of sample overlap can be established and datasets compared; and*
*(5) **agrees** that the Southern Hemisphere Blue Whale Catalogue should be continued to help understand blue whale movements, with a priority focus on matching photographs within regions to measure regional abundance of pygmy blue whales.*

Attention: SC, G

*The Committee **encourages** analysis to provide an estimate of Australian blue whale abundance using mark-resight data.*

Attention: SC, G, CG-A

The Committee notes that the distribution and population isolation of blue whales is poorly understood in the northern and western Indian Ocean. The Committee therefore:

*(1) **strongly encourages** further acoustic work in the western Indian Ocean and Arabian sea to better understand the distribution, seasonality and overlap of blue whale calls;*
*(2) **strongly encourages** the collection and analysis of available tissue samples for analysis of genetic population structure in this region, to assist with characterising these populations; and*
*(3) **agrees** that catch allocations of blue whales be revised to include the new blue whale song in the northwest Indian Ocean as a potential distinct 'stock'.*

Attention: SC, G

With respect to information on blue whales off New Zealand, the Committee:

*(1) **welcomes** this work to understand abundance and connectivity, which will contribute towards the pygmy blue whale population assessments; and*
*(2) **agrees** that New Zealand photo-identifications should be combined with others within the Southern Hemisphere Blue Whale Catalogue to provide the fullest possible assessment of regional abundance and connectivity.*

Attention: SC, G

In view of the recent identification of movements of Chilean blue whales into the South Atlantic and ongoing questions about the distribution of this population, the Committee:

*(1) **encourages** further satellite tracking and surveys (including collection of photo-ID and genetic data) to assess the population limits, habitat use and abundance and sub-species identity of blue whales in Chile;*
*(2) **encourages** compilation of morphometric data available for northeast Pacific blue whales and comparison with Chilean data, to assess morphological differentiation of these whales in the eastern Pacific and evaluate sub-species identity; and*
*(3) **welcomes** plans for further photo-ID catalogue matching within this region to assist with regional abundance estimation.*

7.1.2 Fin whales

In view of the absence of available data to inform Southern Hemisphere fin whale stock structure, the sub-committee **encouraged** further work using satellite telemetry, photo-identification, acoustics, biopsy sampling and length measurements to better understand fin whale population structure, movements and habitat use. They also **strongly encouraged** the continued work of the Brazilian Antarctic Program on these questions in the Antarctic Peninsula. Given that there are two sub-species of fin whales proposed to occur in the Southern Hemisphere (Clarke, 2004; Committee on Taxonomy, 2017), further work to understand the genetic and morphological identity of fin whales across their range was encouraged.

In particular, the sub-committee:

(1) **agreed** to conduct a review of available fin whale acoustic data and analysis to analyse fin whale call types and their distribution patterns across the Southern Hemisphere. This would cost the sub-committee £12,000 to undertake during 2019/20;
(2) **strongly encouraged** the co-collection of photo-IDs along with genetic samples, and use of hexacopters to measure body length by Chilean researchers working in Chilean waters;
(3) **encouraged** further sampling and sequencing of multiple nuclear loci from Chile and other Southern Hemisphere locations to investigate subtle population structure patterns;
(4) **agreed** to conduct a review of all published and unpublished Discovery mark data on fin whales to assess population connectivity patterns, to be conducted by Pastene and Jackson;
(5) **reiterated** their previous recommendation that the IWC Secretariat provide a letter of support for Archer (Southwest Fisheries Science Center, USA) to obtain a sample for establishing the genetic identity of the type specimen of *B. p. patachonica* currently held in the Buenos Aires museum;
(6) **encouraged** continued compilation and meta-analysis of Western Antarctic Peninsula and Scotia Sea sightings data to measure recent fin whale distribution, density and habitat use; and
(7) **encouraged** the calculation of fin whale distribution maps using all available catches and applying the relative density model developed by de la Mare (2014). This work will be conducted inter-sessionally by de la Mare. The sub-committee also **encouraged** construction of a histogram of catches by longitude, to help identify high latitude aggregations.

A new estimate of fin whale abundance from the IDCR-SOWER CPIII surveys is anticipated to be available shortly and the sub-committee **recommended** that this estimate be reviewed at SC/68a to determine suitability for use in population assessment. The sub-committee also **encouraged** initiatives to enhance collection of photo-identifications from high latitudes in order to enhance data collection for the Southern Hemisphere fin and Antarctic blue whale catalogues.

Attention: SC, G, S

Knowledge of population structure is essential to future efforts to assess Southern Hemisphere fin whales. To determine the differentiation and potential sub-species structure among fin whales the Committee:

(1) agrees that analysis of concurrently collected acoustic recordings of fin whales, to assess song variation around the Southern Hemisphere, is a priority;
(2) agrees that a review of all Discovery mark data published on fin whales to assess population connectivity patterns should be carried out; and
(3) requests that the Secretariat provide a letter of support for a study examining the evidence for B. physalus patachonica*, which requires access to the holotype for this species from the Bernardino Rivadavia Natural Sciences Museum in Buenos Aires.*

The Committee also ***encourages****:*

(1) analysis of fin whale distribution and geographic aggregations using all available catches;
(2) strategic biopsy sampling and analysis to measure the genetic differentiation of fin whales around the Southern Hemisphere;
(3) further biopsy sampling and sequencing of multiple nuclear loci to establish Chilean fin whale differentiation patterns, with co-collection of photo-IDs and body length measurements to establish population identity;
(4) satellite telemetry to discern seasonal movements; and
(5) photo-identification to understand site fidelity and residency patterns and linkages between high- and low-latitude grounds.

Attention: SC, G, CG-A

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

(1) ***encourages*** *a meta-analysis of the Antarctic Peninsula and Scotia Sea sightings data, to measure recent fin whale distribution, density and habitat use;*
(2) ***strongly encourages*** *continued work by the Brazilian Antarctic Program towards the understanding of fin whale population structure, movements and habitat use;*
(3) ***recommends*** *presentation of a new abundance estimate for fin whales for review at next year's meeting; and*
(4) ***welcomes*** *news that fin whales can be used in photo-ID studies, and* ***encourages*** *further photo-ID data collection at high latitudes.*

7.1.3 Southern right whales

The sub-committee **agreed** to support work applying the modelling framework developed in SC/67b/SH22 to other southern right whale populations, in particular the southwest Atlantic, Head of the Bight and southwest Australia calving grounds, in order to measure regional demographic parameters and investigate commonalities in the population dynamics of these populations. This work would require a budget allocation of £13,600 GBP for 2018/19 and £13,600 GBP for 2019/20.

The sub-committee **supported** a proposal for a southern right whale catch series workshop to be held during 2019/20, to update regional estimates of Southern Hemisphere right whale catch using the substantial additional offshore voyage data which has recently become available (see Item 5.2). This work is anticipated to require 10-12 invited participants and would cost £15,800 to hold in 2019/20.

Attention: SC, G, C-A, CG-A

The Committee is ***concerned*** *that the future of the exemplary long-term monitoring programme of right whales in South African waters remains uncertain. The Committee therefore* ***reiterates*** *that they:*

(1) ***strongly recommend*** *continuation of the sighting survey;*
(2) ***request*** *the Commission to urge South Africa to do all it can to ensure the long-term future of this vital monitoring programme; and*
(3) ***encourage*** *South African scientists to investigate the offshore movements and locations of southern right whales with future surveys.*

Attention: SC, G, CC, CG-A

The Committee ***recognises*** *the value of the Australian long-term right whale monitoring programmes to understand right whale population trends and dynamics and* ***recommends*** *that this monitoring continue.*

In regard to right whales in southeast Australia, the Committee ***reiterates*** *concerns expressed in 2017 that abundance remains low despite this area having been a significant historic calving ground. The Committee therefore:*

(1) ***recommends*** *an assessment of the likely effects of fish farms and other developments in hindering population recovery in this region; and*
(2) ***encourages*** *further work to estimate the abundance of the southeast Australia population.*

Attention: SC

The Committee ***encourages*** *further mark recapture analysis of the genotype data of the 14-year dataset collected in the high latitudes of Area IV, to estimate the abundance in this feeding area.*

Attention: SC, G

To better understand patterns of right whale population dynamics around the Southern Hemisphere, and further the work on updated assessments, the Committee:

(1) ***agrees*** *that analysis of the three southern right whale calving grounds (Head of the Bight and southwest Australia, southwest Atlantic and south Africa) should be undertaken using the same life-history model, to estimate regional demographic parameters and investigate commonalities in the population dynamics of these populations; and*
(2) ***supports*** *the compilation of new data on pre-modern right whale catches, and organisation of a workshop to measure regional right whale catches and rates of whales struck but lost by fisheries, in order to proceed toward regional population assessments.*

7.1.4 Humpback whales

The sub-committee **reiterated** their recommendation that a re-analysis of the pilot study conducted by duFresne *et al.*, (2014) be carried out to assess the feasibility of future abundance surveys off West Australia.

Attention: SC, G, CG-R

The Committee ***agrees*** *that 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* ***reiterates*** *its recommendation that 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.*

7.1.5 IWC-SORP

IWC-SORP activities planned for 2018/19 and 2019/20 include but are not limited to: (1) continued analysis of data/samples from previous IWC-SORP voyages/fieldtrips;

Table 3

Proposed work plan.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Antarctic blue whales				
Catalogue matching	Catalogue matching of 45 photo-IDs from 2014-2017 ICR cruises (Olson convenor)	Report	Catalogue matching (opportunistic photos from citizen scientists and collaborators)	Report
Abundance estimation	Mark recapture modelling work to update SC/67b/SH08 (Olson convenor)	Report		
Photo-ID outreach material	Create photo-ID information booklets for distribution via IAATO operators	Report		
SH non-Antarctic blue whales				
Population assessment	Improve catch separation model and explore alternative catch allocation models (Branch convenor)	Report	Population assessment to analyse minimum and extrapolated recovery status for all pygmy blue whale populations for which abundance is available	Report
Catalogue matching	Catalogue matching of photo-IDs within southeast and central east Pacific (Galletti convenor)	Report	Catalogue matching (opportunistic photos from citizen scientists and collaborators) if funds are available	Report
Blue whale song library	Complete development of blue whale song library (Širović convenor)	Report		
Perth Canyon abundance estimate	Analyse Perth Canyon blue whale abundance using mark recapture data (Double convenor)	Report		
SH fin whales				
Fin whale acoustic structure	Review fin whale call patterns across Southern Hemisphere and investigate call variation (Širović convenor)	Report		
Discovery marks	Review available published and unpublished Discovery mark data on fin whales (Pastene and Jackson)	Report		
Catch maps	Update fin whale catch model to include Soviet catch data (de la Mare)	Report		
Southern right whales				
Modelling	Measure southern right whale demographic parameters (South Africa, southwest Atlantic, south and southwest Australia) using Cooke modelling framework (Charlton convenor)	Two meeting reports	Further development of modelling framework and comparison of demographic parameters between areas	Two meeting reports
Workshop	Organise right whale catch series workshop (Jackson and Carroll)		Workshop (convened under Jackson and Carroll)	Workshop report
SH humpback whales				
Survey feasibility	Reanalyse pilot study to assess feasibility of future West Australia surveys (Kelly)	Report		
IWC-SORP				
Analyses	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report
Voyages	Argentine coastguard '*Tango'* voyage along Western Antarctic Pensinsula (early 2019)	Cruise report		
	Almirante Maximiano voyage along Western Antarctic Pensinsula (early 2019)	Cruise report		
	Australian-led *RV Investigator* voyage to Ross Sea (early 2019)	Cruise report		
	New Zealand-led *RV Tangaroa* voyage to Ross Sea (early 2019)	Cruise report		
	German-led *RV Polarstern* voyage to Scotia Sea (early 2019)	Cruise report		
	Baleen whale and krill research voyages along Western Antarctic Peninsula	Reports	Baleen whale and krill research voyages along Western Antarctic Peninsula	Report
Ships of opportunity	Continued use of ships of opportunity to conduct cetacean research	Reports	Continued use of ships of opportunity to conduct cetacean research	Report
Acoustics	Retrieval and redeployment of passive acoustic recorders	Report	Retrieval and redeployment of passive acoustic recorders	Report
	Completion of annotated library of acoustic detections	Report		

Table 4

Summary of the 2-year budget request for Southern Hemisphere sub-committee.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
1	Southern right whale catch series workshop	-	15,800
Modelling/Computing			
2	Multi-ocean analysis of southern right whale demographic parameters	13,600	13,600
Research			
3	Analysis of fin whale song variability across the Southern Hemisphere	-	12,000
12,4	Updated catch series and assessments of four pygmy blue whale populations	6,185	12,865
Database/Catalogues			
5	Photo-Identification Information Placards for Naturalists and Citizen Scientists	1,000	-
6	Southern Hemisphere Blue Whale Catalogue 2019/2020	16,810	3,000
7	Southern Hemisphere Blue Whale Catalogue IWC host cost	900	900
8	Antarctic blue whale catalogue 2019/2020	3,000	800
9	Blue whale song library IWC host cost	450	450
Total request		**52,495**	**46,965**

(2) the planning and execution of several research voyages to the Southern Ocean; (3) the continued use of ships of opportunity to conduct cetacean research; (4) retrieval and redeployment of passive acoustic recorders.

Attention: SC, G

The Committee **reiterates** *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.*

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8. ADOPTION OF REPORT

The report was adopted at 18:41 on 2 May 2018. The Chair thanked the rapporteurs for all their hard work.

REFERENCES

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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 and catch allocation
   - 3.2 Antarctic blue whales
     - 3.2.1 Cruise reports
     - 3.2.2 Progress toward population assessment
   - 3.3 Non-Antarctic Southern Hemisphere blue whales
     - 3.3.1 Southeast Pacific blue whales
     - 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 Southern Hemisphere abundance
   - 4.4 Cruise reports
5. Southern Hemisphere right whales not subject to CMP
   - 5.1 Southern Hemisphere population structure
     - 5.1.1 New Zealand right whales
     - 5.1.2 Australian right whales
     - 5.1.3 South Africa right whales
     - 5.1.4 Feeding grounds
   - 5.2 Progress towards population assessment
6. Southern Hemisphere humpback whales
   - 6.1 Progress towards assessment of Breeding Stock D
7. Work Plan and budget requests for 2019-20
   - 7.1 Work Plan for 2019-20
     - 7.1.1 Blue whales
     - 7.1.2 Fin whales
     - 7.1.3 Southern right whales
     - 7.1.4 Humpback whales
     - 7.1.4 IWC-SORP
   - 7.2 Budget requests for 2019-20
8. Adoption of report

Appendix 2

MINIMUM AND MAXIMUM RANGES OF PYGMY BLUE WHALE POPULATIONS

Trevor A. Branch

Catch time series have been developed for pygmy blue whale populations based on model surfaces fitted to mostly acoustic receiver data (SC/67b/SH23). These efforts do not characterise the uncertainty in catches, although this is planned in future efforts using bootstrapping of the underlying acoustic recorders. Here I present possible minimum ranges (Fig. 1) and maximum ranges (Fig. 2) for each population of pygmy blue whales that could be used to develop minimum and maximum catch time series for each population.

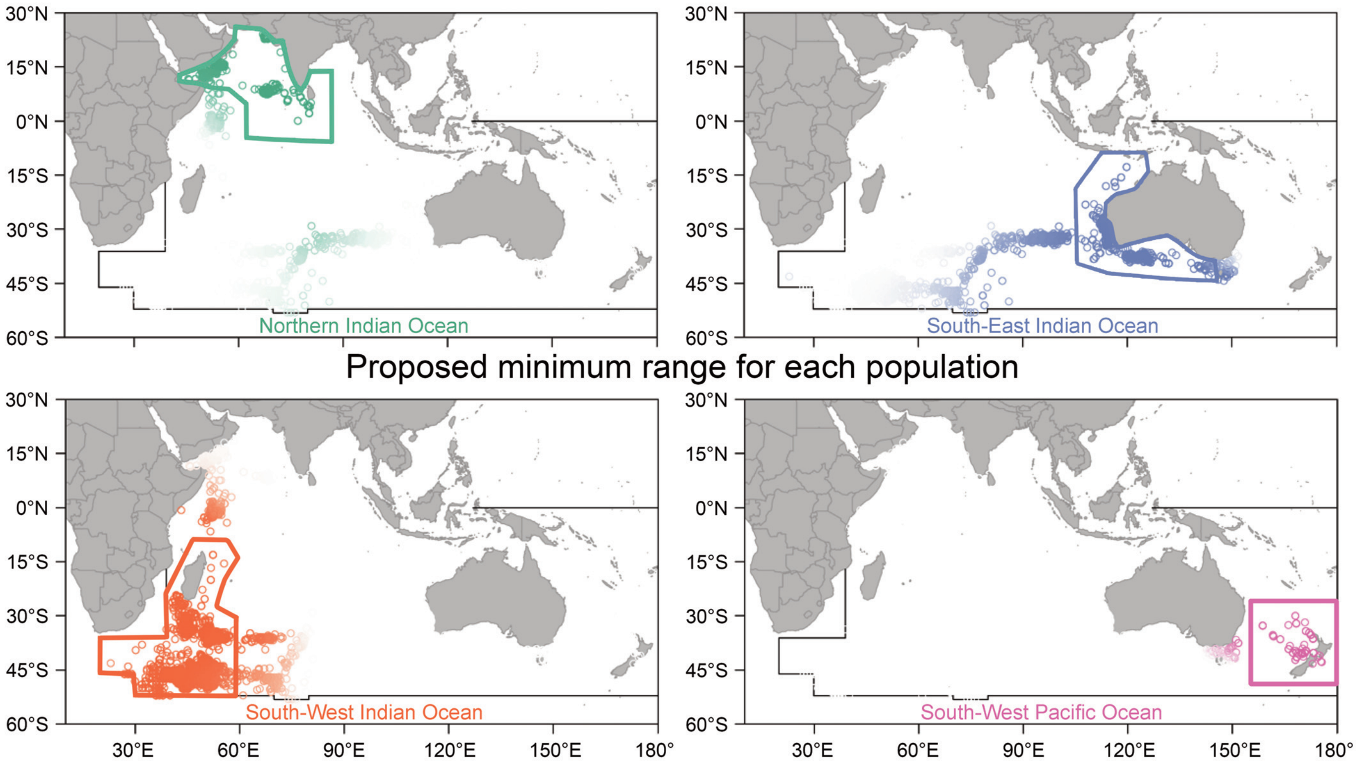

Fig. 1. Possible minimum ranges of each pygmy blue whale population.

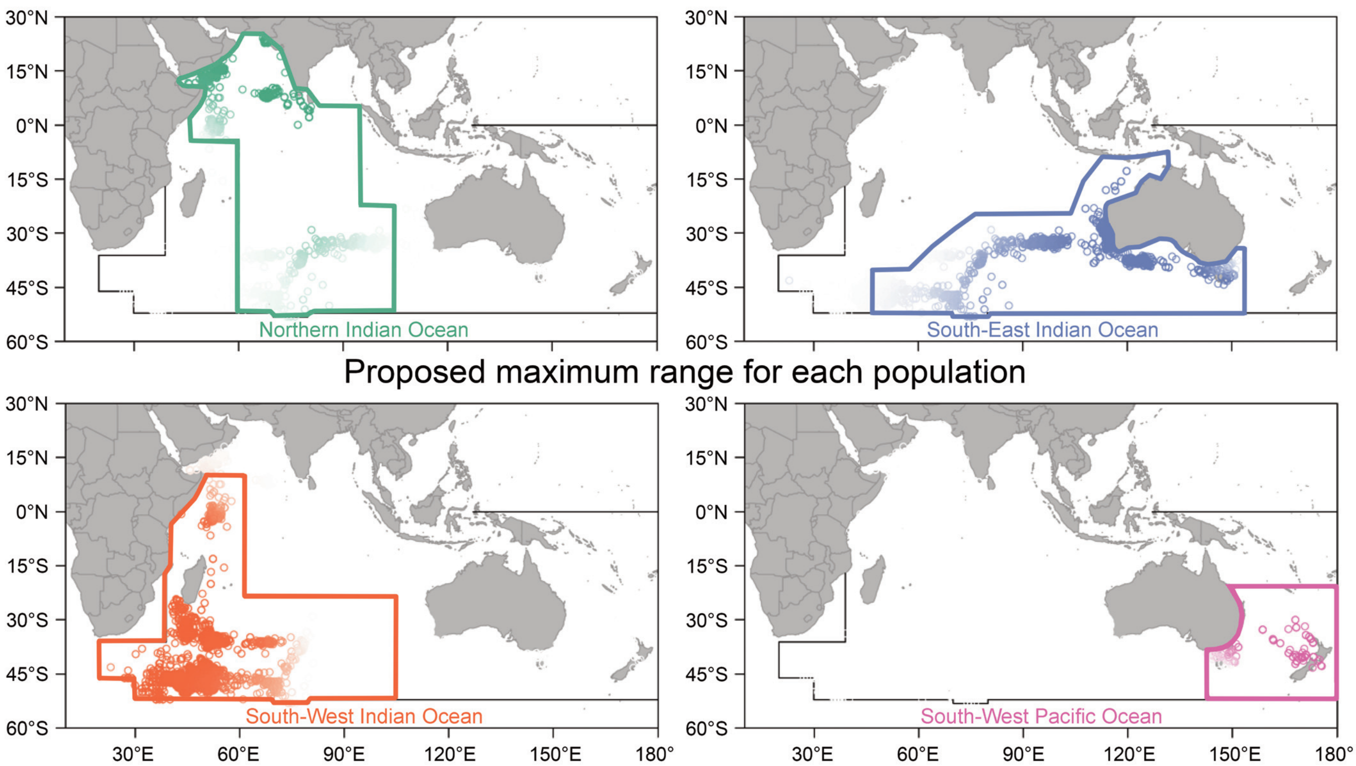

Fig. 2. Possible maximum ranges of each pygmy blue whale population.

Appendix 3

A NOTE ON THE SIZE DISTRIBUTION OF FIN WHALES (*BALAENOPTERA PHYSALUS*) IN THE SOUTHEAST PACIFIC AND IMPLICATIONS FOR THE COMPREHENSIVE ASSESSMENT OF SOUTHERN HEMISPHERE FIN WHALES

J.G. Cooke

Data

A total of 6,785 fin whales are recorded caught by modern whaling off Chile during 1908-83, but with only 6 caught after 1970 (Allison 2017). Body lengths are recorded for 3,310 fin whales. The measured whales were from several stations in three main areas: North (~20°S), Central (30°-38°S), and South (44°S) (Fig. 1). The catches in the South were few and before 1945. The whales were taken in all four seasons, but fewer in winter (Table 1). The length distribution is shown in Fig. 2. The modal length is 16.5m for each sex, with little difference in mean length between seasons, compared with 20.3m (males) and 21.4m (females) for fin whales caught by Antarctic fleets (data from Allison 2017).

If the whales caught off Chile were southern fin whales (*B. p. quoyi*), then the size of 16.5m would correspond to age 1 to 2 years, according to the growth curve estimated by Lockyer (1972). The minimum legal size for catching fin whales that was in effect in Chile during 1954-79 was 15.2m[1].

Toro *et al*. (2016) classed 502 out of 519 fin whale sightings around the Chanaral and Choros Islands (29°S) in summer and fall as 'adults' but used a size criterion of 17m developed for the smaller North Atlantic Fin Whale; the 'adults' could have included whales of any age class except calves of the year. Pacheco *et al*., reported two mother-calf pairs off northern Chile (Mejillones Bay, 23°S) in spring 2006 but obtained no body length estimates.

[1]Decreto Supremo N° 432 del 23 de septiembre de 1954 (Diario Oficial del 22 de noviembre de 1954).

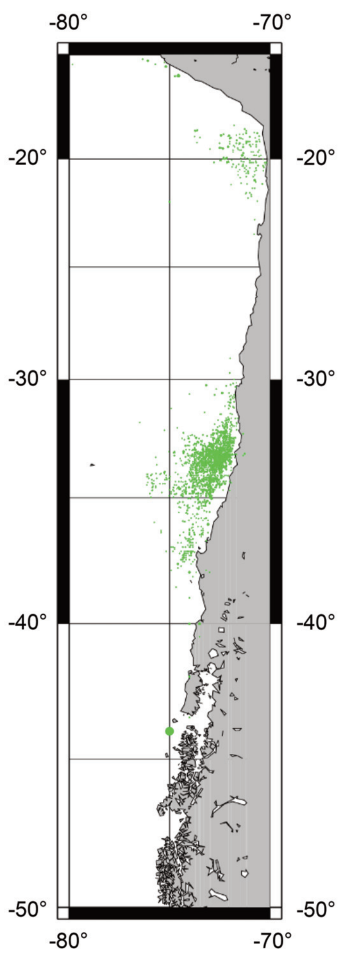

Fig. 1. Locations of measured fin whale catches in Chilean waters.

Discussion

The Chilean whales are much smaller than the measurements given by Clarke (2004) for adults of the putative subspecies *B. p. patachonica. Furthermore, SC/67b/SH13 finds no evidence of genetic differentiation between fin whales sampled of Chile at about 19°S during 2003-17 and fin whales sampled in the Antarctic and off Australia.* Given the recovery in the Antarctic in 1961-62 of four of 11 marks placed in fin whales off Chile between 30°-34°S in 1958 (Clarke, 1978), it seems likely that the Chilean fin whale catches were of juvenile Southern Fin Whales.

Different migration patterns for mature and immature animals seem to be fairly common among baleen whales (Leaper *et al.,* 2000). Migration to the Antarctic entails proportionally greater energetic costs for smaller individuals; furthermore, the younger animals are likely to have lower fat reserves such that a long migration with limited feeding en route is less attractive or feasible for them. It is possible that adult Antarctic fin whales also migrate in the southeastern Pacific, but further offshore.

Implications for the comprehensive assessment

If the fin whales feeding along the Chilean coast are indeed mainly juveniles, then current and future data individual identification data (photographic or genetic) will need to be interpreted in this light, because the apparent survival rate will appear to be too low.

Potentially useful research could include photogrammetric measurements (e.g. from drones) to check whether fin whales in Chilean waters today have a similar length distribution to past catches.

Table 1

Summary of fin whale lengths (m) in Chilean waters and sub/Antarctic

Season	Sex	N	Mean	SD	Mode
Chilean waters					
Summer	M	745	17.1	1.4	17.0
Jan-Mar	F	677	17.2	1.4	16.5
Autumn	M	430	16.7	1.3	16.5
Apr-Jun	F	421	17.0	1.2	16.5
Winter	M	177	17.2	1.2	17.0
Jul-Sept	F	164	17.4	1.6	16.8
Spring	M	393	17.3	1.5	18.0
Oct-Dec	F	303	17.5	2.0	16.5
All	M	1,745	17.1	1.4	16.5
Jan-Dec	F	1,565	17.2	1.5	16.5
Antarctic (incl. subantarctic)					
All	M	310,246	19.9	1.4	20.4
	F	298,452	20.8	1.8	21.3

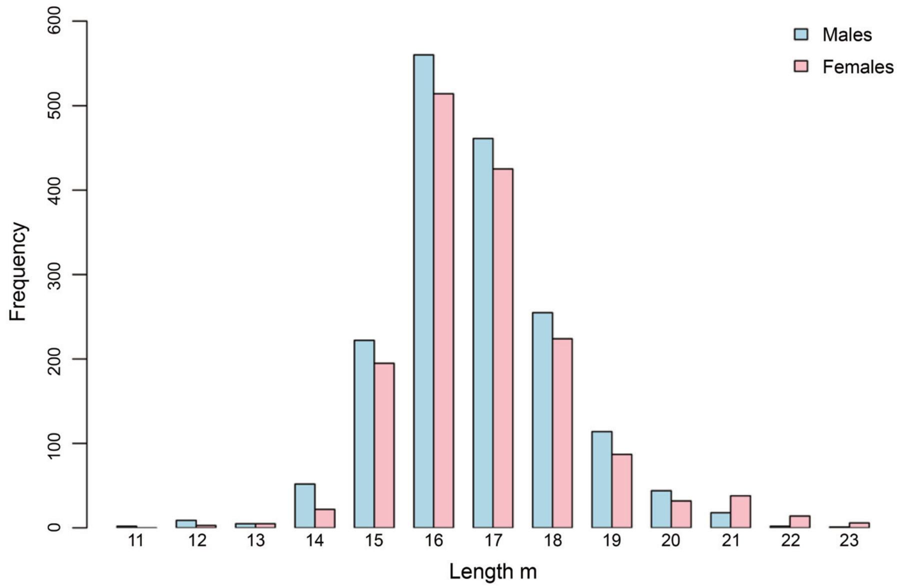

Fig. 2. Length frequency distribution of Chilean fin whales.

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Annex I

Report of the Working Group on Stock Definition and DNA Testing

Members: Lang (Convenor), Tiedemann (co-Convenor), An, Archer, Baird, Baker, Bickham, Bruniche-Olsen, Buss, Butterworth, Carroll, Cholewiak, Cipriano, Clapham, DeWoody, Donovan, Givens, Goto, Hoelzel, Inoue, Ivashchenko, Jackson, H-Y. Kim, E-M. Kim, Kitakado, Jarman, Pastene, Scordino, Širovič, Skaug, Solvang, Suydam, Taguchi, Víkingsson, Wade, Walløe, Weller, Yoshida.

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 appointed as co-chairs, and Cipriano acted as rapporteur.

1.3 Adoption of Agenda

The adopted agenda is given in Appendix 1. Items 2.1, 2.3, and 2.4 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/67b/SDDNA01-06; SC/67b/ASI05; SC/67b/SH02-03, SC/67b/SH05-06, SC/67b/SH11, SC/67b/SH13; SC/67b/NH02; Carroll *et al.* (2018a); Carroll *et al.* (2018b); Leroy *et al.* (2017); Attard *et al.* (2018); Baker *et al.* (2018); Frasier *et al.* (2015); Tiedemann *et al.* (2018); Jost *et al.* (2018).

2. DNA TESTING

2.1 Genetic methods for species, stocks and individual identification

The Working Group discussed two papers under this agenda item: Carroll *et al.* (2018b), which reviews technological advances in genomic monitoring, including approaches useful in identifying species, stocks, and individuals; and Baker *et al.* (2018), which presents the results of a study to evaluate the feasibility of using seawater samples to collect DNA from killer whales in the Salish Sea.

Carroll *et al.* (2018b) provides a review of how genetic monitoring has been used in the field of conservation biology and looks at how high throughput sequencing (HTS) and other technological advances could aid genetic monitoring in the future. Carroll highlighted the results of the literature review to identify what genotyping methodologies are compatible with producing genotypes from minimally invasively collected samples, considering factors such as running costs and error rates. This was done in the context of genetic monitoring for conservation and management purposes, which require a reproducible set of loci that can be used with low quality and/or quantity DNA templates, but do not necessarily need the 10,000s markers that whole genome or reduced representation approaches provide. The authors acknowledge that many of these platforms do need considerable investment and resources to develop the assays at the outset, which often requires a high-quality DNA template. Among the SNP genotyping platforms that were reviewed, the Fluidigm system, MassArray, and Illumina Goldengate genotyping platforms have been used in the literature with good results. Target capture approaches included some recently published work on microsatellite genotyping via HTS (e.g. De Barba *et al.*, 2017). This could have the advantage of bridging between legacy microsatellite datasets and new HTS datasets by having a certain number of markers in common. However, it seems that the microsatellite loci need to be optimised for HTS, which could limit the number of markers used across time and platforms. The authors also covered the target capture approach known as GT-seq, which is essentially a massively multiplex PCR to amplify hundreds of markers simultaneously (Campbell *et al.*, 2015). One advantage of these target capture approaches *vs* SNP genotyping platforms is the ability to get multi-allelic or phased haplotypic data, for loci with more than one SNP, which could be more informative than single SNPs per locus.

The Working Group thanked Carroll for presenting this review.

In discussion, it was noted that much of the genetic work done to address needs of the SC has relied on generating microsatellite datasets. With advances in HTS and the generation of genome-scale data for many species, other approaches, such as SNP genotyping, are now available, often at comparable costs. SNP genotyping has several advantages over the use of microsatellites (reviewed in Morin *et al.*, 2004), and, importantly, facilitates sharing data across labs and maintaining datasets across time and changes in technology (e.g. sequencing platforms). However, in many cases, including the work done to maintain DNA registries of bycaught or special permit catches (see Appendices 2-4), 'legacy' datasets include microsatellite genotypes for hundreds to thousands of individuals. Thus, one challenge facing the SC in recent years has been determining how to take advantage of these technological advances without decreasing the utility of these large and long-term microsatellite genotype datasets. As such, microsatellite genotyping via HTS (e.g. De Barba *et al.*, 2017) could provide the means to 'bridge the gap' by maintaining the utility of these legacy datasets while also taking advantage of the newer HTS approaches. While appealing, the Working Group noted that there would be several challenges to taking such an approach, including: (1) selecting microsatellites with repeat lengths appropriate for the read lengths typically used by HTS platforms; (2) the design of primers to sequence microsatellites in the absence of genome data, which is not yet available for many species; and (3) bioinformatics difficulties associated with the alignment of sequence data across microsatellite repeat regions that will be of differing lengths. It was noted that this switch (into sequencing of microsatellites) has been made by the human forensics scientists, and additional exploration of their process could be informative. It was also noted that pedigree data might be used to impute genotypes useful in integrating legacy microsatellite datasets into those generated via HTS sequencing. This could be mathematically challenging but might be feasible in large datasets.

In Baker *et al.* (2018), Baker and co-authors describe methods for using droplet digital (dd) PCR technology for detection and species identification of cetaceans using environmental (e)DNA collected from seawater. For this, they conducted a series of eDNA sampling experiments in the vicinity of killer whales, *Orcinus orca,* in Puget Sound (the Salish Sea). The regular habits of killer whales in these inshore waters allowed the authors to locate pods and collect seawater during 25 encounters at an initial distance of 200m and at 15-minute intervals for up to two hours after the passage of the whales. To optimise detection, they designed a set of oligonucleotide primers and probes to target short fragments of the mitochondrial (mt)DNA control region, with a focus on identification of known killer whale ecotypes. They confirmed the potential to detect eDNA in the wake of the whales for up to 2 hours, despite movement of the water mass by several kilometers due to tidal currents. Re-amplification and sequencing of the eDNA barcode confirmed that the ddPCR detection included the 'southern resident community' of killer whales, consistent with the calls from hydrophone recordings and visual observations.

The Working Group thanked Baker for presenting this paper, which presents a new approach for detecting and identifying cetacean species, including those that may be elusive to study using other methodologies. In discussion, the Working Group noted that one technical challenge associated with using this methodology is that, when sequencing such low quantities of DNA, PCR-generated sequencing errors may be more difficult to detect, and thus careful screening of the resulting data (e.g., validating haplotypes with single-base pair differences) is needed. This issue is less of a concern when using the method for species-level identifications but could be problematic when assessing questions addressing intraspecific diversity. In terms of evaluating presence/absence patterns from eDNA, additional technical considerations include the need to control for false negatives, which can occur because of the low quantity of target DNA present and/or due to the presence of PCR inhibitors in sea water, as well as for false positives that might be present due to contamination.

Although this approach has been more broadly used to detect the occurrence of species in an area (i.e., DNA barcoding), it could provide sequence data useful for stock-level identifications of cetaceans under certain circumstances (e.g., when a single animal is present). It was noted, however, that its utility in addressing questions requiring individual identification via multi-locus genotyping is, at least currently, limited for scenarios in which the water sample could contain DNA from multiple individuals. However, advances in single-cell sequencing technology may provide avenues for additional studies in the future (Lan *et al.*, 2017; Shapiro *et al.*, 2013).

Attention: SC

The Committee ***welcomes*** *the opportunity to review papers that take advantage of technological advances to improve the ability to detect and identify species, stocks, and individual cetaceans. It* ***encourages*** *the submission of similar papers in the future and recognizes the relevance of these techniques to the Committee's work.*

2.2 'Amendments' of sequences deposited in GenBank

GenBank is essentially an uncurated database, and inconsistencies and/or out-dated information in the metadata (e.g. taxonomic status, geographic location, locus misassignment) exist. In previous years, Cipriano has corresponded with GenBank to attempt to identify a mechanism by which these inconsistencies could be corrected. Unfortunately, Cipriano's contact at the NCBI (National Center for Biotechnology Information) passed away last year, and no further progress on this work was made.

At SC/67a, the Working Group agreed that the revised DNA quality guidelines (see Item 3.1) would contain a section discussing the precautions that should be used when including GenBank sequences in a study. Text to include in this section was drafted intersessionally and will be incorporated into the revised guidelines, which are to be completed this year.

2.3 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, 2012, 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 the Japanese register (Appendix 2). The collection of samples is from scientific whaling in the North Pacific (1994-2016 JARPN-JARPNII, NEWREP-NP 2017) and the Antarctic (1987/88-2016/17, JARPA-JARPAII and NEWREP-A), and from bycatch (2001-17).

Skaug reported on the status of the Norwegian register (Appendix 3). The collection of samples of North Atlantic common minke whales is from commercial catches for the period 1997 to 2017.

Vikingsson reported on the status of the Icelandic register (Appendix 4), which includes samples from scientific whaling (2003-07) and commercial catches (2006-17).

2.4 Reference databases and standards for diagnostic DNA registries

An update of the Japanese register is shown in Appendix 2. 100% of the samples collected from North Pacific minke whales (n=128) and North Pacific sei whales (n=134) under NEWREP-NP in 2017 have been analysed for both mtDNA and microsatellites. MtDNA and microsatellite analyses are also complete (100%) for the North Pacific minke whales (n=164) and North Pacific humpback whales (n=3) that were bycaught in 2017. No bycatch of North Pacific Bryde's, sei, right, fin, or sperm whales occurred during 2017. MtDNA and microsatellite analyses are complete (100%) for all Antarctic minke whales (n=333) sampled under NEWREP-A in 2017.

An update of the Norwegian register is shown in Appendix 3. With the exception of one missing sample, 100% of the North Atlantic common minke whales (n=431) caught in 2017 were genotyped using both microsatellites and SNPs. As noted at SC67a (IWC, 2018a, p.228-9), Norway has discontinued mtDNA typing of samples and substituted it with SNP genotyping. The SDWG would welcome information as to the diagnostic abilities of the Norwegian SNP panel (species and/or stock identification).

An update of the Icelandic registry is shown in Appendix 4. The North Atlantic common minke whales caught by commercial whaling in 2017 (*n*=17) have not yet been screened for either mtDNA or microsatellites. No North Atlantic fin whales were caught by commercial whaling in 2017.

The Working Group appreciated the efforts of Japan, Norway and Iceland in compiling and providing this detailed information of their registries.

Attention: CG-A

The Committee ***expresses appreciation*** *to Japan, Norway and Iceland for providing updates to their DNA registries using the standard format agreed in 2011 and providing the detailed information contained in their DNA registries.*

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3. GUIDELINES AND METHODS FOR GENETIC STUDIES AND DNA DATA 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. The DNA data quality guidelines are currently being updated (see Item 3.1 below), while the guidelines for genetic data analysis are in press with the *Journal of Cetacean Research and Management*.

In discussion, it was noted that while the DNA data quality guidelines are available on the IWC website, they are included as a link from within the Scientific Committee Handbook. The guidelines are thus difficult to find on the website. The Working Group agreed to discuss the possibility of including both sets of guidelines as a separate link under the main Scientific Committee webpage in order to ensure that they can be easily found. Lang offered to raise this issue with the Secretariat. In addition, the Working Group suggested that the guidelines would be more accessible to the broader scientific community if they were made accessible under ResearchGate, which is a web-based platform designed to facilitate collaboration and sharing of scientific information. Lang offered to explore this option as well.

Attention: SC

The Committee ***emphasizes*** *the importance of keeping its guidelines related to genetic data quality and analyses up to date. It therefore:*

(1) ***reiterates*** *the need to update these guidelines to incorporate the discussion of data quality measures used for Next Generation Sequencing data; and*

(2) ***agrees*** *to continue the intersessional e-mail group to review revised sections of the DNA data quality guidelines that apply to data generated from next generation sequencing platforms, including SNPs and whole genome sequencing, with the goal of posting an updated version of the guidelines on the website next year.*

3.1 Update DNA quality guidelines to include discussion of NGS data

The DNA data quality control guidelines are already available on the IWC website (*http://iwc.int/scientific-committee-handbook#ten*). In recent meetings, data derived from next generation sequencing (NGS) approaches, including SNPs, have been utilised to address stock structure questions. In light of these developments, the Working Group agreed during SC/66b (IWC, 2017b, p.264) that it would be timely to update the DNA data quality control guidelines to cover these types of data. At SC/67b, Tiedemann updated the Working Group on intersessional progress, which included revisions to the sections covering data, including SNPs, produced using NGS approaches. For SC/68b, the group will complete their review of the updated sections so that a revised version can be posted on the IWC website next year. The intersessional group formed during SC/67a will continue to work on this task intersessionally (see Workplan, Item 6.1.1).

3.2 Further applications of DNA techniques

Leroy *et al.* (2017) explores the use of quantitative metrics to detect and monitor genetic erosion. Monitoring systems should not only characterise the mechanisms and drivers of genetic erosion (inbreeding, genetic drift, demographic instability, population fragmentation, introgressive hybridisation, selection) but also its consequences (inbreeding and outbreeding depression, emergence of large-effect detrimental alleles, maladaptation and loss of adaptability). Technological advances in genomics now allow the production of data that can be measured by new metrics with improved precision, increased efficiency and the potential to discriminate between neutral diversity (shaped mainly by population size and gene flow) and functional/adaptive diversity (shaped mainly by selection), allowing the assessment of management-relevant genetic markers. The requirements of such studies in terms of sample size and marker density largely depend on the kind of population monitored, the questions to be answered and the metrics employed. The prospects for the integration of this new information and metrics into conservation monitoring programmes was discussed.

The Working Group thanked DeWoody for his presentation and noted that one of the examples given in the paper (monitoring trends in the abundance of Māui dolphins, Baker *et al.,* 2016) was reviewed by the Working Group last year.

In discussion, it was questioned whether natural selection should be included as a mechanism causing genetic erosion. Although purifying or directional selection may reduce diversity at the selected locus, that reduction is associated with increased adaptation. Selection could cause reduced diversity in loci that are linked to the locus under selection via hitchhiking ('selective sweeps'). However, this would not constitute genetic erosion acting on the locus under selection.

Jost *et al.* (2018) attempts to clarify two primary classes of population genetic structure measures: fixation metrics (F_{ST}, G_{ST}, etc) that describe how close a set of demes are to fixation, and allelic differentiation metrics (Jost's D, entropy differentiation) that describe how different the allelic frequency distribution of demes are. The paper encourages the use of D to better capture genetic diversity in populations of conservation concern.

The Working Group thanked Archer for his presentation and noted that the information builds on the discussion of 'F_{ST} and related measures' that is included in the Data Analysis Guidelines.

In discussion, the Working Group noted that since D is a measure of allelic differentiation, it is highly affected by mutation rate. This presents a challenge when calculating an average value of D across multiple loci with different mutation rates. In such cases, weighting values of D according to the mutation rate of the locus from which it is calculated would be needed to provide an estimate of mean D that is straightforward to interpret.

The Working Group noted that D has not commonly been presented as a metric for differentiation in papers presented to the SC. This may in part be related to the fact that it is not integrated into some of the major software programs (e.g. Arlequin, Excoffier *et al.,* 2010) that are frequently used to analyse data. The Working Group noted, however, that it is possible to estimate D using the R package strataG (Archer *et al.*, 2017) as well as in Genodive (Meirmans and van Tienderen, 2004).

The Working Group also noted a recent, related paper by (Gaggiotti *et al.*, 2018) that presents a unified framework for diversity measures based on Shannon's entropy.

Finally, the Working Group noted that these two families of measures can be complementary, and that the key was understanding when it is appropriate to use each.

4. PROVIDE ADVICE ON STOCK STRUCTURE TO OTHER SUB-GROUPS

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.

In discussion, it was noted many of the papers that the Working Group is asked to review do not include descriptions of the stock structure hypotheses that are being evaluated. The Working Group is comprised of members with varying degrees of familiarity with the work of the other sub-committees or working groups, and thus it can often be challenging to provide a thorough technical review of the paper without an understanding of the stock structure hypotheses being tested. In order to improve this process in the future, the Working Group **encouraged**: (1) presenters of stock structure-related papers provide a brief overview of the relevant stock structure hypotheses prior to discussing their paper; and (2) those who submit a ForInfo paper to consider accompanying it with a working paper that lays out the relevant stock structure hypotheses for the reader. Where possible, the Convenors can assist with the latter task when monitoring the submission of papers.

4.1 Bowhead whales

Paper SC/67b/SDDNA01 focused on stock structure of B-C-B bowheads based on population genetic data from mtDNA sequences (2,494 base pairs) and SNP genotypes (69 autosomal loci). Results from both datasets indicate that the B-C-B and Eastern Canadian Arctic (CAN) stocks are not easily distinguishable, but that the Okhotsk Sea (OK) stock is significantly different from the other two. These conclusions are based on various analyses, including F_{ST}, AMOVA, genic and genotypic differentiation, and STRUCTURE plots. Moreover, there is no evidence of sub-structuring of the B-C-B population. Sub-structure tested included spring *vs* fall harvested whales from Barrow, small *vs* large B-C-B whales (roughly corresponding to young *vs* old), and whales from St. Lawrence Island *vs* Barrow. The mtDNA and SNP results are consistent both with each other and with recent studies on B-C-B bowheads using focal microsatellites and a smaller SNP panel.

The Working Group thanked the authors for presenting this work, which is being evaluated as part of the 2018 *Implementation Review* (IR) of the Bering-Chukchi-Beaufort Seas (B-C-B) stock of bowhead whales.

In discussion, it was noted that the results presented in SDDNA01 have implications for two aspects of bowhead whale stock structure. The primary question of interest for the IR is whether substructure exists within the B-C-B stock. While a number of SNP loci showed significant deviations from Hardy Weinberg equilibrium (HWE) within the B-C-B samples, only about half of these loci exhibited heterozygote deficiencies. This pattern is inconsistent with what would be expected if the deviations from HWE were the result of a Wahlund effect (i.e. due to population substructure). An alternative explanation for the deviations from HWE is that the loci could be under selection pressure. In response, Baird noted that some of the SNPs occur within protein-coding loci, which are more likely to be under selection than non-coding regions.

The Working Group further noted that several of the comparisons previously explored using microsatellite genotypes and mtDNA sequence data (see review IWC, 2008) had been re-examined using the SNP dataset, including: temporal comparisons (whales sampled in the spring *vs* the autumn), spatial comparisons (St. Lawrence Island *vs* Barrow), and the potential for age structure, using length (large *vs* small) as a proxy for age. No significant differences were identified. Based on these results, the Working Group **agreed** that the results presented were consistent with a lack of substructure within the B-C-B stock.

The second question of interest to the SC relates to the degree of mixing between the B-C-B stock and the eastern Canadian Arctic (CAN) stock. Comparisons between these two strata revealed only small, and in some cases statistically insignificant, levels of genetic differentiation in both the mitochondrial and the SNP data. While this pattern could be related to historical connectivity between the two stocks, it could also, or additionally, be driven by some degree of contemporary gene flow. Some evidence of recent movements between these two regions exists (harpoon recovery, reviewed in Rugh *et al.,* 2003; satellite tagging, Quakenbush *et al.,* 2012). To provide increased resolution on the genetic structure within and between these two stocks, the Working Group **recommended** that the authors: (1) analyse the data using ordination methods, such as PCA and DAPC, which can potentially discriminate between groups with low levels of differentiation; and (2) analyse additional samples from the CAN stock in order to increase the power to detect genetic differentiation and to potentially allow for the detection of whales moving between regions via genetic mark-recapture.

Frasier *et al.* (2015) was reviewed as part of a joint session with the *Ad hoc* Working Group on Abundance Estimates, Status and International Cruises. A summary of the discussion can be found in Annex Q under agenda item 3.1.1.

Attention: SC, C-A

The Committee reviewed the results of new genetic analyses of bowhead whales within the Bering-Chukchi-Beaufort Sea (BCB) stock and between the BCB stock and the Eastern Canadian and Okhotsk Sea stocks. The Committee:

(1) ***agrees*** *that the results were consistent with a lack of substructure within the B-C-B stock;*

(2) ***agrees*** *that the results suggested that some level of historic or contemporary gene flow could exist between the B-C-B and the Eastern Canadian stock; and*

(3) *although not of immediate management concern,* ***agrees*** *that additional genetic analyses be conducted prior to the next Implementation Review to explore potential differentiation within and connectivity between the B-C-B and the Eastern Canadian stock, as detailed in Annex I.*

4.2 Gray whales

The population structure and status of gray whales has been the subject of a five-year long review. SC/67b/Rep07 [see Annex O, item 6.1.3] is a report of the most recent Workshop (the 'Fifth Rangewide Workshop on the Status of North Pacific Gray Whales'), which was held in Carmel, CA between 28-31 March 2018. Multiple stock structure hypotheses for gray whales in the North Pacific are being considered as part of this review, and the work presented in SC/67b/SDDNA02 and SC/67b/SDDNA03 provide information relevant to the evaluation of these hypotheses.

SC/67b/SDDNA02 uses whole-genome sequencing to investigate the demographic history of gray whales from the North Pacific and uses environmental niche modelling to make predictions about future gene flow. Sequencing efforts and habitat niche modelling indicate that: (i) western gray whale effective population sizes have declined since the last glacial maximum; (ii) contemporary gray whale genomes, both eastern and western, harbour less autosomal nucleotide diversity than most other marine mammals and megafauna; (iii) the extent of inbreeding, as measured by autozygosity, is greater in the Western Pacific than in the Eastern Pacific; and (iv) future climate change is expected to open new migratory routes for gray whales. The results indicate that gray whale genomes contain relatively low nucleotide diversity and have been subject to both historical and recent inbreeding. Population sizes over the last million years likely peaked about 25,000 years before present and have declined since then. The niche modelling suggests that novel migratory routes may develop within the next century and if so this could help retain overall genetic diversity, which is essential for adaption and successful recovery in light of global environmental change and past exploitation.

In discussion, it was noted that the trajectories of effective population size that were generated from the genome sequence data suggests that the population structure of gray whales within the North Pacific has repeatedly fluctuated in response to glaciation events, with the trajectories generated from the three genomes converging during periods of glaciation and then separating during non-glaciated periods. In more recent evolutionary time (approximately the last 10,000 to 100,000 years), the trajectories generated from the eastern sample and the trajectories generated from the two Sakhalin samples appear to be on somewhat independent trajectories, and the ENP population shows a much higher effective population size at the end of this period. Together with the results of the ABBA-BABA test (e.g. the D-statistic for different topologies), these trajectories suggest some degree of distinctiveness between the eastern North Pacific (ENP) and Sakhalin.

It was further noted that the results indicate a greater degree of inbreeding (as measured by the length and frequency of Runs of Homozygosity, ROHs) among the two whales sampled off Sakhalin when compared to the whale sampled in the ENP. This might be expected under the 'traditional' understanding of gray whale population structure, in which the Sakhalin whales were presumed to represent a small and largely isolated remnant population that remained in the WNP year-round. However, the contemporary view of gray whale stock structure is much more complex, and at least some of the Sakhalin whales (referred to in the stock structure hypotheses as the Western Feeding Group whales, or WFG) are known to migrate to and overwinter in the ENP. The time frame over which the signal of increased inbreeding in the two Sakhalin samples could be generated was discussed. It was noted that recombination could decrease the length of ROHs in a period of several generations, suggesting that the increased length of ROHs in the Sakhalin whales could have developed over ecological time scales. While it seems unlikely that the increased signal of inbreeding in the genomes of the Sakhalin whales would be present if these whales are representative of WFG whales that interbreed at random with the large ENP population (e.g. a large gene pool), such a signal might be generated if WFG whales largely interbreed with each other while on migration and are thus representative of a smaller gene pool. It was noted that one of the Sakhalin whales (WGW1) is known to have migrated to the ENP. In terms of the frequency of ROHs and the total length of ROHs, the inbreeding values for WGW1 fell in between those of the other Sakhalin whale and the ENP sample. Thus it was also questioned if the inbreeding measured in WGW1 could be representative of admixture between WFG whales and whales that are part of the larger ENP population that feeds north of the Aleutians.

The authors noted that it is difficult to draw broad conclusions on the basis of the three genomes that have currently been analysed and that they plan on extending this study by analysing the genomes of a larger number of individuals.

SC/67b/SDDNA03 used a panel of SNPs to investigate the genetic diversity and population structure within the species. Results indicate the gray whale gene pool is differentiated into two lineages (i.e. 'sub-stocks'), that each lineage contains similar levels of genetic diversity, and that both the Eastern and Western geographic samples were derived from mixed-stock aggregations composed of two distinct lineages. Overall, the data are inconsistent with the idea that the gray whale gene pool consists of a single population at equilibrium.

Several of the population structure inferences drawn in SDDNA03 were made using the R package LEA (Frichot and Francois, 2015), and much of the discussion focused on the comparability of this approach with that employed by the program STRUCTURE (Pritchard *et al.,* 2000), which has been broadly used in the context of the SC, particularly with regard to the genetic patterns assessed to form clusters. Both programs can be used to estimate admixture coefficients and to infer the number of genetic clusters present in genetic data. LEA has been designed to run more quickly and efficiently with large numbers of loci. However, the underlying algorithms used by these two programs differ. While STRUCTURE forms clusters such that adherence to Hardy-Weinberg-Equilibrium and linkage equilibrium across loci is maximised within clusters, LEA calculates ancestry coefficients using a least-squares method and uses an 'entropy criterion' and a cross-validation approach to estimate the number of ancestral populations that best explain the genotypic data (Alexander and Lange, 2011; Frichot *et al.*, 2014). It is unclear whether the differences in the underlying algorithms used by these two approaches affects how the results should be interpreted. However, in the case of SC/67b/SDDNA03, both STRUCTURE and LEA were run, and the two programs produced similar results.

The Working Group noted that when making inferences that test against equilibrium assumptions, loci are assumed to be neutral, as balancing/disruptive selection can bias inference, be it at the analysed locus itself or a closely linked locus. The SNPs used in this analysis were derived from genes with known functions in cetaceans. While selection cannot be entirely ruled out, the authors reported that no evidence of selection had been detected for the assessed SNPs at any of the loci (e.g. they have similar measures of expected and observed heterozygosity).

Additional discussion focused on the interpretation of the admixture coefficients calculated for the individuals sampled off Sakhalin. Under the assumption that two genetic clusters were present in the dataset, three patterns were evident: (1) some individuals assigned strongly the Sakhalin cluster (i.e., the cluster comprised primarily of individuals sampled off Sakhalin); (2) some individuals assigned strongly to the Mexico cluster; and (3) some individuals showed intermediate assignment values suggestive of mixed ancestry. The Working Group noted that while the individuals falling in the latter category could represent admixed individuals, it is also possible that the apparent admixture reflects individuals being incorrectly assigned due to a lack of resolution in the dataset, which included genotypes of 95 SNP loci. In addition, the majority of parent-offspring pairs (POPs) identified within this dataset included one individual that assigned strongly (Q>=0.95) to the Mexico cluster and another that assigned strongly to the Sakhalin cluster. If the individual representing the putative offspring in this POP was the result of mating between a Sakhalin and a Mexican whale (and assuming these groups represent separate populations), the admixture coefficient would be expected to reflect a more even distribution of ancestry to the two groups (e.g. a Q-value near 0.5). An explanation for this pattern has not been identified, although it was noted that such results could also reflect mis-assignment in either the parentage analysis or the LEA analysis. There were, however, a few putative parent offspring pairs which more closely fit the expected pattern, in which the Q-value for one member of the pair was more intermediate (0.65-0.72).

The authors noted that in the future, the results of the analyses presented in SC/67b/SDDNA03 will be used to inform the selection of samples for additional whole genome resequencing. Including samples representing individuals falling into each of the three categories identified above could address some of the questions raised above. In addition, integrating the genetic dataset with the existing photographic evidence could provide further insight into these questions.

The Working Group thanked the authors for presenting the work in SC/67b/SDDNA02 and SC/67b/SDDNA03 and noted the value of having genome data for this species. The Working Group **encouraged** the continuation of work to produce additional genomic data from these samples, which may aid in better evaluating the stock structure hypotheses currently under consideration for North Pacific gray whales.

Attention: SC

In reviewing the results of new genetic analyses of gray whales in the North Pacific, the Committee ***advises*** *that the genetic and photographic data for this species be combined to better assess stock structure-related questions. Given the potential for genomic data to aid in better evaluating the stock structure hypotheses currently under consideration for North Pacific gray whales, the Committee* ***encourages*** *the continuation of work to produce additional genomic data from sampled gray whales.*

4.3 North Pacific right whales

SC/67b/NH02 presented the results of a genetic study on stock structure in North Pacific right whale, based on new and published mitochondrial DNA (mtDNA) control region sequences (399bp) of individuals from the western (n=29) and eastern (n=23) North Pacific. A sub-sample from the western side (n=18) was examined with 13 microsatellite loci to investigate the level of nuclear DNA diversity. Striking mtDNA differences were found between western and eastern North Pacific right whales. The F_{ST} between western and eastern North Pacific right whales was high (0.0929) and statistically significant (P=0.0002). This result is consistent with the hypothesis that separate populations inhabit the eastern and western North Pacific. Levels of nucleotide and haplotype diversities were high, 0.0174/0.8916 and 0.0165/0.8538 in the western and eastern populations, respectively. For the microsatellite data, the average expected heterozygosity in the western population was estimated at 0.595. The observed multimodal mtDNA mismatch distribution rejected a model of historical sudden expansion in both populations. Furthermore, Bayesian skyline plots (BSP) generated from the mtDNA data suggested a similar historical trend of female effective population size (Ne_f) for the two populations, with a stable Ne_f over time followed by a recent sharp decline. The timing of the decline ranged between 25,000 and 60,000 years ago (considering different populations and two assumptions of mutation rates), which coincide with the last glaciation period in the Pleistocene. Rapid climate changes during this period could have affected the habitat and prey resources of the North Pacific right whales, resulting in the sharp decline in their abundance. No signal of recent recovery was observed in the BSP analysis; however, this could be due to a lack of resolution for contemporary population size as shown in other studies.

The Working Group thanked Pastene for presenting this work, which was recommended by the NH sub-committee at SC/67a (IWC, 2018a, p.27). It was noted that, at least in the United States, right whales in the eastern and western North Pacific have been managed as separate stocks based on a gap in the distribution of sightings, and it is valuable to see this assumption confirmed by genetic comparisons. The Working Group looks forward to hearing more about this work and **encouraged** the authors to consider its publication in the future.

Attention: SC

The results of new genetic analyses support the recognition of separate stocks of right whales in the eastern and western North Pacific. Given the importance of this work, the Committee ***encourages*** *the publication of this information in the near future.*

4.4 Southern Hemisphere blue, fin, right and sei whales

4.4.1 Non-Antarctic Southern Hemisphere blue whales

A pre-assessment of Southern Hemisphere blue whales was conducted by the SH sub-committee this year. Multiple papers on the stock structure of non-Antarctic Southern Hemisphere blue whales were discussed, including SC/67b/SH03, SC/67b/SH05, SC/67b/SH11, and Attard *et al.* (2018). Review of these papers was conducted as part of a joint

SH/SDDNA session, and details of the discussion can be found in Annex H under agenda item 3.3.

4.4.2 Antarctic blue whales

Paper SC/67b/SH02 presents a comparison of contemporary and historical mitogenome diversity in Antarctic blue whales using 20 blue whale bones collected from the islands at 54°26'00"S/36°33'00"W and the Antarctic Peninsula. This paper was discussed as part of a joint session of the SDDNA Working Group and the SH sub-committee, and details of the discussion can be found under agenda item 3.2 of Annex H.

During the discussion, it was noted that the depletion of tissue samples collected from Antarctic blue whales during the SOWER surveys remains a concern. This issue has been raised in the past, when an intersessional email group was formed to discuss approaches towards mitigating depletion of blue whale biopsy samples from the SOWER cruises (IWC, 2012b p.220). However, given the advances in high throughput sequencing that have occurred over the last several years, the Working Group agreed that revisiting this topic would be beneficial. An intersessional Working Group was formed, with the task of providing recommendations on genomic approaches that would maximise the utility of these and other samples (see Item 6.1.3).

4.4.3 Southern Hemisphere fin whales

Paper SC/67b/SH13 compares mtDNA control region sequence data generated from fin whales sampled off the north-central coast of Chile with published data from the North Pacific, North Atlantic, and the Southern Hemisphere (Archer *et al.,* 2013). Statistically significant levels of genetic differentiation were identified between the two Hemispheres as well as between the North Atlantic and North Pacific, as had been previously reported. However, no significant differentiation was identified between geographic areas in the Southern Hemisphere. This paper was discussed as part of a joint session between the SD&DNA Working Group and the SH sub-committee, and details of the discussion can be found under Annex H, agenda item 4.1.

4.4.4 Southern right whales

Paper SC/67b/SH06 presents the results of a genetic mark-recapture study of southern right whales in Antarctic Area IV. Eight whales were recaptured, suggesting that individual whales tended to return to the same location in the Antarctic in subsequent years.

Carroll *et al.* (2018a) used a dataset of mitochondrial DNA sequences and microsatellite genotypes from 17 loci to examine circumpolar population structure, historical demography, and effective population size in Southern Hemisphere right whales. While significant differentiation was observed amongst wintering grounds for both mtDNA and microsatellites, analyses of nuclear variation identified two clusters corresponding to the South Atlantic and Indo-Pacific Ocean basins.

Both of these papers were discussed in a joint session with SH, and the details of that discussion are provided in Annex H, agenda item 5.1.

4.4.5 Southern Hemisphere sei whales

SC/67b/SDDNA05 reports on progress with genetic analysis of samples collected from sei whales that were part of the largest mass mortality event that occurred in southern Chile in March 2015 (Haussermann *et al.*, 2017). MtDNA control region sequences have been produced from 50 of the 160 skin and bone samples that were collected during this event, revealing relatively high levels of mtDNA diversity among the stranded whales. This study is part of a recently funded project to examine the historical and contemporary population structure of sei whales, and future work will include the collection of additional samples from this and other regions of the Southern Hemisphere.

The Working Group **welcomed** the information provided in this report, noting that there are very few biopsies available from sei whales and thus little is known about population structure in this species.

Attention: SC

*In reviewing the results of stock structure analyses of Southern Hemisphere whale stocks, the Committee **expresses concern** regarding the depletion of tissue samples in existing collections (including those collected during the IWC SOWER surveys). Given recent advances in high throughput sequencing technology, the Committee **agrees** that an intersessional working group should be formed to provide recommendations on genomic approaches to maximize the utility of these samples for future studies.*

4.5 North Pacific common minke whales

A preparatory workshop for the upcoming *Implementation Review* on North Pacific common minke whale (NPM) was held in Tokyo, Japan, on 12-13 February 2018 (SC/67b/Rep05). This new approach of a preparatory workshop was chosen because NPM stock structure has been a matter of controversial debate without agreement, such that all current stock structure hypotheses were ranked 'medium plausibility'. This unresolved issue makes the implementation potentially complicated. During the workshop, the stock-structure related work since the last *Implementation Review* was reported. This work included about 2000 new samples and new types of stock structure inference, i.e. DAPC and kinship analysis. Based on 16 microsatellite loci, STRUCTURE consistently inferred two genetic clusters. Specimens with at least 90% assignment to one of the clusters were assigned to J and O stock, respectively, rendering about 10% of the samples unassigned. Investigating the stock affinity of the unassigned specimens was considered crucial to inform stock structure hypotheses for implementation. Therefore, prior to the first *Implementation Review* workshop, two types of analyses were recommended.

SC/67b/SDDNA06 addressed one of two recommendations on stock structure analysis from the 'Workshop on Western North Pacific common minke whale stock structure in preparation for the start of the *Implementation Review* in April 2018' which was 'Analysis 1'. This study was conducted to review the stock assignment threshold which was currently set at 90% for the program STRUCTURE analysis, using two types of datasets with 26 microsatellite loci: (1) sub-samples with sample sizes that are balanced but not necessarily equivalent among sub-areas (n=336); and (2) sub-samples including all available data (n=538). Each dataset was randomly split into training and test data, and the assignment probability in each sample was estimated for 16 and 26 loci using respective training and test data in the program STRUCTURE. All samples were assigned to stock based on respective threshold of 65%, 70%, 80% and 90% probabilities. The comparison of the results from 16 loci with 26 loci using the training data suggested that the stock assignment with 16 loci was confirmed with 26 loci in 96% of the total cases under the current threshold, and more than about 70% of the unassigned samples with 16 loci went to either of J or O stocks with 26 loci. The likelihood of reversed assignment between J and O stocks was very low regardless of the levels of thresholds, which was at most 2.2%. On the other hand, the mismatch assignment rate between the unassigned and the assigned was higher under the 90% (4.0-4.5%) than the lower (0.8-2.7%) thresholds in both datasets. The performance test using test data for the thresholds of 65% and 70% which were tentatively selected for 16 loci showed a predictive accuracy of around 0.9 in all combinations of datasets and thresholds.

The Working Group thanked the authors for presenting their results and confirmed that the workshop's recommendation for Analysis 1 has been properly completed by this work. It was further clarified that STRUCTURE had been run with the same default parameters for all analysis with 'locprior' disabled.

In discussion, the Working Group noted that a reconsideration of the most appropriate threshold for STRUCTURE assignment is motivated by the idea to leave out J-type specimens in order to enhance resolution for a joint analysis of O-type and unassigned specimens, as kinship analyses indicated a closer affinity of unassigned to O-type specimens (Pampoulie and Daníelsdóttir, 2013). The division of the 26 loci dataset into a training data set and a test data set had reduced sample size for analysis 1 by 1/3. While this allowed for testing of a new threshold/classification rule in a separate data set (i.e. the test data set), the reduction in sample size (from 538 to 336) increased uncertainty in the consistency measures.

In comparing the results of STRUCTURE based on the 16-locus dataset with those generated using the 26-locus dataset, the assignment of some individuals (based on the given threshold) was 'reversed', such that an animal assigned to the O stock using the 26-locus dataset was assigned to the J stock using the 16-locus dataset and vice versa. It was noted that these differences cannot be directly interpreted as error rates (as the true assignment is unknown), but rather comprise measures of concordance/consistency. It was further noted that these reversed assignments underscore the possibility of misassignments (e.g. assigning a 'true' J stock whale to the 'O' stock or the reverse), albeit the frequency of such incidences was low (0 for the 90% threshold and <1% for the 80% threshold). In this context, it was further noted that lack of assignment in STRUCTURE may be due to different reasons, notably noise due to low resolution, admixture, or additional stocks that are less differentiated from either J or O.

After considerable discussion on the effects of changing thresholds for assignment, the Working Group **agreed** to run two types of assignments on the full 16-locus data set, i.e., one with the established threshold of 90% and a second with a threshold of 80%. The latter was chosen based on the finding that this threshold reduced the percentage of unassigned almost by half, while retaining consistency with the 26-locus assignment in >94% of specimens.

In earlier days before genetics, J and O were distinguished by differences in breeding seasons and it was asked whether there is any way to include that type of information for informing the analysis. While this would introduce a new classification rule, a previous investigation showed that classification by breeding season matched with genetic assignment. There has been reported concordance between genetic assignment and fetus lengths for certain time periods. In summary, the Working Group **encouraged** the inclusion of non-genetic biological data to inform stock structure where possible.

Subsequently, the stock structure-related further genetic data analyses (Analysis 2 in SC/67b/Rep05) were discussed. An agreement was reached that South Korea will provide mtDNA data from specimens from subareas 5 and 6W for inclusion in the analyses. Most of these samples have been also typed for microsatellites. Although there has not been any cross-validation in microsatellite typing across Japanese and South Korean laboratories, the Working Group **encouraged** the inclusion of these data in the upcoming analyses.

It was noted in discussion that emphasis shall be on analyses with higher resolution power than STRUCTURE. It was further noted that – in the *Implementation Review* – stock structure inference has the prime function to inform trial structure. The previously used mixing matrix has been invalidated, such that a new mixing matrix has to be compiled. In this context, stock structure should be discussed in light of its relevance for running trials.

Based on the workshop recommendations, the Working Group **agreed** that the following analyses should be performed prior to the implementation workshop (notwithstanding that further analyses are welcome where feasible and appropriate):

(1) F_{ST}, F_{IS}, heterozygosities, haplotype diversity, and related measures;
(2) PCA (or FCA) analyses, including partitioning based on multiple components, and DAPC;
(3) spatially explicit analyses (especially Geneland, but also BAPS, TESS; spatial pattern of diversity measures);
(4) updated kinship analyses including most recent samples; and
(5) (if possible) Wahlund analyses as undertaken by Waples in 2011 (Tiedemann *et al.*, 2014).

A workplan, including details on available data and sample stratification, is provided in Appendix 5 (also see Workplan Item 6.1.3). As specified in SC/67b/Rep05, the primary analyses will be organised and performed by ICR (Pastene and coworkers), under the advice and assistance of the advisory group, where appropriate.

Data will be available under the Data Availability Agreement, Procedure A.

Attention: SC, C-A

The Committee reviewed new results of genetic analyses that were recommended at the intersessional Workshop (SC/67b/Rep05) to better evaluate the use of genetic data to assign stock affinity in North Pacific common minke whales.

The Committee:

(1) ***agrees*** *that future analyses should incorporate a range of assignment thresholds to encompass uncertainty;*
(2) ***supports*** *the additional genetic analyses described in Annex I Appendix 5 relating to the second recommendation of the intersessional workshop and* ***agrees*** *that they should be performed prior to the next intersessional workshop; and*
(3) ***encourages*** *the inclusion of non-genetic biological data to inform stock structure where possible.*

4.6 North Atlantic common minke whales

An intersessional workshop focused on the development of *SLA*s (*Strike Limit Algorithms*) for the Greenlandic hunt was held between 20-24 March 2018 in Copenhagen, Denmark (SC/67b/Rep06). During the workshop, results of genetic analyses focused on further evaluation of the four stock structure hypotheses under consideration for NA minke whales were presented (see Fig. 1 in Tiedemann *et al.,* 2018). After reviewing this new information, the Workshop **agreed** that one of the hypotheses (Hypothesis IV) was not supported and that another (Hypothesis III) was less plausible than the remaining two hypotheses. At SC/67b, the Working Group reviewed the results of the genetic analyses presented at the Workshop.

Tiedemann *et al.* (2018) utilised currently available genetic data (mtDNA typing of 1,563 specimens, 15 typed microsatellite loci for 1,732 specimens) for NA common minke whales to evaluate the current stock structure hypotheses. Results of Parent-Offspring analysis were not fully compatible with the hypothesis III of complete panmixia among NA minke whales. Further, there was no pervasive occurrence of positive inbreeding coefficients (F_{IS}) within subareas, as would be expected under hypothesis IV, in which all feeding grounds contain a mixture of two separate stocks in any subarea. Hypothesis IV is hence not supported by the genetic data.

Subsequent analyses concentrated on the western (W) and central (C) areas (i.e. not using data from area E) in order to assess the plausibility of hypotheses I and II. The subarea-specific inbreeding coefficient (F_{IS}) was significantly positive for subareas WG and CIC, indicating that minke whales in these areas originate from more than one breeding stock. There is some indication in the present data for 2 W stocks (hypothesis I): The genetic data exhibit a high genetic diversity in WC, which appears separated from the other subareas in both spatial Principal Component Analyses (sPCAs). WG is separated from CIC according to the sPCAs of both marker systems. CG appears intermediate between WG and CIC.

There are significant temporal fluctuations in the genotype composition in WG and CIC, suggesting an influx of deviant genotypes in certain years. The observed genotype patterns are best reconciled in a scenario where WG and CIC are predominantly used by two different (albeit genetically similar) stocks. In some years the more western stock moves also into CIC, in some years the more eastern stock moves into WG. In the light of these inferences, hypotheses I and II were modified to allow for migration of W2/W into CIC (see SC/67b/Rep06). There is no indication that mixing among W/W2 and C stock affects one sex preferentially.

With this mixing scenario in mind, one may aim to identify particular years in which the mixing would be low, in order to use them as a reference year for genetic characteristics of the respective stock. Such a year should be expected to show a low mtDNA diversity and low F_{IS} values in both stocks and across sexes. Across all analyses performed, these criteria are well met for year 2007.

Using 2007 as a reference year, PC values provided by the spatial Principal Component Analysis of genotype data were utilised to assign single specimens to putative stocks, based on 6-dimensional vector distance (3PCs for each microsatellites and mtDNA). This approach yielded estimates for year specific mixing rates for 2003 to 2016, with average proportions of W:C stock as follows: WG 66:34; CG 61:39; CIC 33:67. The underlying assumptions (identification of a reference year; stock affinity reflected in proximity of individual PC values to stock mean PC values) remain so far untested. As true mixing proportions are unknown, validation of the estimated proportions is currently not feasible. The estimated mixing proportions may nonetheless prove useful in compiling mixing matrices, as they may constitute the only quantitative information available.

In discussion, it was clarified that these analyses relied on the same genetic markers as previous stock structure inferences on this species and that microsatellite scores originating from different laboratories had been made comparable by re-typing a representative subset of samples for inter-lab calibration. As a general feature of microsatellite fragment length typing, it was further noted that homoplasy, i.e. identical size of different alleles, cannot be excluded.

The subsequent discussion centered around the utilisation of an ordination approach (here, sPCA) to provide estimates of stock mixing proportions. It was clarified that this analysis stratifies the genetic data (here, microsatellite and mtDNA data) along principal components (PCs), taking into account also sampling location. It was further clarified in discussion that this method provides a classification rule for which the probability of correct individual assignment is not known. This contributes to uncertainty in the assignment. There is however no reason to expect a bias in the assignment to one or the other stock, as long as the standard deviations for any utilised PC are similar across stocks for the reference year (as was the case for year 2007 used as reference here). It was also clarified that a hypothetical random classification rule should – on average – result in mixing ratios of 50:50 in all areas, while the application presented here yielded average mixing rates significantly different from 50:50, i.e., around 65:35 and 35:65 for WG and CIC, respectively.

The Working Group **agreed** that inferred mixing rates – despite of associated uncertainties – comprise a step forward for AWMP/RMP simulation trials, as previously used mixing rates were not based on any specific empirical data. It was further noted that the approach used here could be used to infer stock structure below the resolution level of the STRUCTURE approach and that the mixing scenario suggested here was compatible with an earlier assessment, applying DAPC to NA common minkes (Hoelzel *et al.*, 2014). The precision [albeit not the accuracy] of the mixing rate estimation could be assessed with a resampling approach (e.g. jackknife).

Further discussions compared the approach used here (using only the first three PCs for any marker set) to DAPC. The latter may utilise a substantially higher number of PCs and may hence tend to overclustering, i.e. identify more clusters than biologically relevant.

The Working Group **encouraged** the attempt to utilise genetic data to estimate mixing rates and encouraged its utilisation in other IWC-related contexts and for further genetic loci (i.e. SNPs). As this study mostly focused on the Central and Western North Atlantic, an extension of the study to the Eastern North Atlantic was also encouraged.

Attention: SC, C-A

The Committee reviewed the use of a new approach that utilized ordination analyses of genetic data to assign stock mixing proportions. While this new approach requires making certain assumptions about the data, the Committee:

(1) ***agrees*** *that the inference of mixing rates was informative for AWMP/RMP simulation trials in the absence of empirical data; and*
(2) ***encourages*** *the attempt to use genetic data to estimate mixing rates in the context of other IWC-related tasks.*

4.7 Further stock structure advice

SC/67b/ASI05 was reviewed during a joint session of the SDDNA Working Group and the Ad hoc Working Group on Abundance Estimates, Status and International Cruises. A summary of the discussion can be found in Annex Q under item 3.1.2.

5. NEW STATISTICAL AND GENETIC ISSUES RELATING TO STOCK DEFINITION

5.1 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 (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; Hoban *et al.*, 2012). At SC67a, the Working Group agreed that reviewing the available packages and evaluating their utility to address issues of interest to the IWC Scientific Committee would be useful, and an email correspondence group was formed to conduct this review intersessionally (IWC, 2018b). The group was unable to report on their findings this year and thus agreed to continue work on this item intersessionally (see Work Plan Item 6.1.4), with the goal of providing a summary at SC/68a. In addition, the possibility of bringing in an Invited Participant with specialised expertise in this topic to present an overview of the applicability of this approach to the SC was discussed. The Working Group **agreed** that this strategy would facilitate making progress on this item, and Lang and Tiedemann offered to look into this possibility.

Attention: SC

*The Committee noted that while simulation-based approaches have been particularly valuable in informing the interpretation of results of stock structure-related analyses, they have not been broadly utilised within the Committee for this purpose. The Committee **agrees**:*

(1) to continue an intersessional review via an e-mail correspondence group (Annex I Table 2, ICG-3) of the available simulation tools and their potential utility to the Committee; and

(2) to consider bringing in invited expertise to present an overview of the applicability of such approaches in order to expedite progress on this agenda item.

5.2 PCA, DAPC, and related methods

Tiedemann *et al.* (2018) employed a novel approach to utilise the results of ordination-based analyses (sPCA) to estimate mixing rates in North Atlantic common minke whales. Details of this discussion are provided above under Item 4.6 above. In addition, SC67b/SDDNA03 (see Item 4.2) and Carroll *et al.* (2018a) (discussed in Annex H, item 5.1) used a Discriminant Analysis of Principal Components (DAPC) to evaluate population structure within gray and southern right whales, respectively.

5.3 Terminology

The status of the glossary on key terms in stock definition was revisited. It was suggested to restrict this discussion first to only those terms of most relevance to discussions of baleen whales, and see if there could be agreement on those within SD.

It was noted that, although the SC has not formally agreed on the terminology suggested earlier in the Working Group, the consistent use of key terms by members Working Group (e.g. using 'stock' only for breeding stocks') has overall increased consistency in terminology in SD related issues.

In its current version, the glossary uses the term 'biological stock'. While the current definition is well grounded in population genetics where it is similar to a 'population', it was noted that this term is hardly ever used outside the Working Group. It was further noted that, while stock definition typically incorporates information on genetic population structure, a defined 'stock' may additionally reflect management rationales.

One could maintain this approach to define 'stock' as close to some biological reality or, alternatively, use 'stock' as a management term (as in fisheries), and then explain how 'population' or 'deme' relate to 'stock'. In the IWC context, a stock is a unit that is managed separately and simulated as a separate unit in IWC *Implementations*. To define stocks constitutes hence a core concept for how IWC implementations are performed.

The Working Group **agreed** that the term 'stock' refers to a breeding assemblage ('biological stock'), while feeding grounds may be used by different stocks (mixed-stock (adj.) feeding aggregation). The potentially complex scenarios of differential migration among breeding grounds and feeding areas can be classified in 'archetypes', as has been forwarded during the development of TOSSM.

The Working Group further **agreed** to establish an intersessional e-mail group (see Work Plan Item 6.1.5) to revisit in more detail the current terminology and suggest revisions where appropriate for consideration at SC/68a.

Attention: SC

*The Committee **agrees** to establish an intersessional email group to revisit terminology with specific reference to the implications of inferred stock structure in other sub-committees, particularly those that deal with large whale assessments, and suggest revisions where appropriate for consideration at SC/68a.*

5.4 Close-kin mark-recapture

During last year's meeting (SC/67a), an overview of the close-kin mark-recapture (CKMR) approach (Bravington *et al.,* 2016) was presented to the SC. 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.

No papers applying the CKMR approach were reviewed by the Working Group this year, although the value of integrating data from epigenetic aging (see discussion below, Item 5.5) into CKMR was noted. Given that CKMR has multiple applications that fall within the Scientific Committee's scope of work, the Working Group **encouraged** the submission of papers utilising this approach in the future.

Attention: SC

Given that close-kin mark-recapture has multiple applications that fall within the Committee's scope of work, the Committee ***encourages*** *the submission of papers utilising this approach in the future.*

5.5 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 SC to the concept and methodological developments in the technique (IWC, 2017). At SC/67b, the SH sub-committee, in coordination with the Working Group, invited Jarman, who was the lead scientist on the humpback whale work, to give this presentation, which was organised as a special night session in order to enable participation across sub-committees and Working Groups. Following this open presentation, the Working Group also heard the results of SC/67b/SDDNA04, which focussed on evaluating the feasibility of using this technique to estimate the age of Antarctic minke whales.

Jarman's presentation focussed on the prospects for age estimation in cetaceans by DNA methylation analysis. Cetacean population biology is commonly studied through a variety of analyses based on skin biopsy samples and generating age information from these samples will be valuable for addressing many questions. Age estimation of human tissues by DNA methylation analysis is now established as the method of choice for biological age estimation in medical research; and as a proxy from chronological age estimation in forensic studies. Similar work on mice and non-human primates have demonstrated the effectiveness of this class of methods in other mammals. One published study on age estimation in humpback whales (Polanowski *et al.*, 2014) demonstrates the potential of these sorts of methods for cetacean age estimation. 'Epigenetic clock' like change in DNA methylation at specific CpG sites in different mammal genomes is a mechanism for regulation of expression specific genes in an age-related manner. The scale of change in DNA methylation at age-regulated CpG sites appears to scale to lifespan and display some conservation among mammal species. Jarman then spoke about issues specific to age estimation in cetaceans, including why DNA methylation-based age estimation are likely to work well in cetaceans and what current and near-future prospects there are for this class of methods.

SC/67b/SDDNA04 presented the results of the feasibility study of the DNA-methylation (DNA-M) technique to determine age in the Antarctic minke whale. A total of 100 Antarctic minke whale samples, for which earplug readings were considered excellent or good, were selected for the DNA-M feasibility study. Seven CpG sites in three genes (TET2, CDKN2A and GRIA2) were selected for this study because they showed significant correspondence between CpG methylation levels and age in a previous study on humpback whales. In addition, SDDNA04 investigated changes in the DNA-M rate among different positions of the whale's body, some involving dorsal side (expose to sunlight) and others on the ventral side. DNA-M rate of the seven CpG sites were scored successfully, and regressions of each CpG methylation against age determined by earplug were conducted. Coefficients of determination (R^2) of all CpG sites were lower than that of the previous humpback whale study. The assay predicted age from skin samples with a standard deviation of 8.865 years. For some loci DNA-M rate fluctuated among 8-10 positions of the whale body. The authors concluded that age determination of Antarctic minke whale based on the seven DNA-M sites (from three genes) used in this study is not feasible particularly for use in population dynamics models such as SCAA.

The Working Group thanked Goto for presenting these results. While this study was initiated in response to a recommendation made during the Expert Panel review of the proposal by Japan for NEWREP-A (IWC, 2016, p.17), it was noted that identifying methods to estimate age in cetaceans is valuable not only in the context of the RMP implementation, as in the NEWREP-A exercise, but has multiple uses in the context of the SC, including the ability to discriminate between the parent and offspring among genetically identified parent-offspring pairs, which can inform both assessment of stock structure as well as genetic mark-recapture estimates of abundance (e.g. CKMR).

In discussion of the technical aspects of the paper, the Working Group noted that while it was reasonable to first evaluate the utility of DNA methylation studies for estimating age in Antarctic minke whales using the seven sites that proved useful in humpbacks, screening additional loci would be beneficial. This could be done by identifying loci correlated with age in humans or mice, and then making use of the now available minke whale genome to localise the homologous loci in this species. For the Antarctic minke whale analysis presented here, one site (TET-3) showed a relatively high age-related effect, while two others demonstrated a more minor effect (TET-2 and Cdkn2a3). Other loci (e.g. Cdkn2a1 and Cdkn2a2 and F) did not show any correlation. All seven loci were integrated into the model used to estimate age, and thus using only those loci that appear to have an age-related effect might reveal a stronger relationship.

The Working Group further noted that the information provided in SDDNA04 on positional sampling was useful, and that some of the differences identified between tissues collected from different regions of the body could have been driven by sampling a mix of cell types from different tissues rather than from environmental influences.

Importantly, during the discussion it was noted that a humpback whale age assay had a precision of 3.7 years, measured as the mean absolute difference (MAD) between estimated and known ages (Polanowski *et al.*, 2014). That was a preliminary study demonstrating the fundamental feasibility of this approach, and is not as accurate or precise as tests developed for humans and mice based on analysis of many more CpG sites. While precision is expected to be improved with the inclusion of more CpG sites, the maximum precision possible for any DNA methylation-based age estimator is likely limited by the imperfect relationship between chronological age and biological age. To date, that precision measured as MAD/lifespan has ranged from 3.9% in humpback whales (Polanowski *et al.,* 2014, assuming a 95-year lifespan), to 3.2% of lifespan in humans (e.g Horvath, 2013) and 1.7% of lifespan in mice (Stubbs *et al.*, 2017). These observations indicate that the SD and 95% CI for age estimation described in Polanowski *et al.* (2014) and in SC/67b/SDDNA04 could be substantially improved before an inherent limit is reached. It was further noted that these precision estimates adhere to age determination in individual specimens. Hence, averaged age estimates over cohort will improve over larger sample sizes and may be more precise.

The Working Group noted that the implications of this upper limit on precision in estimating age for individuals would need to be evaluated in the context of the specific application for which the age data were being used. For example, although additional precision is helpful, CKMR studies may be informed by relatively crude estimates of age allowing the parent to be discriminated from the offspring (i.e. ordinal age).

In conclusion, the Working Group **agreed** that: (1) the results presented in SC/67b/SDDNA04 were not sufficient to provide individual age estimates that would be appropriately precise to use in the population dynamics modelling exercise recommended for NEWREP-A; and (2) that screening of additional loci would likely allow more precise age estimates to be provided in the future. Given that there is an upper limit on the degree of precision that can be achieved, however, the SC needs to evaluate whether, if optimal precision is achieved, epigenetic-based age estimates will be useful in the specific context of the NEWREP-A recommendation.

Attention: SC

*The Committee welcomed the results of the study to evaluate the feasibility of using epigenetic techniques to estimate age in Antarctic minke whales and **agrees**:*

(1) that the current set of loci did not provide sufficient precision for use in the population dynamics modelling exercise recommended for NEWREP-A;
(2) that identification of additional sites with an age-related DNA-methylation pattern is encouraged, as it would likely allow more precise estimates of age to be made in the future; and
(3) given that there is an upper limit to the degree of precision that can be achieved using this technique, evaluating the utility of epigenetic age estimation to the Committee should be further evaluated by the sub-committees concerned with regard to the degree of precision needed for the specific application of interest.

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6. WORK PLAN

6.1 Work Plan

6.1.1 DNA quality guidelines

The e-mail group formed to discuss updating the DNA quality guidelines will continue intersessionally. The draft guidelines have been revised to incorporate sections covering data, including SNPs, produced using next generation sequencing (NGS) approaches. For SC/68a, the group will complete their review of the updated sections, such that a revised version can be posted on the IWC website next year. The group was convened under Tiedemann and included Archer, Baird, Baker, Bickham, Carroll, DeWoody, Hoelzel, Goto, Jackson, Lang, Palsbøll, Pampoulie, Solvang, Taguchi, and Waples.

6.1.2 Recommendations to maximise utility of tissue samples

An intersessional e-mail group was convened to provide recommendations on genomic approaches that would maximise the utility of tissue samples, including those collected as part of IWC surveys, that are in danger of becoming depleted in the future. The group was convened under Lang and included Baker, Bickham, Carroll, Goto, Taguchi, and Tiedemann.

6.1.3 North Pacific minke whale genetic analyses

The Working Group agreed that additional genetic analyses should be performed prior to the *Implementation Review* for North Pacific minke whales. A work plan with details of the analyses is included in Appendix 5. As specified in SC/67b/Rep05, the primary analyses will be organised and performed by ICR (Pastene and coworkers), under the advice and assistance of the advisory group, where appropriate.

6.1.4 Simulation tools

The intersessional e-mail group that was convened at SC67a to discuss the utility of simulation tools for evaluating spatial structure will be continued. 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/68a. The group was convened under Lang and included Archer, Bickham, Carroll, DeWoody, Hoelzel, Kitakado, and Tiedemann.

6.1.5 Terminology

An intersessional e-mail group will be re-convened to discuss the use of stock structure-related terms within the Scientific Committee reports and in papers submitted to the Scientific

Table 1
Summary of the Workplan.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
3.1 DNA quality guidelines	Intersessional email group to review recent revisions to the DNA quality guidelines that pertain to data produced using NGS approaches.	Report and finalise updated guidelines		
4.4.2 Recommendations to avoid sample depletion	Intersessional email group to provide recommendations on genomic approaches to maximise the utility of tissue samples that are in danger of becoming depleted in the future.	Report and provide advice		
4.5 North Pacific minke whale stock structure	Perform genetic analyses detailed in Appendix 5; report results at intersessional workshop on the North Pacific minke whale *Implementation Review.*	Review results and provide advice		
5.1 Simulations	Intersessional email group to review software packages and evaluate utility to the SD&DNA.	Report	Continue as needed	Report (if needed)
5.3 Terminology	Intersessional email group to continue discussions of the use of stock structure-related terms within the SC.	Report	Continue as needed	Report (if needed)

Table 2
Intersessional e-mail Groups.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 3.1/SD&DNA	ICG-1	DNA quality	Review recent revisions in sections of the DNA quality guidelines that pertain to data produced using NGS approaches.	Tiedemann (Convenor), Archer, Baird, Baker, Bickham, Carroll, DeWoody, Hoelzel, Goto, Jackson, Lang, PalsbØll, Pampoulie, Solvang, Taguchi, and Waples
Item 4.4/SD&DNA	ICG-2	Sample depletion	Discuss and provide recommendation on genomic approaches to maximise the utility of tissue samples, particularly those in danger of depletion.	Lang (Convenor), Baker, Bickham, Carroll, Goto, Taguchi, Tiedemann
Item 5.1 Simulation tools	ICG-3	Simulations	(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.	Lang (Convenor), Archer, Bickham, Carroll, DeWoody, Hoelzel, Kitakado, Tiedemann
Item 5.3 Stock structure-related terminology	ICG-4	Terminology	Revisit the definitions that were previously put forward for stock-related terms at IWC 2014, particularly those related to large whale assessments, and revise them where necessary.	Tiedemann (Convenor), Baird, Bickham, Carroll, Cipriano, Lang, Scordino

Table 3
Summary of the 2-year budget request for SDDNA.

RP no.	Title	2019 (£)	2020 (£)
Other			
	Collaborative analysis of WNP minke whale stock structure using Japanese microsatellite DNA database and spatially explicit population structure analyses	£6,247	
Total request		**£6,247**	

Committee. The focus of this group will be to revisit the terminology definitions that were previously put forward (IWC, 2014), particularly those related to large whale assessments, and revise them where necessary. This group will be convened under Tiedemann and will include Baird, Baker, Bickham, Carroll, Cipriano, Lang, and Scordino.

6.2 Budget requests for 2019-20

The Working Group received one budget request for 2019-20 (see Table 3). This request was put forward by Hoelzel and addresses the need to complete recommended analyses on the stock structure of North Pacific minke whales prior to the 2019 intersessional Workshop on the North Pacific minke whale *Implementation Review*. Specifically, the funding requested is to help complete the work included in the 'Analysis 2' recommendation made in SC/67b/Rep05. This project would represent a collaborative effort with Pastene and his colleagues, who would provide access to the Japanese microsatellite data. The Working Group **agreed** that completing this work prior to the intersessional Workshop is important and **recommended** that this work be funded.

7. ADOPTION OF REPORT

The report was adopted at 17:00 on 2 May 2018.

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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. DNA testing
   2.1 Genetic methods for species, stocks and individual identification
   2.2 'Amendments' of sequences deposited in GenBank
   2.3 Collection and archiving of tissue samples from catches and bycatches
   2.4 Reference databases and standards for diagnostic DNA registries
3. Guidelines and methods for genetic studies and DNA data quality
   3.1 Update DNA quality guidelines to include discussion of NGS data
   3.2 Further applications of DNA techniques
4. Provide advice on stock structure to other sub-groups
   4.1 Bowhead whales
   4.2 Gray whales
   4.3 North Pacific right whales
   4.4 Southern Hemisphere blue, fin, right and sei whales
      4.4.1 Non-Antarctic Southern Hemisphere blue whales
      4.4.2 Antarctic blue whales

4.4.3 Southern Hemisphere fin whales
4.4.4 Southern right whales
4.4.5 Southern Hemisphere sei whales
4.5 North Pacific common minke whales
4.6 North Atlantic common minke whales
4.7 Further stock structure advice
5. New statistical and genetic issues relating to stock definition
5.1 Simulation tools for spatial structuring (e.g. TOSSM)
5.2 PCA, DAPC, and related methods
5.3 Terminology
5.4 Close-kin mark-recapture
5.5 Epigenetic aging
6. Work Plan
6.1 Work plan
6.2 Budget requests for 2019-20
7. Adoption of report

Appendix 2

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

Notes:	1	2	3	4	5	6	7	8	9	10	11	12
	Type	No. of whales	No. of duplicate	No. missing	Lab problem	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	
NP minke whale												
1994-2016	SP	2,680	0	0	8	2,672	100	2,672	100	2,680	100	
2017	SP	128	0	0	0	128	100	128	100	128	100	
2001-16	BC	2,008	0	26	2	2,008	100	1,980	99	1,978	99	
2017	BC	164	0	0	0	164	100	164	100	164	100	
NP sei whale												
2002-16	SP	1,354	0	0	4	1,350	100	1,354	100	1,354	100	
2017	SP	134	0	0	0	134	100	134	100	134	100	
NP Bryde's whale												
2000-17	SP	730	0	0	3	727	100	730	100	730	100	
2001-16	BC	5	0	0	0	5	100	4	80	4	80	Include three Omura's whale and one from the East China Sea stock
2017	BC	0	0	0	0	0	0	0	0	0	0	No BC
NP humpback whale												
2001-16	BC	63	0	0	0	63	100	63	100	63	100	
2017	BC	3	0	0	0	3	100	3	100	3	100	
NP right whale												
2001-16	BC	3	0	1	0	3	100	2	67	2	67	Missing by the 2011 tsunami, no microsats
2017	BC	0	0	0	0	0	0	0	0	0	0	No BC
NP fin whale												
2001-16	BC	11	0	0	0	11	100	11	100	11	100	
2017	BC	0	0	0	0	0	0	0	0	0	0	No BC
NP sperm whale												
2000-17	SP	56	0	0	0	56	100	56	100	56	100	
2001-16	BC	2	0	0	0	2	100	2	100	2	100	
2017	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	Including dwarf; 87/88-88/89. no microsats.
2005/06-2015/16	SP	4,217	0	549	162	2,978	71	3,506	83	4,217	100	Some missing by the 3/11 tsunami in 2011.
2016/17	SP	333	0	0	0	333	100	333	100	333	100	
Antarctic fin whale												
2005/06-2011/12	SP	18	0	0	0	18	100	18	100	18	100	

Notes:
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 other reasons than sample switching.
5. Genetic laboratory not able to obtain microsatellite profiles or 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 total samples analysed for sex.
12. Other problems or information.

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 NEWREP-NP) 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 2017 is as follows.

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Appendix 3

AN UPDATE OF THE NORWEGIAN MINKE WHALE DNA REGISTER

Hans J. Skaug

University of Bergen and Institute of Marine Research

Notes:	1	2	3	4	5	6	7	8	9	10	11	14		12
	Type	No. of whales	No. of duplicates	No. missing	Lab problem	No. tDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	SNP	% SNP	
NA minke whale														
1997-2016	C	11,307	109	75	2	11,121	100	11,121	100	11,121	100	578	5	-
2017	C	431	3	1	0	0	0	430	100	430	100	430	100	-

Notes:
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 other reasons than sample switching.
5. Genetic laboratory not able to obtain microsatellite profiles or 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 total samples analysed for sex.
12. Other problems or information.
13. Discontinued starting from 2016.
14. Started in 2016.

Appendix 4

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.

The table 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 (2008-17), as well as from commercial NA fin whale catches have been genotyped and information stored in the database.

Notes:	1	2	3	4	5	6	7	8	9	10	11	12
Species/year	Type	No. whales	No. duplicate	No. missing	No. lab problem	No. mtDNA	% mtDNA	No. msat	%msat	Sex analysed	% sexed	
NA minke whale												
2003-07	SP	189	0	0	0	189	100	189	100	189	100	-
2008-16	C	414	0	0	0	362	87	365	88	367	89	-
2017	C	17	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	-

Notes:
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 other reasons than sample switching.
5. Genetic laboratory not able to obtain microsatellite profiles or 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 total samples analysed for sex.
12. Other problems or information.

Appendix 5

WORKPLAN FOR GENETIC DATA ANALYSIS RECOMMENDED PRIOR TO THE FIRST *IMPLEMENTATION* WORKSHOP ON NORTH PACIFIC COMMON MINKE WHALE (BASED ON DISCUSSIONS IN SDNA-NPM SMALL GROUP)

This work plan is based on the recommendations from the Workshop on Western North Pacific common minke whale stock structure in preparation for the start of the *Implementation Review* (SC/67b/Rep05) and takes into account that the recommended *Analysis 1* has already been completed (SC/67b/SDDNA06).

For *Analysis 2*, the Workshop **agreed** on the importance of trying to better understand the nature of unassigned individuals and suggested several analyses to resolve this issue. This work plan specifies available genetic data, sample partitions to be compiled, sample stratification for specific analyses, and analytical methods to be applied.

Available data

The following table lists available genotyped samples from South Korea (subareas 5 and 6W; data hold by Hyun Woo Kim and coworkers) and Japan (other subareas; Pastene, Goto, Taguchi). The South Korean scientists have kindly agreed to provide their mitochondrial DNA sequence data to Pastene and co-workers for joint analyses.

Sample partitions

The recommended analyses are to be performed for the entire data set available. In this context, both the 16 loci and the 26 loci data set should be utilised.

Further, two types of partitions are to be analysed:

The first will include O-stock together with the unassigned individuals, using both the 80% and 90% thresholds for assignment (based on 16 microsatellite loci).

The second will not be based on the STRUCTURE results but rather will include only the relevant geographic areas that are not dominated by J-stock (i.e. subareas 7, 8 and 9).

Clustering in the PCA/DAPC analyses may identify putative J-stock individuals as a strongly supported cluster that could be excluded in further analyses if this facilitated the resolution of more weakly differentiated clusters. The objective is to diminish or eliminate the strong signal identifying the distinction between O and J stocks to increase the potential to identify a weakly differentiated stock. However, the priority should be to resolve local patterns by the selection of geographic samples without post-hoc purging if possible.

	Sub-area													
Marker set	1E	2C	5	6W	6E	7CN	7CS	7E	7WR	8	9	10	11	Total
mtDNA**	69	338	114	922	916	1,178	925	49	89	251	541	15	129	5,536
16 microsat loci**	69	338	-*	-*	916	1,178	925	49	89	252	541	15	129	4,501
26 microsat loci	26	28	-	-	126	42	148	27	27	35	39	15	25	538

*Microsatellites were also typed in South Korea, but have not yet been cross-validated with Japanese typings.
**Japanese samples from 2016 not yet included.

Stratification

All available samples will be stratified as follows: 1. By year and subarea; 2. By month and subarea.

In this stratification, by-catches shall be flagged to facilitate analyses as to the effect of inclusion/exclusion of by-caught specimens. Depending on the number of available samples per year/month and subarea, adjacent years/months may be combined to increase sample size per stratum (e.g., looking at two years or two months periods).

Analysis

It was agreed that the following analyses should be performed prior to the implementation workshop (notwithstanding that further analyses are welcome where feasible and appropriate):

(1) F_{ST}, F_{IS}, heterozygosities, haplotype diversity, and related measures;

(2) PCA (or FCA) analyses, including partitioning based on multiple components, and DAPC;

(3) spatially explicit analyses (especially Geneland, but also BAPS, TESS; spatial pattern of diversity measures);

(4) updated kinship analyses including most recent samples; and

(5) (if possible) Wahlund analyses as undertaken by Waples in 2011 (Tiedemann *et al.*, 2014).

As specified in SC/67b/Rep05, the analyses will be organised and performed by ICR (Pastene and co-workers), under the advice and assistance of the advisory group, where appropriate.

Annex J

Report of the Sub-Committee on Non-Deliberate Human-Induced Mortality of Cetaceans

Members: Leaper (Convenor), Currey (co-Convenor), Al Harthi, Alfaro Shigueto, An, Andriolo, Aoki, Archer, Atkinson DeMaster, Avila, Bell, Bjørge, Brierley, Brownell, Buss, Caballero, Castro, Cipriano, Collins, Cooke, Cosentino, Cubaynes, DeMaster, Di Tullio, Doniol-Valcroze, Double, Ferriss, Fortuna, Frey, Fruet, Gallego, Galletti Vernazzani, Gulland, Haug, Hielscher, Hubbell, Hughes, Iñíguez, Irvine, Jacob, Kato, Kim, E., Kim, H.W., Lang, Langerock, Lauriano, Leaper, Leslie, Lundquist, Mallette, Mangel, Marcondes, Mattila, Mazzariol, Minton, Mwabili, Nelson, Nicol, Northridge, Palka, Panigada, Parsons, Phillips, Pierce, Porter, Reeves, R., Reeves, S., Reyes Reyes, Ridoux, Ritter, Robbins, Rodriguez-Fonseca, Rojas-Bracho, Rose, Rowles, Ryeng, Santos, Scheidat, Scordino, Sequeira, Siciliano, Simmonds, Slooten, Slugina, Smith, Stachowitsch, Stack, Stimmelmayr, Svoboda, Tarzia, Taylor, Thomas, Trejos Lasso, Urbán, Van Waerebeek, Víkingsson, Wade, Walters, Weinrich, Weller, Williams, Willson, Yaipen-Llanos, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Leaper welcomed participants. He noted the establishment of the IWC Bycatch Mitigation Initiative, and the recent appointment within the IWC Secretariat of the Bycatch Coordinator. The Bycatch Mitigation Initiative will provide opportunities for joint action on bycatch, but also challenges for the Committee in relation to how time and limited resources can be used effectively to contribute. Leaper highlighted paper SC/67b/HIM12, outlining the strategic assessment of the Bycatch Mitigation Initiative and for the sub-committee to keep this in mind during the discussion its recommendations, with the highest action being the identification of priority cetacean species/populations or fisheries to focus targeted work for bycatch pilot projects.

1.2 Election of chair and appointment of Rapporteurs

Leaper was elected as Chair, Currey as co-chair. Mattila and Tarzia volunteered to serve as rapporteurs.

1.3 Adoption of Agenda

The Agenda was adopted with an additional item (Item 2.1.4) added on electronic monitoring.

1.4 Available documents

SC/67b/HIM01-12; SC/67b/AWMP08, Temple *et al.* (2018); Kiszka *et al.* (2017); Anon. (2016); and Avila *et al.* (2018).

2. BYCATCH AND ENTANGLEMENT

2.1 Review new estimates of bycatch and entanglement rates, risks and mortality

2.1.1 Baleen whales

SC/67b/HIM03 provided information on stranded humpback whales along the south-eastern coast of Brazil during the 2016-17 winter seasons. In addition, information on apparent feeding behaviour of humpback whales and entanglements off the São Paulo coast was provided. Nine records of stranded or entangled humpback whales were gathered. Two live stranded whales were towed back to the sea, although long term survival was unclear. Three records of entanglement in gillnets and feeding behaviour were described. In all cases, yearlings were involved in the interactions. These records combine two poorly understood situations of migrating humpback whales: apparent feeding behaviour in mid-latitude waters and attraction to fishing gear. The study highlighted the need for cetacean awareness campaigns and training of local environmental officers.

It was noted that these entanglements occurred in a small-scale fishery, which is not permanently in operation and which fishes in the very near-shore coastal environment.

SC/67b/HIM09rev1 reviewed ten baleen whale species and subpopulations listed as either Critically Endangered or Endangered by IUCN or with populations of less than 500 individuals remaining, for which bycatch appears to have substantial conservation implications. Six of the ten have an estimated population size of less than 100 individuals, and include the Gulf of Mexico 'Bryde's', eastern North Pacific right whale, Chile-Peru right whale, upper Gulf of Thailand Bryde's, Arabian Sea humpback whale, and western gray whale. The remaining four populations have less than 500 individuals including Okhotsk Sea bowhead, Central American humpback, North Atlantic right, and the western North Pacific right whale. Of these cases where bycatch has been documented, common fishery types are involved and generally include gillnets, pots and traps attached to line, and set nets. Further efforts are needed to assess the extent and rate of fishery interactions, as well as the population level consequences. These entrapments and entanglements are seasonally dependent on the presence of baleen whales associated with their migration, feeding or breeding activities. Right whales, humpback whales, and gray whales appear to be the species most prone to entanglements in many parts of the world and similarly for bowhead whales in Arctic waters. The authors suggested that more attention must be given to all the populations with fewer than 500 individuals. For those populations with less than 100 individuals immediate action is necessary to address bycatch. In seven of the 10 populations presented with documented bycatch, less than four range states are involved. However, few national and no international programs exist to address this problem in a systematic way. A review of fishing gear across species is also needed to better understand common problems and gear types attributed to baleen whale bycatch.

In discussion about the necessary follow-up work, the author noted that detailed post-mortems are needed to identify the fishing gears causing bycatch. The sub-committee noted that there were at least two distinct categories for prioritisation presented in the paper; those populations under 100 individuals which require urgent action (including consideration of total fisheries closure); and those populations which number more than 500 individuals, for which there is a little more time available. Furthermore, the cases identified could be further categorised based on the extent of evidence available to indicate that bycatch is the main cause for population declines. For example, in the case of the Arabian Sea humpback whale there is strong evidence that entanglement has been experienced by between 30%-40% of animals within a population of less than 100 animals, emphasising the need for urgent action. Such evidence is less clear for other populations. The authors emphasised their view that the focus should be on the populations which are at immediate risk of extinction, however others noted that focusing on such critically endangered populations might be too late, and that ideally efforts should focus on populations where there is some possibility of success. There is likely to be relevant experience in other countries for mitigation and management of problematic gears for baleen whales that could be useful in assisting countries to tackle the issue for these ten priority species and sub-populations.

SC/67b/AWMP08 contained information on entangled bowhead whales. The author noted that two entangled whales had been harvested in spring 2017 in Barrow, Alaska. During the hunt, one was believed to be a whale that had been recently struck and lost dragging a harpoon line, but upon capture, it was determined to be rope associated with fishing. Further examination suggested that the rope and remaining gear from both whales belonged to the Bering Sea pot fishery (crab/cod). Later, fishers from that industry confirmed the gear was from the pot fishery, however they could not be sure whether the gear was from Russia or the USA. In addition, the wear on the rope suggested that it might be 'ghost' gear. Previously, only one dead beach-cast whale in the region, from 2015, had identifiable gear on it and in that case was from the US Bering Sea crab fleet. Previous work (Citta *et al.*, 2013) has suggested that these animals overlap in space, but not time with the crab fishery, suggesting they may predominately encounter lost gear rather than gear that was being actively fished at the time.

In discussion, it was noted that the colour of the rope in both entanglements was tan/green, and that this may ultimately prove to be useful information, given ongoing studies of right whale vision and avoidance of various colours of simulated rope. Also, the author noted that analysis of cortisol in the baleen plates showed a sudden increase of at least one order of magnitude that began in the winter of 2016, but that these levels were starting to fall prior to its death in the spring of 2017, as it also appears to have done prior to death in southern right whale calves showing evidence of kelp gull attacks (SC/67b/CMP04).

2.1.2 Inferences from strandings

SC/67b/HIM01 describes preliminary results from largely opportunistic monitoring efforts of beach-cast cetaceans in 11 locations along the Peruvian coast in 2000-17, with a focus on species prevalence and estimation of a minimum human interaction rate (58.8%). A total of 942 specimens (873 identified) covered eight species: Burmeister's porpoise, dusky dolphin, common dolphins (mostly long-beaked), common bottlenose dolphin, and single specimens of Risso's dolphin, dwarf sperm whale and Peruvian beaked whale. Clear evidence of continued high bycatch rates and some intentional takes, as well as utilisation for food or bait was ubiquitous. Unused bycatch discards were novel. The overwhelming prevalence of Burmeister's porpoises beach-cast nation-wide (66%) and a low 25% of dusky dolphins (central coast) contrast with 1985-90 statistics when dusky dolphins accounted for three quarters of all cetacean captures. The authors reiterated prior concerns (Van Waerebeek, 1994) about a persistent long-term trend of a significant decline in prevalence of Peruvian dusky dolphin in catch and stranding records. The authors recommended regular, dedicated beach surveys with standardised protocols to improve data on human-induced and natural mortality, species/age/sex prevalence, together with collection of samples for further natural history studies.

In discussion, the author noted that Peru has never had a national strandings network, or a standardised approach to monitoring stranded animals. Those involved in beach monitoring activities in Peru include groups looking at different taxa (e.g. seabirds) and so it is difficult to ensure that standardised protocols are followed for collecting data on stranded cetaceans when this is not their focus. The Peruvian Government has a research vessel that collects cetacean data, which might be useful for determining species abundance, however this has not yet been analysed or processed. The sub-committee noted the situation regarding bycatch in Peru and **recommended** that the IWC Secretariat make contact with the Peruvian government to offer IWC assistance. The observed high mortality levels in Burmeister's porpoise are a serious concern, and action is needed to avoid the same critical situation as with the closely related vaquita. Burmeister's porpoise is already included in a preliminary list for potential Conservation Management Plan development in Genov *et al.* (2015), and dusky dolphin could potentially also be included. The sub-committee noted possible opportunities to focus on these species through the new IWC Bycatch Mitigation Initiative and **recommended** that these were considered for potential pilot projects (see Item 2.5). The sub-committee reiterates the Committee recommendations from 2008 regarding bycatch monitoring programmes and mitigation efforts in these fisheries (IWC, 2009, p.323).

Attention: C-A, CC

The Committee draws the attention of the Commission to its serious concern over the high mortality levels from bycatches in Peru and especially those of the Burmeister's porpoise and dusky dolphin. It stresses that action is needed to avoid the same critical situation for Burmeister's porpoise as with the closely related vaquita. In this regard the Committee:

(1) ***reiterates*** *its advice (IWC, 2009, p.323) on bycatch monitoring and mitigation in these fisheries;*
(2) ***reiterates*** *that the Burmeister's porpoise is a potential candidate for a Conservation Management plan;*
(3) ***highlights*** *opportunities to focus on the bycatch of small cetaceans in Peru through the new IWC Bycatch Mitigation Initiative and recommends that they are considered as a potential pilot project; and*
(4) ***offers its assistance*** *to the Government of Peru; and*
(5) ***requests*** *that the Commission, through the Secretariat, transmits the Committee's concern and offer of assistance to the Government of Peru.*

SC/67b/HIM05 and SC/67b/HIM08 use stranding data to make inferences about small cetacean mortality. They follow on from previous work published or presented at IWC/SC meetings since 2012. The general long-term aim of this series of studies is to elucidate the different mechanisms that interplay in the stranding process in order to improve the ability to use stranding-based data sets to estimate population parameters.

SC/67b/HIM05 aimed to: (1) identify likely mortality areas at sea of harbour porpoise *Phocoena phocoena* in the

Bay of Biscay, English Channel and North Sea; (2) to estimate total number of dead harbour porpoises per year in this large area; with a focus (3) on mortality due to fishery activities on harbour porpoise population in the Bay of Biscay and the English Channel. Harbour porpoise stranding time series from 1990 to 2015 were obtained from stranding schemes established in Denmark, Germany, the Netherlands, Belgium, the United Kingdom and France. In order to link every stranded harbour porpoise stranding to its likely area of death at sea, reverse trajectories were calculated by using the drift prediction model MOTHY (Peltier *et al.*, 2012). Estimated numbers of dead harbour porpoises were estimated by correcting both for drift conditions and proportion of buoyant animals, which was estimated at 17.9% [9.3%; 28.8%] (Peltier *et al.*, 2016), under the assumption that harbour porpoise and common dolphin (*Delphinus delphis*) carcasses are similar in this respect. The total number of dead porpoises in the whole study area estimated from the stranding data increased from yearly values under 7,500 individuals before 2004 to figures up to 22,000 yearly from 2005 onward, with an unusual peak of 47,000 in 2013. Mortality areas were concentrated in the southern North Sea from the mid 2000s onward, which is consistent with the southward shift in the species distribution (Hammond *et al.*, 2013). Bycatch related mortality in the Channel and the Bay of Biscay, followed a similar temporal pattern and peaked at 1,500-1,900 individuals in the years 2013 and 2014.

SC/67b/HIM08 investigated the spatial consistency between areas of common dolphin bycatch mortality in the Bay of Biscay, as inferred from strandings by modelling carcass drift, with the distribution of total fishing effort split by gear type and flag. The study focused on the two unusual stranding events recorded in the first week of February 2017 and the first ten days of March 2017. This work, which should be considered as a feasibility study, is related to discussions at SC/67a on whether drift of bycaught carcasses can help identify the fisheries involved. The likely mortality areas at sea of stranded common dolphins diagnosed as bycaught were identified by using the reverse drift modelling methodology (Peltier *et al.*, 2016). Animals categorised as 'fresh' were considered to have <5 days death-to-stranding time, whereas animals classified as 'putrefied' were assumed to have been drifting for 5-15 days (Peltier *et al.*, 2012). Only locations corresponding to each carcass decomposition condition were retained. Fishing effort data were generated on the basis of vessel speeds derived from Vessel Monitoring System positional data and provided by IFREMER. Fishing effort during mortality events and carcass drift locations were aggregated in the same 0.4° x 0.4° grid. Generalised Additive Models (GAMs) were used to explore the spatial correlation between the distribution of fishing effort for ten different fisheries and the distribution of common dolphin bycatch mortality. The distributions of fishing effort by French midwater trawlers, Spanish bottom otter trawlers and French Danish-seiners were significantly and positively correlated to the distribution of bycatch mortality corresponding to the two unusual stranding events. Overall, the analysis provided plausible results, highlighting three gear types that would deserve further investigation with respect to interactions with the common dolphin. Future work could expand the temporal frame of the analysis, and split fishing gear categories by main landed fish species, in order to investigate the relationship between mortality areas and fishing effort at the *métier* level.

An intersessional group was established at SC/67a to provide advice on consistent ways to estimate bycatch across both large and small cetaceans, and specifically, review the methods applied in Peltier *et al.* (2016) focused on small cetaceans.

The terms of reference for the intersessional group were:

(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.

The intersessional group agreed to focus on the methods applied by Peltier *et al.* (2016), and to identify the uncertainties and assumptions being made with respect to: (i) estimation of total mortalities given the number of animals that strand; (ii) determining cause of death and time since death for those animals that strand; and (iii) attribution of total mortalities to fisheries (specific areas/fleets/target species/gear type). The group made a number of recommendations.

(a) Recommendations to address uncertainties in bycatch estimates derived from strandings

The group recommended further work to address uncertainties in the analysis arising from parameters that either don't appear to have been quantified directly in the analysis to date, or that have been assessed directly but with either very limited sample size or samples obtained in potentially unrepresentative contexts. The group also highlighted uncertainties in the estimation of immersion level, the probability of being buoyant, the probability of stranding, the time of death and potential sensitivity of this approach to application beyond the Bay of Biscay.

(b) Recommendations for how bycatch estimates derived from strandings could be used

The group recommended that any application of this method to derive bycatch estimates from strandings be considered with the following caveats. It was agreed that the method was only able to provide estimates for areas where carcasses are released where prevailing winds and currents result in carcasses stranding with sufficiently high frequency to enable detection. The group further agreed that animal distribution may also reduce or preclude the likelihood of stranding (e.g. taxa with offshore distributions or variable movements). Consequently, the group agreed that the number stranded and scaled estimates derived, assuming the scaling factors are accurate and unbiased, could only ever provide a minimum estimate and one may well be fishery-specific as carcasses released too far offshore may strand with such low frequency as to inhibit detection or estimation (e.g. the Channel bass trawl fishery in which dolphin carcasses were tagged and released but never reported stranded). Finally, the group agreed that correlation of stranding events results in overdispersion of stranding data e.g. because of variable overlap between the fishery and the cetacean distribution. Overdispersion also occurs with observer data but, as it can be directly estimated from observer data, it is more readily addressed, which is not the case with stranding data.

(c) Recommendations to assess if strandings can identify gaps in observer coverage

The group recommended further work to assess if strandings can identify gaps in observer coverage. The group recommended that any such application should involve an initial step to assess if there are in fact gaps in observer coverage by conducting a fishery characterisation to document fleet effort and observer coverage directly. The group recommended back calculation to generate estimates of spatial and temporal uncertainty associated with the at-sea time and location of origin, and therefore the uncertainty in identifying fisheries to which mortalities may be able to be attributed. The group recommended experimental work to achieve this, using carcasses dropped in the sea at a known time and location recovered ashore and then the methodology of Peltier *et al.* (2016) applied to see where the carcasses were determined to have come from. The group also recommended examination of carcasses for net marks to infer mesh size and twine type to aid in attributing mortalities to specific fisheries. This could also be considered in any further experiments with for example net marked carcasses being released at sea. Finally, the group noted the value of observer studies in adjacent areas to aid in assessing the risk of mortality.

The sub-committee endorsed these recommendations and discussed them, SC/67b/HIM05 and SC/67b/HIM08 in combination. In response to a question as to the possible causes for the particularly high level of strandings recorded in 2013/14 reported in SC/67b/HIM05, Ridoux noted that it was not clear why the number of dead harbour porpoises in the North Sea had been so much higher than for other years, and that this could have introduced some bias into the analysis. There are no bycatch estimates available for common dolphins in the relevant EU countries. Only one or two countries have tried to produce bycatch estimates, and France has not done this despite an observer programme with thousands at-sea days over the past 10 years. It was further noted that within the European Union, Regulation 812/2004 was put in place to fulfil the requirements under the EU Habitats Directive, which requires all fisheries to be monitored for their impact. Ridoux noted that in France this monitoring has been restricted to vessels over 15m and only to some specific fisheries. Furthermore, in some jurisdictions, fishing captains are able to refuse to carry observers on board without sanction, which can complicate the effectiveness of monitoring programmes and the subsequent understanding of bycatch estimates.

The sub-committee noted the value of attempting to correlate the stranding information and modelling of spatial distribution of mortality with fishing vessel tracking data or information on fishing effort. The discussion also included the consideration presented within the paper, and supported by the results of the SCANS surveys, that harbour porpoise have undergone a southwards shift in distribution, moving into areas where there is now a high likelihood of bycaught animals stranding. There are some areas within the North Atlantic, including in the North Sea, where the seasonal wind conditions would result in a very low chance of finding a stranded animal on the coast. Attention was drawn to the conclusion in ICES (2016) that the data collated were indicative of potentially substantial total annual removals of common dolphins in some European fisheries that may cumulatively exceed safe limits depending on the size of the population from which the bycatch is being taken.

In further consideration of the inferences about bycatch from strandings, considerable information was provided about the Santos Basin Beach Monitoring Project (PMP-BS), required by the Brazilian federal environmental agency for the environmental licensing of the oil and natural gas production and transport by Petrobras. To evaluate the potential impacts of these activities on marine turtles, seabirds and marine mammals, approximately 1,040km of coastline are being systematically monitored, either daily (65% of the area) or weekly (14% of the area), or through calls from the local population (21% of the area). The monitoring effort started in August 2015 and is still underway. During these two years of monitoring, 2,072 cetaceans (117 mysticetes, 1,926 odontocetes and 29 unidentified cetaceans) were recorded in the area, most during regular monitoring (66.5%). However, stranding rates were very different among species, with 86.5% of all stranded odontocetes being franciscanas, Guiana dolphins or common bottlenose dolphins. Data from the necropsies in fresh and initial decomposition states (stages 2 and 3) indicate that 43% Guiana dolphins and 45% bottlenose dolphins had deaths caused by anthropogenic factors. The number of Guiana and bottlenose dolphins recorded in the first two years of monitoring by the PMP-BS was much higher than what was expected by the researchers involved in the project. Although the 11 organisations that are part of the PMP have been working with marine mammals along this area for many years, the PMP intensive monitoring revealed a greater number of carcasses than those previously recorded by the same institutions, especially for small cetaceans. These results suggest that the turnover of carcasses on the beaches can be quite high and thus beach monitoring with lower frequencies may underestimate stranding rates.

The Brazilian PMP beach monitoring project has also provided information about stranded franciscana. Whenever possible, sex of stranded carcasses was determined, either by external observation or by the macroscopic analysis of gonads; total length was also measured. Classification of developmental stage was based on total length: calves were animals less than 90cm; adult males larger than 116cm; adult females larger than 126cm; and juveniles between 90cm and 116cm for males or 126cm for females. Between October 2015 and September 2017, 1,123 franciscana dolphin carcasses were recorded stranded in the area. Most of the carcasses (62%) were found in advanced decomposition stage and thus it was not possible to identify their development stage and sex. For animals where this information could be obtained, juveniles represented the highest number of individuals. The number of males was slightly higher than females and this pattern was observed in both years. Considering only the animals where sex could be identified, most males were juveniles in both years but for females the frequency of adults was higher in the second year, while in the first year the highest frequency was for juveniles. Considering the decomposition of the carcasses, 821 could be necropsied and 32.4% had signs of interaction with human activities; interactions with fishing gear were the most common of these (86.5% of interactions).

The numbers show that the franciscana is continuously under strong pressure in Brazilian waters, despite the regulations for the use of fishing nets established by the government. It was noted that the existing regulation on gillnets, implemented in 2012 is either not being effectively enforced or is not efficient in reducing bycatch. The sub-committee **recommended** the need for this to be investigated further. Barreto noted that urgent actions are needed to reduce bycatch and the risk of extinction of franciscana in Brazilian waters. He also noted that many of the carcasses found had clear signs of bycatch, and that the collected data (which included necropsies to investigate internal trauma, disease) is still being processed, but that when complete, the aim will be to understand potential population level effects rather than just individual causes of death. Many of the animals were found to have died by drowning or asphyxiation, although there was not additional evidence to link that to a fishing gear type, or definitively prove that it was caused by bycatch.

The sub-committee further noted the importance of observer programmes, including electronic monitoring, and the limitations of stranding information for determining the type of fishing gear implicated in a bycatch event, or in determining reliable bycatch estimates. In small scale fisheries, observer programmes are particularly complicated, given the small size of vessels, and electronic monitoring may not capture the animals falling from the net during hauling.

In conclusion, the sub-committee **recommended** that the effectiveness of bycatch mitigation measures be evaluated through a combination of monitoring measures. It was noted that this recommendation was particularly relevant to the situation in Brazil as outlined in the previous paragraphs. Such measures could include well-designed and effectively implemented observer, electronic monitoring and stranding programs. The sub-committee **agreed** that using a combination of measures is likely to provide a more robust evaluation of bycatch mitigation measures.

Attention: CG-A

*The Committee **draws attention** to the fact that the franciscana continues to be under strong pressure from human activities, especially bycatch, in Brazilian waters despite the regulations for the use of fishing nets established by the government. The Committee therefore:*

(1) ***advises*** *that the existing regulation on gillnets, implemented in 2012, is either not being effectively enforced or is not effective in reducing bycatch; and therefore*
(2) ***recommends*** *the need for this to be investigated further by the Brazilian authorities.*

Attention: CG-A, SC, G

With respect to methods for obtaining bycatch estimates the Committee:

(1) ***agrees*** *with the recommendations of its intersessional group regarding: (a) uncertainties in bycatch estimates derived from strandings; (b) the use of bycatch estimates derived from strandings; and (c) assessing whether strandings can identify gaps in observer coverage;*
(2) ***notes*** *the importance of observer programmes, including electronic monitoring, and the limitations of stranding information for determining the type of fishing gear implicated in a bycatch event, or in determining reliable bycatch estimates;*
(3) ***recognises*** *that in small scale fisheries: (a) observer programmes are particularly complicated, given the small size of vessels; and (b) electronic monitoring may not capture the animals falling from the net during hauling;*
(4) ***advises*** *that a robust evaluation of the effectiveness of bycatch mitigation measures requires a combination of monitoring measures, including well-designed and effectively implemented observer programmes, electronic monitoring and stranding programmes;*
(5) ***advises*** *that the above advice is relevant to the situation of the franciscana in Brazil; and*
(6) ***agrees*** *that given the increased use of Remote Electronic Monitoring techniques and the rapid development of camera and associated electronic technology, these techniques should be a focus topic at SC/68a.*

2.1.3 Spatial dynamics

SC/67b/HIM02 reported on an individual-based model for Maui dolphin. The model was calibrated to ensure dolphin movements match field data on depth preferences, average distance moved per hour, home range sizes and group size. Several recent studies have used individual-based, spatially explicit models to study marine mammal bycatch, including for harbour porpoise in the North Sea (Nabe-Nielsen *et al.*, 2018; Van Beest *et al*., 2017). These studies map cetacean habitat, with each grid cell having attributes like water depth, number of cetacean and fishing nets. Cetaceans in the model move through the area and interact with gillnets and trawling vessels. An individual-based approach is essential for small populations like Maui dolphins, vaquita and other Critically Endangered populations and is also being used in other contexts for much larger whale populations (e.g. SC/67b/EM07). A spatially explicit approach such as Netlogo (SC/67b/HIM02) is particularly appropriate for impacts like fishing. Especially where cetacean movements are sufficiently large that they are unlikely to stay inside areas with or without protection.

The sub-committee welcomed this paper, and discussion focused around the potential to use this approach in other contexts. Spatially explicit modelling is increasingly being used and be of particular value when the range of movements are likely to be large enough to include moving between inshore/offshore zones.

2.1.4 Electronic monitoring

Bartholomew *et al.* (2018) summarised the results of a study comparing remote electronic monitoring (REM) systems with onboard observer records of target catch (sharks and rays) and bycatch (marine mammals, sea turtles) by Peruvian small-scale driftnet fishing vessels. The study showed that REM can provide a time- and cost-effective method to monitor target catch in small-scale fisheries and can be used to overcome some of the challenges of observer coverage (e.g. monetary cost, vessel space). With ongoing modifications to the camera specifications, REM performance was expected to improve for all target catch and bycatch species.

The sub-committee commended this work and its focus on electronic monitoring of small scale vessels. The discussion included consideration of whether the electronic system would allow for spatially plotting fishing effort. The author noted that it was not possible to measure the extent of the net with the sampling rate used in the trials (an image captured every 40 seconds), however in the most recent version of the technology this would be possible. It was further noted that a number of researchers have begun to develop algorithms to determine the extent of fishing effort, including the length of net that was set, from electronic data.

In relation to the effectiveness of this method for determining the number of animals dropping out of the net during hauling, the author noted that under low-light conditions, or when the recording was not prioritising cetacean bycatch, the system performed less well. The group acknowledged the advantages presented by a portable monitoring/VMS system, particularly as an aid for randomising samples across fleets, and avoiding this bias. The sub-committee further noted that there was a workshop held by ASCOBANS in 2015 on electronic monitoring. Given the increased use of these techniques and the rapid development of camera and associated electronic technology, the sub-committee **recommended** that this should be a focus topic in the work plan for next year.

2.2 Review proposal for global entanglement database

At SC/67a the Committee reviewed the progress on developing a dedicated entanglement database for the use by the teams of trained responders in the Global Whale Entanglement Response Network (GWERN). This included user interface, fields and structure. In October 2017 a small group met to: (1) finalise the data fields and descriptions; and (2) decide whether to construct it with off the shelf, commercial software, or a bespoke solution developed by the IWC using open-source technologies. Primarily because of the IWC's move to a common database language, for consistency and to avoid obsolescence, the group decided to go with that solution. However, given an estimated cost of £20,000 GBP, it was decided to bring up this topic at the upcoming meeting of the GWERN, 5-7 June 2018. At which time a similar database will be demonstrated, and it is hoped that a consensus will be reached in how to proceed with the IWC database (e.g. whether to raise the funds or not).

2.3 Reporting of entanglements and bycatch in National Progress Reports

As in previous years, reports of large whale bycatch and ship strikes from the National Progress Reports were reviewed. These are given as Appendix 2.

Bjørge noted that of the large whales reported entangled in the progress report from Norway, two of the humpback whales and the minke whale were released alive.

In discussion, the incomplete nature of the bycatch information provided was noted. The sub-committee noted that a similar table of bycatch of small cetaceans is appended to the SM report (see Annex M). The National Progress Reports only include an unknown but probably small proportion of recorded bycatch and not estimates of bycatch which would be reviewed by the Committee if papers are submitted. It was further noted that it would be useful for the sub-committee to map out which countries are collecting bycatch data and determine how best to get access to this information.

The sub-committee noted that there was an effort last year to re-focus the national reporting format to improve and streamline it, and that reporting is time consuming. General issues associated with difficulties in submission of National Progress Reports will be discussed in the full Committee.

2.4 The IWC Bycatch Mitigation Initiative

SC/67b/HIM12 provides the preliminary outcomes of an assessment on the potential work areas for the new IWC Bycatch Mitigation Initiative, with an evaluation of where the IWC can add the most value in tackling cetacean bycatch. Five different mechanisms were identified as being the most significant for bringing about change in how bycatch is tackled from local to international scale. The mechanisms include identifying high risk areas for future targeted work (pilot studies), testing and demonstrating effective solutions, working directly with fishing communities, and transferring knowledge and developing capacity on bycatch mitigation and management, and collaborative work with regional and international fisheries bodies. The IWC's potential role within each of these mechanisms was then evaluated based on existing gaps, the current or likely strengths of the IWC to work within these areas, and the current challenges and opportunities. Each of the mechanisms was found to be important for bringing about change in how cetacean bycatch is tackled, and the IWC could play a significant role within specific work areas under each. In order to be effective, the Bycatch Mitigation Initiative needs to draw on the expertise of the different parts of the IWC, including the Committee where so much research on this topic has already taken place.

Specific recommendations for the Committee in relation to potential work areas that would help progress the Bycatch Mitigation Initiative, included: (i) identify the priority fisheries/sites/species/populations to be considered for pilot projects based on conservation need and establish bycatch baselines for relevant cetacean populations where mitigation is to be trialled; (ii) lead in communicating the need for increased research on mitigation measures/management approaches for cetaceans to the broader scientific community; (iii) annual review of mitigation measure tables; (iv) provide technical assistance to the coordinator and the expert panel in the development of scientific trials/monitoring programmes to evaluate mitigation measures; and (v) collaborate with researchers identifying fishing effort using vessel monitoring and tracking systems and assess bycatch risk, with a particular focus on small scale fisheries.

The sub-committee thanked Tarzia (the Bycatch Coordinator) and welcomed the comprehensive outline of activities. The sub-committee strongly endorsed the strategic assessment and the recommendations for the Committee work plan and **recommended** that the Bycatch Mitigation Initiative be supported when costed, including ongoing support for the Bycatch coordinator, when brought to IWC/67. It was noted that these recommendations for the Committee were in line with the sub-committee's anticipated work plan, and that the Committee could play a strong role within the initiative, particularly in relation to identifying priorities, driving innovation and reviewing outputs from pilot studies. There was some discussion of 'rapid bycatch and risk assessment' tools and the sub-committee **recommended** that consideration of these also be a focus topic at SC/68a.

Recognising the potential role for the Committee to help raise awareness across the broader scientific community in relation to the current gaps and needs associated with research towards mitigation of cetacean bycatch, the sub-committee suggested that its members should assist in promoting such research, and the Bycatch Mitigation Initiative through existing networks, at conferences, workshops and with students. It also suggested that some of the approaches taken in relation to ship strikes (e.g. multilingual brochures and annotated Powerpoint presentations) might be useful as a communication aid.

The sub-committee noted that review of tables of mitigation measures was already in the work plan. Also that consideration of vessel monitoring and tracking and remote electronic monitoring systems to assess bycatch would also be considered next year. Discussion focussed on the identification of priorities for pilot projects because this was considered the most urgent in view of presenting a work plan for consideration at IWC/67.

The sub-committee first considered criteria that could be used to identify the priority fisheries/sites/species/populations to be considered for pilot projects. It was noted that Reeves *et al.* (2004) had suggested criteria for determining priorities related to bycatch. Based on these and discussion of the specific role and mandate of the IWC Bycatch Mitigation Initiative, the following five broad criteria were agreed to allow possible pilot projects to be selected. The first stage would be for the coordinator to compile sources of data to allow projects to be identified. She will then consult with the expert panel to apply the criteria, including contact with any of the governments involved, to select the projects for review by the Standing Working Group.

(1) Urgency of conservation situation driven by bycatch or concern over situations with little or no data on bycatch, but suspected overlap between high risk fishing gears and vulnerable cetacean species. With respect to this the sub-committee agreed that the BMI should be able to select pilot projects where there was information to show a pressing conservation issue, but also where there were indications that a serious problem may exist, but no data to confirm this. In the former case, the pilot project would focus on mitigation, whereas in the latter it would focus on an assessment of bycatch (e.g. a rapid assessment process) as the first step.
(2) Enabling conditions necessary for success. The sub-committee noted that there are useful enabling conditions listed in SC/67b/HIM12 and that these could be further refined with reference to Reeves *et al.* (2004) to make these more specific to assessing the feasibility of pilot projects.
(3) Scope for IWC to contribute (e.g. enhanced international cooperation).
(4) Ability to monitor effectiveness of mitigation actions.
(5) Potential for project to contribute to mitigation of bycatch in other areas.

A number of data sources were also identified to assist in compiling the initial list for evaluation using the criteria. These include papers from SC/67b (SC/67b/HIM01, SC/67b/HIM07, SC/67b/HIM09, SC/67b/SM06, Avila *et al.*, 2018); previous recommendations under HIM and the Small Cetaceans sub-committees, including species prioritised during the Small Cetaceans sub-committee of SC/67b (see Annex M), information contained in the SOCER reports, and external sources including Reeves *et al.* (2013), the 2018 NOAA list of foreign fisheries (*https://www.fisheries.noaa.gov/foreign/international-affairs/list-foreign-fisheries*) and Williams *et al.*, 2016). Information from CMS, IUCN and ICES are also likely to be useful. The sub-committee discussed potential candidate locations for pilot projects, suggesting that identified fisheries in the Republic of Congo, Peru, Ecuador, Pakistan and India appear to fulfil many of the criteria and are locations where past or present IWC work is being carried out which is relevant to bycatch.

The bycatch coordinator will compile this information and then together with the expert panel apply the criteria and discuss the prioritised list of species/locations with the standing working group and relevant governments.

The IWC's technical advisor for reducing unintended human impacts, Mattila, reported on relevant activities under the entanglement initiative. Since SC/67a, IWC entanglement trainings have been conducted in Sakhalin (Russia), Arica (Chile), Sortland (Norway) and Bahía Solan (Colombia). The training in Sakhalin was a joint stranding and entanglement response training in cooperation with IFAW, and the Colombia training was the first conducted in Spanish only. This brings the total number of trainees in this initiative to 1,130 from 27 countries. In addition, two apprentices were hosted this year, one from Chile and one from Oman. Mattila also presented the IWC's work with entanglement in two workshops at the Society for Marine Mammalogy biennial conference (2017).

The sub-committee noted the important activity of the GWERN programme, and Mattila was thanked for his leadership and good humour in coordinating the initiative. It was noted that the contacts made could be of particular value to the Bycatch Mitigation Initiative.

The sub-committee also considered Avila *et al.* (2018) in relation to its potential relevance for identifying priority populations and locations as requested by the Bycatch Mitigation Initiative. Based on a literature review the authors geo-referenced and encoded available information on marine mammal threats in a database, which is available with the paper. Threats affecting 121 marine mammal species between 1991 and 2016 were included. From the database a series of risk maps were developed, linking information about species-specific vulnerabilities to large-scale species distributions, thus providing an assessment of how threat levels for marine mammals vary in space. Risk areas were produced based on binary (presence/absence) range maps using the core habitat. Incidental catch (which included bycatch) affected the most species (112 species), followed by pollution (99 species), direct harvesting (89 species) and traffic-related impacts (86 species). Bycatch, defined as an animal bycaught in active fishing gear for fishing use affected 109 marine mammal species worldwide, mainly odontocetes. High-risk areas were concentrated mainly in coastal waters of North America, India, Australia and the Mediterranean, Baltic and Arabian Seas. In relation to marine cetacean species, 78 species have been documented to be affected between 1991 and 2016 worldwide.

Attention: C-R, SC, CC

The Committee discussed the strategic assessment of the Bycatch Mitigation Initiative and the role of the Committee. The Committee:

(1) ***agrees*** *to incorporate in its workplan the five work areas listed in its report under Item 13.6.1 and also consideration of 'rapid bycatch and risk assessment' tools;*
(2) ***agrees*** *to the criteria listed in its report under Item 13.6.1 when identifying priority fisheries/sites/species/populations; and*
(3) ***recommends*** *to the Commission that the Bycatch Mitigation Initiative continues and is supported, including the provision of ongoing support for the Bycatch coordinator.*

2.5 Collaboration with FAO on bycatch related issues

The IWC's bycatch coordinator gave a brief overview of the FAO's Expert Workshop on Means and Methods for Reducing Marine Mammal Mortality in Fishing and Aquaculture Operations, attended by the coordinator and a number of scientific committee members. The workshop, held in March 2018, produced a report with recommendations to the FAO's Committee on Fisheries (COFI), and a review of mitigation measures with tables indicating proven mitigation measures (by fishing gear type, and cetacean species) and a decision tree providing guidance on choosing a bycatch mitigation pathway. This document will potentially form the ground work for the development of technical guidelines under FAO on marine mammal bycatch. In addition to the workshop, the IWC's executive secretary and bycatch coordinator will be attending the COFI meeting in July 2018, and the regional secretariat's network meeting held at the same time. Mattila also represented the IWC at an FAO technical consultation on gear marking, 5-9 February 2018 (Rome), the results of which will be reported at SC/68a.

In discussion the sub-committee welcomed the efforts of the FAO to consider cetacean bycatch, and **recommended** that the IWC secretariat to continue these collaborations with the FAO.

Attention: C-R

The Committee welcomes the efforts of the FAO to consider cetacean bycatch, and recommends that the IWC Secretariat continues to collaborate with the FAO on this issue.

2.6 New information on cetacean bycatch in the Western, Central and Northern Indian Ocean

Reeves presented SC/67b/HIM07, noting that it was intended as a follow-up to the Committee's recommendation at last year's meeting that, 'in light of the scope and scale of cetacean bycatch in the Western, Central and Northern Indian Ocean and the considerable data gaps associated with intensive and extensive gillnet fisheries,' the topic be included in the work plan for this meeting and the Secretariat establish communications on the issue with the Indian Ocean Tuna Commission (IOTC) (IWC, 2018, p.46). Tuna fisheries, both industrial and small-scale, are of major socioeconomic importance throughout the Indian Ocean. Cetacean bycatch rates in this region are thought to be relatively low in pelagic longlines and purse-seines, but the increasing use of drift gillnets, particularly in the northern Indian Ocean, is of concern. The IOTC is the responsible authority for managing fisheries for tuna and tuna-like species. At its annual meeting in September 2017 the Working Party on Ecosystems and Bycatch acknowledged the importance of cetacean bycatch and adopted a work plan that includes this matter as a research priority. While a severe shortage of data remains, the stage is set for collaboration with the IOTC on data collection and ultimately for mitigating bycatch in the region.

The group noted that this issue came up during SC/67a, and that the sub-committee had made two recommendations, that this be included in the 2018 work plan, and that the IWC Secretariat contact the IOTC Secretariat about collaboration/assistance. The IWC's Executive Secretary provided an update on engagement with the IOTC, including a recent teleconference with the IOTC Executive secretary to discuss areas of collaboration. The IOTC is holding some training sessions for on board observer programmes, including those targeting the small scale artisanal sector, and the IWC has been offered the possibility of sending some experts to the training. It was further noted that the IOTC is producing cetacean identification guides to provide to observers and the fishing industry, and that these have been carefully peer-reviewed.

Attention: C-A, CC, SC

With respect to bycatches of cetaceans in the Indian Ocean, the Committee:

*(1) **reiterates** its willingness to collaborate with the IOTC on this issue; and*
*(2) **encourages** the Secretariat to continue to work with the IOTC Secretariat.*

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3. SHIP STRIKES

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

DeMaster presented a short summary of a pilot study to better characterise ship strikes in SE Alaska. The work is being coordinated among the Alaska Fisheries Science Center, the University of Alaska SE, and the US Park Service. The focus of the effort is to combine remote electronic monitoring, passive acoustics, and a remote bio-sampling tool to provide information on ship strikes of cetaceans that may be missed by existing methods. The sub-committee encouraged the Principal Investigators to continue this work and to keep the sub-committee informed of their efforts.

3.1.1 Review progress on global database

SC/67b/HIM11 summarised the sixth term of work carried out by the IWC ship strike data coordinators between May 2017 and April 2018. In 2016, the Committee recommended that priority should be given to validation of all the records in the database and thus special attention was given to continuing the data review process while also keeping the database updated with new entries. The process of reviewing all records has been conducted by starting with the most recent records. All the incidents since 31 December 1999 have now been reviewed and assigned a category in consultation with the Data Review Group (DRG). In total, 320 reports were assessed in the last year and are now listed as reviewed cases in the database. Since 1st of May 2017, 21 new reports have been submitted. Some entries were realised by the data co-ordinators, but an increasing number also stemmed from the public, including scientists working in the field. There is still a need to finalise tools to allow the bulk upload of data to the database. When this option is implemented, it is anticipated that several hundred more reports stemming from different sources will be added. These include records from the USA and it is anticipated that many of the records in the US database hold greater detail on each incident than those that are already in the IWC database. These records will not be reviewed until the full US data has been uploaded. All incidents reported in National Progress Reports are reviewed using the standard procedure, except for those from Australia and the USA, who review reports that come to them with the same (or greater) rigor than the IWC process.

With regard to outreach on the ship strike issue, the IWC PowerPoint presentation, poster and associated briefing materials are available from the Secretariat, and the ship strike brochure is available to download in Arabic, Chinese, English, French, Russian and Spanish on the IWC web site. The data coordinators have also maintained contact regarding ship strikes with ASCOBANS, ACCOBAMS and the Pelagos Sanctuary Executive Secretariat.

The sub-committee commended Panigada and Ritter for their intersessional work, and **recommended** its continuation and the development of the bulk upload tools by the IWC

Secretariat. It also urged that the records in the IWC Ship Strike database are reconciled with those in the National Progress Reports. Panigada and Ritter noted that when they made verbal follow up enquires about incidents, these were all documented in writing and placed with each record. Panigada also provided an update on a new project funded by the Pelagos Agreement on ship strikes in the Pelagos Sanctuary. This project will aim to assess ship strikes in the area, together with suggesting mitigation measures to be applied in the Pelagos Sanctuary and in other areas of the Mediterranean Sea.

Attention: C-R

*The Committee **reiterates** the importance of the global ship strikes database to its work. It therefore:*

*(1) **welcomes** the work undertaken thus far; and*
*(2) **recommends** the continuation of this work including that of the co-ordinators and Data Review Group on the review of historical records and the Secretariat on upload tools.*

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/67b/HIM04 identified the vessels posing the highest potential risk of ship strikes in the Pelagos Sanctuary area. Passenger and cargo ship traffic together present around 80% of the total traffic at risk. Italian and French vessels accounted for more than 50% of the travelled distance in 2014. Overall, the entire 2014 traffic in Pelagos generated an estimated 3,465 potential collision risk events, among which 3,168 events were related to fin whales and 297 to sperm whales. Collision risk is dominated by a relatively small number of vessels. Seven companies operating vessels that would potentially benefit most from the implementation of the REPCET reporting system were identified. The 96 ships belonging to those companies represent almost half of the traffic risk in the Pelagos sanctuary and one third of the expected collision risk events. Two of these companies are French and the other five are Italian. In France, anti-collision systems, such as REPCET, became mandatory on July 1 2017 for French passenger, cargo vessels and state owned vessels longer than 24m which cross the Pelagos Sanctuary more than 10 times a year. This increase of REPCET equipped vessels led to an increase in reports of cetacean sightings from 492 in 2016 to 927 in 2017.

The sub-committee welcomed the information provided by the authors of SC/67b/HIM04 and commended the Government of France for requiring reporting systems for certain vessel types. It was noted that the information provided in the paper was not sufficiently detailed to allow the estimates of collision risk events to be evaluated. It was also noted that 'Alerting' systems like REPCET require a trained observer and a subsequent avoidance action of some sort by the vessel in order to be a considered as a mitigation tool. With the increased use of REPCET on more vessels an evaluation of its efficacy for ship strike risk reduction is needed. If actions such as diverting or reducing speed were to be required from vessels using REPCET there is concern from the companies operating these vessels about competitiveness if measures are not required for other vessels not fitted with the system. The authors also noted that solutions are currently being investigated for situations such as low visibility or night use to supplement the current visual observation methods used by REPCET.

It was suggested that a Particularly Sensitive Sea Area (PSSA) designation, with associated measures that apply to all large vessels might be fairer and more effective. Reduced speed is a possible measure that has been shown to be effective in other areas. Mandatory speed restrictions implemented off the east coast of the USA to reduce risks to North Atlantic right whales have been evaluated and found to be effective. Voluntary speed restrictions have also been implemented including for Bryde's whales in the Hauraki Gulf and through the 'Blue Skies' initiative in SW California which provides incentives for speed reduction to reduce emissions and also ship strike risk for blue whales. There was some discussion about the scientific aspects of a PSSA proposal which would need to be considered, including the possibility that high use whale habitats with overlapping shipping routes extended outside of the Sanctuary boundaries. If a PSSA were to be proposed, this might stimulate further research to determine the most appropriate boundaries. The basin wide survey planned by ACCOBAMS later in 2018 will cover both inside and beyond the boundaries of the Sanctuary.

The sub-committee **agreed** on the importance of evaluating the efficacy of the REPCET system. The Pelagos Sanctuary has been identified as a potentially high risk area and the sub-committee **recommended** further work to develop and evaluate mitigation measures, such as speed restrictions, that might be associated with the designation of a Particularly Sensitive Sea Area (PSSA) in the area.

3.2.2 Consideration of methods to identify 'high risk' areas

Panigada reported on a workshop held in April 2018 at the conference of the European Cetacean Society (ECS), organised jointly by the IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force and by the Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS). The workshop goal was to take an initial look at overlaying specific anthropogenic threats with recently identified Important Marine Mammal Areas (IMMAs).

Specific threats to cetaceans in the ACCOBAMS area were mapped by overlaying the Mediterranean IMMAs with the available area-explicit information on shipping. Three case study areas containing IMMAs, the Alborán Sea, the Northwest Mediterranean and the Strait of Sicily, were discussed. The overlap between IMMAs and ship traffic appeared to be of particular concern for fin, sperm and Cuvier's beaked whales. The workshop produced a suite of recommendations which will be considered further at the proposed IWC-IUCN Task Force workshop. Panigada noted that the ECS workshop provided a preliminary attempt to overlay threats on IMMAs for potential conservation and management advice. The proposed joint IWC-IUCN TF workshop (see Item 4.2) would be a more in depth look to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes. The sub-committee **recommended** ongoing IWC engagement with the process to identify IMMAs, including consideration of their utility to address threats.

An intersessional group had been established at SC/67a in order to be able to respond to requests for advice related to ship routeing proposals. However, the Committee did not receive any such requests in the intersessional period following SC/67a. There are several scenarios when the Committee's advice may be requested in future. These could include, but are not limited to, when routeing measures are proposed for the first time or alterations are proposed to an existing measure, or when new shipping routes are being established. Advice may also be requested for routes where the primary function of the route is not intended to reduce ship strikes, but ship strike risk may be affected. The IWC Strategic Plan to Mitigate Ship Strikes 2017-20 describes a number of stages in identifying high risk areas and developing the appropriate mitigation measures. The nature of the advice required from the Committee will depend on which stage assistance was required. Table 1 outlines the role the SC could play at each stage. The sub-committee suggested that the table could be placed in the ship strike section of the IWC website to encourage proposals to be brought to the SC in time to allow the best advice to be provided.

The group also considered how best to collate information regarding cetaceans in the Western Arctic and Bering Strait migratory routes. Following discussions at the IMO Maritime Safety Committee (related to papers MSC 98/17/2 and MEPC 71/7) on the marine mammal avoidance provision in the Polar Code, IMO invited countries to submit information on populations of marine mammals. Discussion of the matter was referred to the sub-committee on Navigation, Communication, Search and Rescue (NCSR). NCSR 5 in February 2018 considered two papers related to marine mammal avoidance (FOEI *et al.* 2018a; FOEI *et al.* 2018b). The IMO invited its Member States to share relevant spatial marine mammal information. There could be a role for IWC, possibly in collaboration with Arctic Council and its working group on Protection of the Arctic Marine Environment, in assisting with this.

Proposals by the United States for three recommendatory Areas To Be Avoided (ATBA) encompassing King Island, and Nunivak Island, and St. Lawrence Island in the Bering Sea (United States, 2018) were recommended for adoption by the IMO NCSR with some modifications. The King Island area was identified as biologically important for the gray whale, while the St. Lawrence Island's ATBA was intended to provide protection to bowhead whales, gray whales, and Humpback whales to the north and west of the island, with a high concentration area to the north of Gambell in Anadyr Strait. The United States has created a Waterways Safety Committee for the Western Arctic and IWC participation may be possible.

The sub-committee thanked the intersessional group for its work, and asked it to continue with the task of responding to any intersessional requests for advice related to ship routeing proposals.

At SC/67a the Committee continued discussion of the high risk area for ship strikes to blue whales south of Sri Lanka which had also been identified in the IWC Ship Strike Strategy. The Committee had agreed that the results presented would allow it to provide advice on the relative risks of different routing options and that the available data supported a proposal to IMO to move the shipping lanes off the southern coast of Sri Lanka. In 2017, major shipping organisations represented at IMO also wrote to the Sri Lankan government requesting the routing change to reduce ship strike risks and improve maritime safety. So far there has been no response from Sri Lanka. The sub-committee **recommended** that the Secretariat contact the relevant authorities in Sri Lanka to re-iterate the previous offer of assistance from IWC on this issue.

The Hellenic Trench west of Greece is an identified high risk area for sperm whales. In 2015, the Committee recommended that interested parties (including Greece, ACCOBAMS and the shipping industry) move forward with Greece in order to develop a proposal for routing measures in accordance with the IMO guidelines. In 2016, the Committee had recommended that the Secretariat continue to engage on the issue with the Ministry of Mercantile Marine in Greece. There have been further discussions on this within Greece and the sub-committee **recommended** the Secretariat follow up on previous correspondence.

At SC/67a the Committee recommended that the Secretariat and HIM Convenor explore possibilities for

Table 1

Potential advice from the Committee in response to requests related to different stages of implementation of mitigation measures identified in the IWC Strategic Plan to Mitigate Ship Strikes.

Stage	Potential advice from the Committee
Stage 1: High risk area of potential concern identified based on overlap of shipping and whale distribution or a high number of reported incidents	The Committee could examine the available information on shipping and whale distribution and extract records for that area from the Ship Strike Database. The Committee could draw attention to other assessments such was those used to identify Important Marine Mammal Areas (IMMAs).
Stage 2: Survey data for whales, AIS data for shipping used to inform risk analysis and local *vs* international jurisdiction.	The Committee reviews the data available on whale habitat use, and analysis of risk.
Stage 3: Consideration of possible practical options based on risk analysis. Recommendations from IWC Scientific Committee, IWC approaches relevant states to offer information and advice.	The Committee reviews the proposed routing or other risk reduction measures. If the routing measure is associated with a Particularly Sensitive Sea Area (PSSA) the SC may consider reviewing any other Associated Protective Measures (APMs) and their potential impact on whales. In line with 2.2.4 of the Strategic Plan, the Committee could identify any known aids to voyage planning available in the area, or assist in applying such technologies in these areas. If a particular type of vessel traffic appears primarily responsible for ship strikes in the area, the SC could draft guidance for operators of these vessels.
Stage 4: Stakeholder workshops to discuss possible mitigation measures and optimise risk reduction with stakeholder interests.	Especially valuable where new routes are being discussed, the Committee could offer advice on what associated protective measures would fit based on region and known species.
Stage 5: Relevant states consider proposals to IMO assisted by supporting information from IWC.	The IWC could submit supporting information for a routing measure to the relevant IMO Committee meeting based on the Committee evaluation. This submission could be especially important if the proposed routing measure is not primarily concerned with ship strike mitigation.
Stage 6: Measures implemented through IMO.	-
Stage 7: Continued Monitoring to evaluate ongoing effectiveness of measures.	The Committee could provide a review of the most recent data on whale distribution along with any known ship strikes since the implementation of the measures. If risk analyses are conducted then further advice to improve risk reduction could be provided.

developing a memorandum of understanding between IWC and an AIS data provider. IWC could then pass on data requests in a standardised format which would minimise the work for the data provider. The first company approached was Marine Traffic who have generously donated data for previous papers that have been discussed by the Committee. The response from Marine Traffic was enthusiastic and it is hoped to develop an MOU to enable data to be provided for studies coming forward to the Committee.

Attention: C-A, CC, SC, G

The Committee has continued its work on identifying high risk areas for ship strikes and potential mitigation measures. In this regard the Committee:

*(1) **recommends** continued work to develop and evaluate mitigation measures, such as speed restrictions, that might be associated with the designation of a Particularly Sensitive Sea Area (PSSA) in the Pelagos Sanctuary area;*
*(2) **reiterates** its previous recommendations on the importance of evaluating the efficacy of the REPCET system for reducing the risk of ship strikes;*
*(3) **requests** the Commission via the Secretariat, to remind the authorities in Sri Lanka of its previous offer of assistance from IWC on this issue;*
*(4) **requests** the Commission via the Secretariat, to follow up on previous correspondence on the ship strike risks to sperm whales off Greece;*
*(5) **agrees** to support a workshop to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes; and*
*(6) **agrees** to continue ongoing IWC engagement with the process to identify IMMAs, including consideration of their utility to address other threats.*

3.3 Co-operation with IMO Secretariat and relevant IMO committees

Cooperation with IMO is described under Item 4.11. The Secretariat had maintained a dialogue with the IMO Secretariat on ship strike issues, including meetings during IMO MEPC 72. The sub-committee **recommended** that this dialogue continue.

Attention: C-R, S

*The Scientific Committee **reiterates** the importance of cooperation with IMO:*

*(1) **welcomes** the ongoing co-operation the Secretariat has maintained with IMO and its Secretariat on ship strike issues, including meetings during IMO MEPC 72; and*
*(2) **recommends** that this dialogue continue.*

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4. WORKPLAN AND BUDGET 2019-20

4.1 Workplan for 2019-20

(See Table 2)

4.2 Budget requests for 2019-20

The sub-committee received two requests for funding, both related to ship strikes.

Mattila outlined the funding proposal for a workshop looking at Important Marine Mammal Areas and the applicability of this approach for identifying high risk areas for ship strikes. A joint IWC-UNEP ship strike workshop held in Panama in 2014 reviewed the IUCN's Marine Mammal Protected Areas Task Force initiative to identify Important Marine Mammal Areas (IMMAs) around the World, and recognised that it might be helpful to the process of identifying areas for high risk of ship strike. Subsequently, both the Scientific Committee and the Ship Strike Standing Working Group have encouraged cooperation on this idea

Table 2
Work plan for HIM.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Bycatch and entanglement				
Bycatch Mitigation Initiative	-	Review aspects relevant to Committee and respond to requests for advice	-	Review aspects relevant to Committee and respond to requests for advice
Rates and risks	-	Review new estimates of entanglement rates, risks and mortality	-	Review new estimates of entanglement rates, risks and mortality
Mitigation	-	Review new information on mitigation	-	-
Rapid risk assessment	-	Consideration of 'rapid risk assessment' tools and outputs	-	-
Electronic monitoring	-	Consideration of remote electronic monitoring and vessel tracking	-	-
Mitigation measures tables	-	Develop table of mitigation measures for small cetaceans and update table for large whales from 2017 if needed.	-	-
Global disentanglement database	Mattila to discuss the development of a global database from disentanglement activities conducted by members of the IWC network at GWERN meeting	Review Progress	Advance database development if considered feasible	Review Progress
Collaboration with FAO	Secretariat attend COFI meeting	Review FAO outputs on bycatch	Continue collaboration	Continue to review
Encouraging innovative research on mitigation	Promoting the Bycatch Mitigation Initiative through existing networks, at conferences, workshops and with students – all members of Committee with relevant expertise	Review progress	-	-

Table 2 (*Cont.*)

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Ship strikes				
Rates and risks	-	Review estimates of rates of ship strikes, risk of ship strikes and mortality	-	Review estimates of rates of ship strikes, risk of ship strikes and mortality
Mitigation	-	Review new information on mitigation	-	-
Advice on routeing measures related to ship strike risk	Provide advice as required (Ship routeing group)	Review advice	Provide advice as required (Ship routeing group)	Review advice
Follow up on previous contacts offering IWC assistance regarding high risk areas	Secretariat to contact Sri Lankan and Greek authorities	Review progress on identified high risk areas in IWC Ship Strike Strategic Plan	-	-
Continued co-operation with IMO	Secretariat to maintain dialogue with IMO Secretariat. Attend relevant IMO meetings.	Review cooperation	-	-
Ship strike database	Continue ongoing data entry into Ship Strike Database and validation of records	Review progress against specific deliverables and time line	Continue ongoing data entry into Ship Strike Database and validation of records	Review progress against specific deliverables and time line
Provision of AIS data	Secretariat to develop MOU with Marine Traffic for provision of data	Consider best way to handle requests for data through the MOU	-	-
Use of IMMAs to identify high risk areas for ship strikes	Hold workshop to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes.	Review workshop report	-	-

between the IUCN TF and the IWC. In 2013 the IUCN task force on marine mammal protected areas thought that the IMMA approach might be a good approach for identifying areas for high risk with ship strikes. This could be a more systematic attempt at identifying high risk areas. The objective of the workshop is to identify if this is feasible and how it could best be achieved. The sub-committee noted the utility of the workshop and **recommended** that it should be funded. In particular, IMMAs are of specific interest to some governments at the moment.

The other proposal with budget implications is the ongoing work of the ship strike data coordinators. The sub-committee **recommended** that this should be funded over the two-year budget period and given the highest priority of the funding requests put forward by the sub-committee. The sub-committee noted that other organisations look towards IWC for ship strike data and providing this will not be possible without the work of the ship strike coordinators. Until the review process is complete the IWC is not in a position to make the database available for use. However, there have been some concerns in relation to the internal prioritisation of the ship strike coordinators in relation to how much time is spent on the data entry and outreach activities. Some form of performance assessment is needed so that the coordinators have guidance in relation to priorities. The IWC Secretariat could address some of the communication and outreach aspects. Furthermore, the project should identify clear timelines and associated outputs so that these can be followed up closely and the progress assessed.

Table 3

Summary of the two-year budget request for HIM.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
		10,000	
Modelling/Computing			
Research			
Database/Catalogues			
		10,000	10,000
Total request		**20,000**	**10,000**

5. ADOPTION OF REPORT

The report was adopted at 11:45 on 2 May 2018.

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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 bycatch and entanglement rates, risks and mortality
        - 2.1.1 Baleen whales
        - 2.1.2 Inferences from strandings
        - 2.1.3 Spatial dynamics
    - 2.2 Consider scientific aspects of bycatch and entanglement mitigation measures and prevention
        - 2.2.1 Summary table on measures to mitigate bycatch of small cetaceans
    - 2.3 Review proposal for global entanglement database
    - 2.4 Reporting of entanglements and bycatch in national progress reports
    - 2.5 The IWC Bycatch Mitigation Initiative
    - 2.6 Collaboration with FAO on bycatch related issues
    - 2.7 New information on cetacean bycatch in the Western, Central and Northern Indian Ocean
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 on 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
4. Work plan and budget 2019-20
    - 4.1 Work plan for 2019-20
    - 4.2 Budget requests for 2019-20
5. Adoption of report

Appendix 2

BYCATCH AND VESSEL STRIKES OF LARGE WHALES ENTERED INTO THE 2018 PROGRESS REPORTS

Prepared by Marion Hughes

Table 1

Reports of bycatch entered into the 2018 Progress Reports.

Large Area	Local area	Species	Year	Indivi-duals*	Targeted species	Gear type
Argentina						
Atlantic Ocean - Argentine Sea	63°32.3S/61°00.6W	Humpback whale (*Megaptera novaeangliae*)	2015	1	N/A	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Atlantic Ocean - North	Coastal Buenos Aires province	Common minke whale (*Balaenoptera acutorostrata*)	2018	1	-	
Australia						
Pacific Ocean - Coral Sea	-	Unidentified large whale	2016	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - Coral Sea	-	Unidentified large whale	2016	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - Tasman Sea	-	Unidentified large whale	2016	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Southern Ocean	Gulf St Vincent	Unidentified large whale	2017	1	Unknown	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Pacific Ocean - South	Queensland	Humpback whale (*Megaptera novaeangliae*)	2017	8	White, tiger, bull sharks	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	-	Humpback whale (*Megaptera novaeangliae*)	2017	2	-	[LHM] HOOKS AND LINES - Handlines and pole-lines (mechanised)
Southern Ocean - Bass Strait	Low Rocky Point - SW Tasmania	Humpback whale (*Megaptera novaeangliae*)	2017	1	Rock lobster	[FPO] TRAPS - Pots
Southern Ocean	Tasman Peninsula	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	[LNB] LIFT NETS - Boat-operated lift nets
Southern Ocean	Port Davey Region, SW Tasmania	Humpback whale (*Megaptera novaeangliae*)	2017	1	Rock lobster	[FPO] TRAPS - Pots
Southern Ocean	Tasman Peninsula	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	[LL] HOOKS AND LINES - Longlines (not specified)
Pacific Ocean - South	Wyrrabalong National Park	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Indian Ocean	Western Australia, Broome	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[MIS] MISCELLANEOUS GEAR
Indian Ocean	Western Australia, Cervantes	Humpback whale (*Megaptera novaeangliae*)	2017	1	Western rock lobster	[FPO] TRAPS - Pots
Indian Ocean	Western Australia, Exmouth	Humpback whale (*Megaptera novaeangliae*)	2017	2	Unknown	[MIS] MISCELLANEOUS GEAR
Indian Ocean	Western Australia, Fremantle	Humpback whale (*Megaptera novaeangliae*)	2017	1	Western rock lobster	[FPO] TRAPS - Pots
Indian Ocean	Western Australia, Garden Island	Humpback whale (*Megaptera novaeangliae*)	2017	1	Octopus	[LL] HOOKS AND LINES - Longlines (not specified)
Indian Ocean	Western Australia, Kalbarri	Humpback whale (*Megaptera novaeangliae*)	2017	1	Western rock lobster	[FPO] TRAPS - Pots
Indian Ocean	Western Australia, Mandurah	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	[MIS] MISCELLANEOUS GEAR
Indian Ocean	Western Australia, Rottnest Island	Humpback whale (*Megaptera novaeangliae*)	2017	4	Western rock lobster	[FPO] TRAPS - Pots
Indian Ocean	Western Australia, Rottnest Island	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	[MIS] MISCELLANEOUS GEAR
Indian Ocean	Western Australia, Two Rocks	Humpback whale (*Megaptera novaeangliae*)	2017	1	Octopus	[LL] HOOKS AND LINES - Longlines (not specified)
Pacific Ocean - South	-	False killer whale (*Pseudorca crassidens*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Long-finned pilot whale (*Globicephala melas*)	2017	2	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Long-finned pilot whale (*Globicephala melas*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Long-finned pilot whale (*Globicephala melas*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Melon-headed whale (*Peponocephala electra*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Melon-headed whale (*Peponocephala electra*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Melon-headed whale (*Peponocephala electra*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Melon-headed whale (*Peponocephala electra*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Antarctic minke whale (*Balaenoptera bonaerensis*)	2017	1	-	[LLS] HOOKS AND LINES - Set longlines
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	2	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines

Large Area	Local area	Species	Year	Individuals*	Targeted species	Gear type
Australia cont.						
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	2	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Unidentified large whale	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Unidentified small whale	2017	2	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Southern right whale (*Eubalaena australis*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Long- or short-finned pilot whale (*Globicephala* sp.)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Long- or short-finned pilot whale (*Globicephala* sp.)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Antarctic minke whale (*Balaenoptera bonaerensis*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	Diamond Head, Crowdy Bay, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Coalcliff, Wollongong, NSW, AUS	Southern right whale (*Eubalaena australis*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - South	Ulladulla, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Terrigal, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Sapphire Beach, Coffs Harbour	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - South	Cape Byron, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Myall Lakes National Park, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - South	Hat Head, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Newcastle, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Arrawarra, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	North Solitary Island, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	South West Rocks, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Woolgoolga Headland, Coffs Coast, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	Brooms Head, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Pacific Ocean - South	South Solitary Island, Coffs Harbour, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - South	Crowdy Head, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FPO] TRAPS - Pots
Pacific Ocean - South	Ku-ring-gai Chase National Park	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Denmark						
Arctic Ocean - Baffin Bay	Qeqertarsuaq	Bowhead whale (*Balaena mysticetus*)	2017	1	Crab	[FPO] TRAPS - Pots
Arctic Ocean - Baffin Bay	Sarfannguit near Sisimiut	Humpback whale (*Megaptera novaeangliae*)	2017	1	Cod	[FPN] TRAPS - Stationary uncovered pounds nets
Arctic Ocean - Davis Strait	Napasoq near Maniitsoq	Humpback whale (*Megaptera novaeangliae*)	2017	1	Cod	[FPN] TRAPS - Stationary uncovered pounds nets
Arctic Ocean - Davis Strait	Maniitsoq	Humpback whale (*Megaptera novaeangliae*)	2017	1	Cod	[FPN] TRAPS - Stationary uncovered pounds nets
Arctic Ocean - Davis Strait	Maniitsoq	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	
Arctic Ocean - Denmark Strait	East Greenland	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Arctic Ocean - Baffin Bay	Ilulissat	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	-
Atlantic Ocean - North Sea	Skagen	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Iceland						
Atlantic Ocean - North	Iceland	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Japan						
Pacific Ocean - North	Hokkaido prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	10	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Fukuoka prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Iwate prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	20	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Miyagi prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	10	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Akita prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Chiba prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	6	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kanagawa prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Niigata prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Toyama prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	11	-	[FPN] TRAPS - Stationary uncovered pounds nets

Large Area	Local area	Species	Year	Indivi-duals*	Targeted species	Gear type
Japan cont.						
Pacific Ocean - North	Ishikawa prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	27	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Nagasaki prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	16	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Miyazaki prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kagoshima prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	2	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Miyagi prefecture	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kanagawa prefecture	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kochi prefecture	Humpback whale (*Megaptera novaeangliae*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Aomori prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	8	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Fukui prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	7	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Shizuoka prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	4	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Mie prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	3	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kyoto prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	10	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Wakayama prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	3	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Shimane prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	4	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Yamaguchi prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	3	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Tokushima prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	-	[FPN] TRAPS - Stationary uncovered pounds nets
Pacific Ocean - North	Kochi prefecture	Common minke whale (*Balaenoptera acutorostrata*)	2017	14	-	[FPN] TRAPS - Stationary uncovered pounds nets
Korea						
Pacific Ocean - Yellow Sea	-	Common minke whale (*Balaenoptera acutorostrata*)	2017	20	-	[FPO] TRAPS - Pots, [FSN] TRAPS - Stow nets, [FIX] TRAPS - Traps (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified), [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Common minke whale (*Balaenoptera acutorostrata*)	2017	50	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified), [FPO] TRAPS - Pots, [FIX] TRAPS - Traps (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
New Zealand						
Pacific Ocean - New Zealand	Kaikoura	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Pacific Ocean - New Zealand	French Pass	Unidentified large baleen whale	2017	1	Crayfish, rock lobster	[FPO] TRAPS - Pots
Pacific Ocean - New Zealand	Stewart Island	Pygmy right whale (*Caperea marginata*)	2017	1	-	[FPO] TRAPS - Pots
Norway						
Atlantic Ocean - North	Kaldfjorden	Humpback whale (*Megaptera novaeangliae*)	2017	3	Herring	[PS1] SURROUNDING NETS - One-boat operated purse seines
Atlantic Ocean - North	Lofoten	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	Cod fishery	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Spain						
Atlantic Ocean - North	Mar de Arousa	Fin whale (*Balaenoptera physalus*)	2017	0	-	-
USA						
Atlantic Ocean - North	-	Fin whale (*Balaenoptera physalus*)	2015	1	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Atlantic Ocean - North	-	Humpback whale (*Megaptera novaeangliae*)	2015	26	-	-
Pacific Ocean - North	CA	Blue whale (*Balaenoptera musculus*)	2016	4	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Pacific Ocean - North	Orange, CA	Gray whale (*Eschrichtius robustus*)	2016	3	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Pacific Ocean - North	-	Humpback whale (*Megaptera novaeangliae*)	2016	26	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED, [FPO] TRAPS - Pots
Pacific Ocean - North	CA	Humpback whale (*Megaptera novaeangliae*)	2016	2	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	CA	Humpback whale (*Megaptera novaeangliae*)	2016	24	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Pacific Ocean - North	CA	Unidentified large whale	2016	5	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED

*This column has been aggregated.

Table 2
Vessel strikes of large whales entered into the 2018 Progress Reports.

Large Area	Local area	Species	Year	Indivi-duals*	Submitted to IWC or National Ship Strike Database	Source of information
Australia						
Pacific Ocean - South	Off Tweed Coast, near Casuarina, NSW, AUS	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	NSW Office of the Environment and Heritage
Indian Ocean	Western Australia.	Humpback whale (*Megaptera novaeangliae*)	2017	1	Unknown	Department of Parks and Wildlife WA
Pacific Ocean - South	Peak Island region	Unidentified large baleen whale	2018	1	No	National Collator
Pacific Ocean - South	Cairns region	Unidentified large whale	2018	1	No	National Collator
Pacific Ocean - South	Offshore of North Stradbroke Island	Humpback whale (*Megaptera novaeangliae*)	2018	1	No	National Collator
Atlantic Ocean - North	Gloucester Island area	Unidentified large whale	2018	1	No	National Collator
Pacific Ocean - South	Cairns region	Humpback whale (*Megaptera novaeangliae*)	2018	1	No	National Collator
Pacific Ocean - South	Moreton Bay	Humpback whale (*Megaptera novaeangliae*)	2018	1	No	National Collator
Brazil						
Atlantic Ocean - South	Santa Catarina State, Southern Brazil	Southern right whale (*Eubalaena australis*)	2015	0	No	PBF
Atlantic Ocean - South	Morro de São Paulo	Humpback whale (*Megaptera novaeangliae*)	2017	1	No	IBJ
Atlantic Ocean - North	Baia de Todos os Santos	Andrews' beaked whale (*Mesoplodon bowdoini*)	2017	1	Unknown	IBJ
New Zealand						
Pacific Ocean - South	Hauraki Gulf, seaward of Great Barrier Island	Sei whale (*Balaenoptera borealis*)	2017	1	Yes	National Collator
Spain						
Atlantic Ocean - North	Isla de La Palma. Canary Islands. San Andrés y Sauces	Bryde's whale (*Balaenoptera edeni*)	2017	1	No	TENECON, Tenerife Conservation Research Society
Atlantic Ocean - North	Tenerife, Los Cristianos	Short-finned pilot whale (*Globicephala macrorhynchus*)	2017	1	Unknown	TENECON, as above
Atlantic Ocean - North	El Hierro-Canary Islands	Sperm whale (*Physeter macrocephalus*)	2017	1	Unknown	TENECON, as above
Atlantic Ocean - North	Mar de Arousa	Fin whale (*Balaenoptera physalus*)	2017	1	Unknown	Servicio de Conservación de la Biodiversidad, Consellería de Medio Ambiente, Territorio e Infra-estruturas, Xunta de Galicia
Atlantic Ocean - North	Mar da Coruña	Common minke whale (*Balaenoptera acutorostrata*)	2017	1	Unknown	As above
Atlantic Ocean - Mediterranean Sea	Gulf of Valencia	Fin whale (*Balaenoptera physalus*)	2017	1	Unknown	Instituto Cavanilles de Bio-diversidad y Biologia Evolutiva, Universidad de Valencia
Atlantic Ocean - North	Canary Islands	Bryde's whale (*Balaenoptera edeni*)	2018	1	Unknown	Instituto Universitario de Sanidad Animal, Universidad de las Palmas de Gran Canaria
UK						
Atlantic Ocean - North		Fin whale (*Balaenoptera physalus*)	2017	1	Unknown	UK_CSIP
USA						
Atlantic Ocean - North		Humpback whale (*Megaptera novaeangliae*)	2015	7	Unknown	National Collator
Atlantic Ocean - North		Common minke whale (*Balaenoptera acutorostrata*)	2015	1	Unknown	National Collator
Atlantic Ocean - North		Fin whale (*Balaenoptera physalus*)	2015	1	Unknown	National Collator
Pacific Ocean - North	San Mateo, CA	Blue whale (*Balaenoptera musculus*)	2016	1	Unknown	NMFS Southwest Fisheries Science Center
Pacific Ocean - North	San Diego, CA and Oregon	Gray whale (*Eschrichtius robustus*)	2016	3	Unknown	NMFS Southwest Fisheries Science Center
Pacific Ocean - North	CA-OR-WA	Humpback whale (*Megaptera novaeangliae*)	2016	6	Unknown	NMFS Southwest Fisheries Science Center

*This column has been aggregated.

Annex K

Report of the Sub-Committee on Environmental Concerns

Members: Hall (Convenor), Al Harthi, Al Jabri, Aoki, Atkinson, Avila, Baba, Bell, Bickham, Bjørge, Brierley, Brownell, Burkhardt, Buss, Castro, Cerchio, Cholewiak, Cipriano, Collins, Cosentino, Dalla Rosa, de Freitas, DeMaster, Di Tullio, Domit, Doniol-Valcroze, Donovan, Double, Elwen, Ferguson, Ferriss, Fortuna, Frey, Fruet, Gallego, Galletti-Vernazzani, Genov, George, Gonzalez, Gulland, Haug, Hielscher, Holm, Hubbell, Iñíguez, Inoue, Jacob, Kim, Kitakado, Lang, Langerock, Leaper, Leslie, Litovka, Luna, Lundquist, Mallette, Marcondes, Mattila, Mazzariol, Minton, Murase, Mwabili, Natoli, Nelson, New, Palka, Panigada, Parsons, Phillips, Porter, Reeves, R., Reeves, S., Reyes Reyes, Ridoux, Ritter, Rodriguez-Fonseca, Rojas Bracho, Rose, Rowles, Ryeng, Safonova, Sampaio, Santos, Scheidat, Scordino, Scott, Sequeira, Simmonds, Sironi, Širovič, Slooten, Slugina, Smith, Stachowitsch, Stack, Stimmelmayr, Stockin, Suydam, Svoboda, Tamura, Tarzia, Taylor, Thomas, Torres, Trejos Lasso, Urbán, Víkingsson, Wade, Weinrich, Weller, Williams, Willson, Wilson, Yaipen-Llanos, Yasokawa, Yasunaga, Ylitalo, Zerbini.

1. INTRODUCTION

1.1 Introductory remarks
Hall welcomed the participants.

1.2 Election of Chair
Hall was elected as Chair.

1.3 Appointment of Rapporteurs
Cholewiak, Noren, 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 were identified as SC/67b/E01-02; SC/67b/E03rev1; SC/67b/E04-06; SC/67b/E07rev1; SC/67b/E08-11; SC/67b/E13; SC/67b/E15-16; SC/67b/CMP04; SC/67b/CMP13; SC/67b/HIM06; SC/67b/AWMP03; Cholewiak *et al*. (2018); Hall *et al*. (2018); IMO (2018); Prideaux (2017); Taffi *et al*. (2014); Van Opzeeland and Boebel (2018).

2. POLLUTION

2.1 Review on intersessional progress on the Pollution 2020 initiative
An update on progress within the Pollution 2020 initiative was given by Hall. Following the work plan agreed upon at SC/67b, there have been three main activities:

(a) Continue modelling of the effects of contaminants on cetacean populations, including potential addition of the impact of exposure to brominated flame retardants
The individual based model to investigate the effects of pollutants on cetacean populations (SPOC) has been finalised. A peer-reviewed paper detailing the model and applying it to a number of case studies has been published in *Environmental Pollution* (Hall *et al*., 2018) and the model's R code is available through the repository associated with the paper. The web-based, user-friendly version is now available through the Sea Mammal Research Unit, University of St Andrews server (*http://www.smru.st-andrews.ac.uk/reports/*) and a link will be added to the IWC webpages on the Chemical Pollution page.

The model estimates the effect of exposure to pollutants (currently the polychlorinated biphenyls or PCBs) by integrating tissue concentration-response relationships (using data obtained from published toxicological studies) with information on blubber pollutant levels in cetaceans. The model then modifies the probability of calf survival, and mortality following exposure to a pathogen, for a given population or species. Adding the additional option to investigate the effect of exposure to the brominated flame retardants (or polybrominated diphenyl ethers, PBDEs) on calf survival or reproduction into the model has been difficult. The tissue-related concentration-response functions needed are not available for these compounds. Most studies do not report the tissue concentrations, only to oral dose to which the animals have been exposed. In addition, these chemicals do not occur in isolation but will always be found in combination with the other persistent organic pollutants. Therefore, including the effect of exposure to the PBDEs in a model separately from these other contaminants is unrealistic. However, data from a study published recently by Desforges *et al*. (2017) in which the effects of a mixture of persistent organic pollutants (POPs), extracted from killer whale blubber, on immune function *in vitro* are available. These data, and the relationship between the immune function assay and blubber concentrations of POPs can easily be included in the model. This will therefore be implemented as an option in the web-based version of the model and will be reported at SC/68a.

(b) Data integration and mapping
The contaminant mapping tool presented at SC/67b has been completed and the data on concentrations of PCBs and DDTs in key species for which long-term datasets have been published in the peer reviewed literature, have been included. Additional data published recently and collated by the State of the Cetacean Environment Report (item 6) will be incorporated during the intersessional period. Data on mercury concentrations in cetacean tissues has also been obtained from the papers reviewed in SC/67b/E08 and will be included in the mapping tool that will shortly be available on the web, through the Sea Mammal Research Unit and IWC websites.

(c) Estimating the rate of decline in PCBs in cetacean blubber following reductions in environmental concentrations
A computational model of PCB bioaccumulation in the Adriatic food web has been developed by Taffi *et al*. (2014) following biomass flows in predator-prey relationships at the various trophic levels. This model also investigated the effect that bioremediation measures, i.e. enhancement of the microbial pollutant degradation pathways, may have on the

bioaccumulation of these compounds. The authors developed models that integrate bioaccumulation at the ecosystem level with genome-scale metabolic models of pollutant degrading bacteria. Whilst the bioremediation measures proposed may only be applicable to limited regions, the concept of investigating the rate of decline in blubber PCB concentrations in top predators, due to declines in inputs as a result of various mitigation measures, not just bioremediation, could be addressed using this approach. The applicability of the Taffi *et al*. (2014) model for estimating how long it would take before a decline in blubber PCB contaminants is detectable in cetaceans will be therefore be explored further during the intersessional period and the findings will be reported at SC/68a.

The sub-committee thanked Hall for presenting this update and commended her on the work that has been completed for the Pollution 2020 initiative.

Attention: SC

The sub-committee ***agreed*** *that the Pollution 2020 initiative should be completed and presented at SC/68a. The sub-committee also* ***encouraged*** *a paper be presented at SC/68a summarising the potential mitigation measures for reducing exposure of cetaceans to polychlorinated biphenyls (PCBs) in particular and persistent organic pollutants (POPs) in general.*

2.2 Report on mercury in cetaceans

SC/67b/E08, a review of mercury in cetaceans, was carried out in response to Resolution 2016-4, 'Resolution on Minamata Convention'. The paper highlights the continued global exposure and potential effect of mercury on cetaceans. The fate and transportation of this element in the marine environment is driven by anthropogenic atmospheric and aquatic sources, as well as through natural geogenic inputs, with coastal areas and species being more vulnerable to mercury contamination than the open ocean. Inorganic mercury is converted to the more toxic form of methylmercury following chemical reactions in relation to various biological factors in the marine environment (King *et al*., 2001). Bioaccumulation of the methylated form occurs because it is more efficiently assimilated into tissues but only relatively slowly eliminated (Evans *et al*., 2016). A very wide range of studies have reported mercury concentrations in the tissues of cetaceans and these will be incorporated into the Pollution 2020 contaminant mapping tool during the intersessional period. The main target organ is the liver but mercury has also been reported in many other tissues (Savery *et al*., 2013; Stavros *et al*., 2007; 2008; Trumble *et al*., 2017).

Marine mammals are capable of detoxifying methylmercury and reducing their burden through the demethylation of methylmercury in the liver (Caurant *et al*., 1996; Wagemann *et al*., 1998) and its subsequent binding to selenium to form insoluble and toxicologically inert mercuric selenide or tiemmannite crystals that accumulate in the liver. However, under certain circumstances, when animals are experiencing other metabolic stressors, this mercuric selenide may cause adverse effects.

In a relatively recent review of the research needs related to mercury biogeochemistry, Sonke *et al*. (2013) concluded 'mercury exposure to humans and wildlife are likely to persist unless drastic emission reductions are put in place'. Since then, the Minamata Convention (*http://www.mercuryconvention.org/*) has been ratified by 91 countries and came into force in August 2017. Its provisions include 'a ban on new mercury mines, the phasing-out of existing ones, the reduction and eventual cessation of mercury use in many products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining which use mercury in the extraction process'. The aim of the Convention is to control the anthropogenic releases of mercury throughout its lifecycle thereby reducing global emissions and exposure to both wildlife and humans. Continued monitoring of mercury in cetaceans is therefore required to determine whether these new measures reduce the uptake and impact of mercury on cetaceans in future.

The sub-committee commended Hall for the thorough review of mercury and acknowledged that the summary of information is quite extensive and useful.

SC/67b/E06 reported total mercury concentrations in river dolphins (*Inia* and *Sotalia*) in the Amazon and Orinoco river basins. Mercury was analysed in the tissue of animals found floating dead (n=19), stranded (n=4 and captured for the attachment of satellite transmitters (n=15) in the Arauca and Orinoco rivers (Colombia and Venezuela border), Amazonas river (Colombia and Peru border) and Itenez or Guapore river in Bolivia. The mercury concentration ranges were reported for *I. g. humboldtiana, I. g. geoffrensis, I. g. boliviensis*, and *Sotalia fluviatilis*. As they are top predators, mercury concentrations biomagnify in these dolphins, which would explain the pattern of concentrations found.

SC/67b/E09 reported on mercury concentrations in wild humpback whales (*Megaptera novaeangliae*) sampled in the Colombian Pacific and the Antarctic Peninsula. The G stock of humpback whales undertakes one of the longest cetacean migrations, from the Antarctic Peninsula (feeding area) to the Southeast Pacific (in Ecuador and Colombia), where their breeding and calving areas are located. These whales are exposed to several pollutants, including mercury, which has been previously reported in the Antarctic Ocean. Skin and blubber samples from G stock humpback whales in the Antarctic Peninsula (2015, n=15) and in the Colombian Pacific (Chocó Province, 2015, n=14; 2016, n=42) were collected. Significant differences between levels in different tissue types from the same individual were found, with higher total mercury concentrations found in skin compared to blubber. Furthermore, concentrations of total mercury were significantly higher in Antarctic skin and blubber samples compared to skin and blubber samples from the Colombian Pacific. However, no significant differences in total mercury levels between females and males were found. Although humpback whales are not top predators in the Antarctic trophic ecosystem, this study provides new insights into mercury bioaccumulation in Antarctic meso-predators. The authors suggested that whales detoxify total mercury during migration. In order to further evaluate the mercury exposure and its impacts on cetaceans, future research should focus on assessing mercury concentrations in target tissues as well as investigating the degree of maternal transfer to the offspring.

Additional information on mercury levels and other environmental contaminants measured in tissues of cetaceans from coastal waters of the Chukchi Peninsula was reported in SC/67b/E03. Organs and tissues of necropsied gray and beluga whales were collected after aboriginal whaling and landing by Chukotka Natives over 10 seasons. In addition, more than 20 biopsy blubber samples from belugas from the White Sea were analysed for persistent organochlorine pesticides. In 2017, about 300 baleen samples from bowhead whales, as well as 10 blood and 10 stomach content samples of gray whales, were collected, which are currently being analysed as part of a hormone and prey study. Higher levels of arsenic and cadmium were measured in whale kidney samples but levels did not vary by age or sex. Lead and mercury were found in lower concentrations in the tested tissues and organs in the Mechigmensky Bay whales.

Chukotka Natives consume the intestines and meat of whales and walruses. The concentrations of arsenic, cadmium, mercury, and lead measured in the muscle and blubber samples of gray and beluga whales did not exceed the maximum permissible levels (MPL) recommended as part of the Russian State Sanitary, Epidemiological and Hygienic Requirements. Cadmium concentrations exceeded the MPL only twice in liver samples from one malodorous male gray whale collected in 2008 (58.5% above MPL) and in the liver of a non-malodorous female gray whale collected in 2015 (15% above MPL) out of 89 samples analysed. The MPL for lead was exceeded in three liver and kidney samples collected from malodorous whales in 2008, ranging from 2 to 4 times above the MPL. The toxic element concentrations in two beluga samples from the western Bering Sea were lower than the MPLs. The multiple excess concentrations of cadmium and lead in liver and kidney could be related to the malodorous or so-called 'stinky' gray whale phenomenon, the tainted flesh from which is not fit for consumption, but this relationship should be further studied. However, the authors concluded that the concentrations of lead and cadmium in the most valuable whale products (meat and blubber) of all studied animals, including the 'stinky' gray whales, were below the MPLs for the heavy metals analysed.

The sub-committee thanked the authors for their valuable contribution to our knowledge of mercury in cetaceans but noted the lack of standardisation of reporting units for mercury concentrations in tissues. The sub-committee therefore **encourages** researchers to report these concentrations on both wet and dry weight bases. Preferred tissues for mercury analysis was also discussed. Although mercury analyses are typically conducted on kidney and liver of stranded cetaceans, this is not always possible in carcasses that are in poor condition. In live animals, skin and blubber from biopsy samples are easily collected and these tissues have been analysed for mercury. The sub-committee also noted that mercury levels could be compared across tissues in fresh stranded animals to determine how concentrations vary among matrices and that nutritional status could influence where mercury is deposited in the body. Future studies that examine the relationships between methylmercury and total mercury among tissues in cetaceans were also suggested.

Attention: CG-R

The sub-committee ***recommended*** *the continued monitoring of mercury in cetaceans, as this is required in order to assess the medium- and long-term impact of the Minamata Convention.*

2.3 Impact of heavy fuel oils on cetaceans

Information was presented in SC/67a/E03 last year on heavy fuel oil and the potential impacts of this petroleum product on Arctic cetaceans. Heavy fuel oil is not readily broken down in the environment and thus a heavy fuel oil spill could pose an environmental concern in many regions of the world due to the high viscosity and chemical composition of the spilled oil. In addition, heavy fuel oil poses a substantial threat to the Arctic environment because it is extremely difficult to recover once spilled and impacts associated with mitigation measures (e.g. dispersant use, *in situ* burning) are of concern.

Recent studies have reported on the various effects (physiological and behavioural) of petroleum and petroleum-related compounds on certain species of marine mammals such as bottlenose dolphins from the northern Gulf of Mexico after the *Deepwater Horizon* oil, (Schwacke et *al*., 2013; Venn-Watson *et al*., 2015; Lane *et al*., 2015), oiled ice seals from the Bering Straits of the U.S. (Stimmelmayr *et al*., 2018), and belugas from the White Sea (Andrianov *et al*., 2018) and St. Lawrence Estuary (Poirier *et al*., 2018). Although the effects of heavy fuel oil on selected marine species (e.g. amphipods, fish, seabirds) have been reported (Alonso-Alvarez *et al*., 2007; Brown *et al*., 2017; Incardona *et al*., 2012), little information is available on heavy fuel oil exposure and potential effects in cetaceans. As was noted at SC/67a, the collection of baseline data for cetaceans in the Arctic, including standardisation of measures between bowhead whales and belugas, is necessary with increased vessel traffic and oil industry activities expected in the region in the near future.

The sub-committee discussed differences between oil spills and heavy fuel oil exposure as well as relationships between oil exposure and disease. It is important to note that the compounds from typical oil spills are different from the compounds in heavy fuel oil. This heavy fuel oil (bunker fuel) is added to the marine fuel for vessels and is more toxic.

Attention: CG-A, SC

The sub-committee:

(a) ***reiterated*** *the need to estimate the risk and impact of oil spills, particularly to cetaceans in the Arctic;*
(b) ***noted*** *that heavy fuel oil could pose an environmental threat in many regions due to its high viscosity and chemical composition;*
(c) ***noted*** *that heavy fuel oil poses a special threat in the Arctic due to difficulties in recovery and potential impacts of some recovery measures (e.g. dispersant use and* in situ *burning); and*
(d) ***encouraged*** *the collection of baseline data for cetaceans, including standardisation of measures.*

2.4 Other pollution issues

In addition, the effects of dispersants or dispersed oil to the Arctic ecosystem is not well known. To address this need, the Coastal Response Research Center (CRRC) in the U.S. coordinated a discussion among scientists with dispersant research expertise, as well as those with Arctic expertise, to determine the state-of-science regarding dispersants or dispersed oil, as it applies to Arctic waters. The ecotoxicity and sublethal impacts section of the report has been approved and will be posted later this year at *https://crrc.unh.edu/dispersant_science*.

The sub-committee thanked all the participants for the updates provided on pollution. During discussion, it was noted that the Pollution 2020 initiative will be completed next year (SC/68a) and recognised the need to begin planning for future direction of pollution issues related to cetaceans in sub-committee. An intersessional email group has been established to make progress on this task.

Attention: CG-A, SC

The sub-committee ***encouraged*** *research on the effects of dispersants or dispersed oil to the Arctic ecosystem and for it to be brought forward to future meetings of the Scientific Committee.*

3. CUMULATIVE EFFECTS

A pre-meeting workshop on the cumulative effects of multiple stressors in cetaceans was held on 23rd and 24th April 2018 in Bled, Slovenia. This topic is important to IWC through its concern about the effect of environmental change on cetaceans and follows on from an IWC workshop on Habitat Degradation that was hosted by the University of Siena in 2004 (IWC, 2006).

The objectives of the workshop were: (1) to summarise the methods available for assessing cumulative effects of multiple stressors on cetaceans (both individual and population); (2) to discuss and review those methods and frameworks; (3) to identify case studies on specific species and populations (identifying their pros and cons) to which the frameworks or components of the frameworks could be applied; (4) develop criteria required for robust case studies; (5) to recommend the means and ways of progressing this work and communicating the importance of recognising the potential impact of multiple stressors to a wider audience.

This is a subject of concern across many areas within marine mammal science and the findings of a recent report on 'Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals', recently published by the US National Academies of Science, Engineering and Medicine (National Academies, 2017), was presented at the workshop. There is clearly growing recognition that the effect of single stressors cannot be understood without considering other major stressors and the nature of any interactions among those stressors. Studies to date have focused on effects of noise, and some toxins and contaminants on marine mammals, generally investigating the additive effects of various stressors of major concern. There is growing recognition that there are many stressors affecting cetaceans at both the individual and population levels. Scientific progress in this field has focussed on one of a hierarchy of responses to a stressor, across multiple levels of biological organisation; from the cell and the nature of molecular interactions to the ecosystem and the nature of trophic interactions. However, the conclusion is that it cannot be assumed that effects are additive. For example, a meta-analyses of hundreds of factorial studies on effects of multiple stressors on marine systems concluded that there are few situations where effects of multiple stressors are simply additive and assuming additivity may lead to an underestimate or overestimate of the cumulative impact. This is because interactions between stressors often results in an antagonistic (reduced combined) or a synergistic (enhanced combined) effect.

A framework for studying multiple stressors, as outlined in the National Academies report (National Academies, 2017, Population Consequences of Multiple Stressors [PCOMS]) incorporating effects on multiple individuals and their combined effect on populations, was outlined. In addition, other studies that could assist in investigating cumulative effects, including epidemiological case-control and individual or agent based modelling (IBM) studies, were discussed. Comparisons with research and similar modelling approaches of common interest within the Ecosystem Modelling sub-committee (namely IBM energetic models and modelling the effects of long-term environmental change on cetacean populations) were also discussed and their potential for adaptation to the questions relevant to understanding cumulative effects, were explored.

A number of case studies that could be used, particularly in the PCOMs frameworks or could add information and understanding to some of the components of the framework (e.g. how to assess health and the relationships between health and changes in vital rates) were discussed. Participants presented a summary on; (1) the study species; (2) the region, stocks or populations of interest; (3) trends in abundance and/or distribution; (4) information on vital rates; (5) the different impacts/stressors (natural and anthropogenic) that these animals are facing; (6) what is known (if anything) about the stressors, their individual/population level effects and their interactions. The four cases studies highlighted were bottlenose dolphins in the Gulf of Mexico and the East coast of Scotland, beluga whales in the Cook Inlet, Southern Resident Killer whales and sperm whales in the Gulf of Mexico. The workshop then expanded on these cases and produced a table of potentially beneficial case study species and populations where research on multiple stressors and the nature of their interactions, could be carried out.

The Workshop put forward a number of recommendations:

Recognising the ongoing interest in the IWC on the impact of cumulative effects on cetaceans and that there is considerable uncertainty and the need to provide assessments and management advice with current state of knowledge, the workshop recommended that:

- methods to assess health be developed across species and populations for which similar data sources are available;
- ongoing need to develop biomarkers for use in the field, particularly using 'omics approaches and new technologies, recognising that new techniques need to be applicable to free-swimming cetaceans Methods for investigating interactions should be developed, including in vitro studies;
- case studies be further developed, particularly how stressors interact to affect health and how that relates to vital rates;
- the key data gaps in assessing the nature of the interactions between stressors be addressed, focussing primarily on those that may act through the same pathways;
- primary focus should be on populations for which it is believed there is most chance of success i.e. those for which good information is available on both cetaceans and potential stressors over a reasonable time period, recognising that overall there are few cetacean populations studied with sufficiently broad sampling programmes covering sufficiently long time frames;
- nevertheless, consideration needs to be given to developing a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern. For those where there is immediate concern, where possible action should be taken to mitigate any recognisable adverse effects;
- to develop ways of communicating current knowledge about multiple stressors and their potential for cumulative impacts to a wider audience particularly conservation managers and policy makers, and other stakeholders;
- explore ways of progressing cumulative effects studies in conjunction with other similar initiatives, recognising that implementing these long-term, complex studies is expensive; and

- monitor the progress of cumulative effects studies in the Environmental Concerns sub-committee.

The sub-committee welcomed the information and **agreed** with the conclusions of the cumulative effects pre-meeting. It was also noted that as long as there is some uncertainty in the cumulative effects and how to mitigate them, it may be prudent to follow a precautionary approach.

SC/67b/HIM06 reported on a workshop entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea', held on 7 April 2018 in La Spezia, Italy, within the framework of the 32nd Conference of the European Cetacean Society. The workshop was organised jointly by the IUCN Joint Species Survival Commission/World Commission on Protected Areas (SSC/WCPA) Marine Mammal Protected Areas Task Force (the 'Task Force') and by the Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS). The workshop provided the opportunity to support the ongoing effort to map specific threats to cetaceans in the ACCOBAMS area by overlaying the Mediterranean IMMAs with the available area-explicit information on shipping and seismic surveys, thereby giving preliminary indications of new Cetacean Critical Habitats in the ACCOBAMS area and facilitating the implementation of conservation actions at the regional level. By way of example, three case study areas containing IMMAs – the Alborán Sea, the Northwest Mediterranean and the Strait of Sicily – were discussed during the workshop, where the overlap between IMMAs and ship traffic (suggesting the potential of ship strikes) and seismic survey blocks (with the potential of impacting noise production) appeared to be of special concern for marine mammals, and for fin, sperm and Cuvier's beaked whales in particular. The workshop suggested that the overlay between marine mammal habitat and pressures deriving from shipping and noise, possibly starting from the above listed case study areas, should be addressed in greater detail by the Task Force's regional expert working group and by the ACCOBAMS Scientific Committee, in order to recommend relevant conservation and mitigation measures. An important caution was emphasised by participants, that outside the IMMAs there might be similar, or indeed, other problems and pressures on marine mammals.

The sub-committee welcomed information on this effort to identify and address cumulative effects in the Mediterranean Sea.

Attention: G

*The sub-committee further **encouraged** additional efforts to identify the relevant threats in each of the Important Marine Mammal Areas, in order manage the cumulative effects.*

Attention: CG-R, SC

*The sub-committee **reiterated** the Cumulative Effects workshop recommendation that consideration needs to be given to 'developing a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern. For those where there is immediate concern, where possible, action should be taken to mitigate any recognisable adverse effects'.*

*The sub-committee **endorsed** the results stemming from the workshop (sponsored by the 32nd Conference of the European Cetacean Society in La Spezia, Italy, in April 2018) entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea' and **recommended** that such an effort – aimed at overlaying different sources of threat and pressure on existing Important Marine Mammal Areas (IMMAs) – be continued and carried out in more detail in the other marine regions where IMMAs have already been identified. The sub-committee offered its assistance in such assessments.*

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4. STRANDINGS AND MORTALITY EVENTS

4.1 Update on the IWC Strandings Initiative

As established during SC/66a and SC/66b, the Commission endorsed the recommendations of the Whale Killing Methods and Welfare Issues Working Group (WKM&WI WG) and the Scientific Committee that the initiative on Strandings, including the establishment of a Stranding Expert Panel (SEP) and Coordinator post, should progress.

An Intersessional Steering Group (ISG) on Strandings was tasked during SC/66b with selecting the SEP members, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate. Nominations were solicited, taking into consideration the Terms of Reference recommended during SC/66b that the SEP 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 Panellists was achieved through an online voting process. While under-representation was overcome during the SC/67a for Asia, this was not done for the African nations. The ISG-proposed governance structure for the IWC Initiative on Strandings which included a Stranding Coordinator position description, was agreed at SC/67a.

Following agreement with the Commission, the ISG will be substituted by a Steering Group. This Group would guide and assist the work of the SEP and coordinate work on strandings amongst the SEP, Scientific Committee, WKM&WI WG and Commission. This work will include the: (a) development of an initial budget and review of subsequent budgets proposed by the SEP for recommendation to the Commission; (b) appointment of Panel Members (with advice from the Chair and Co-convenor) to ensure appropriate turnover of membership and continuity; (c) provision for communication amongst the SEP, Scientific Committee, WKM&WI WG and Commission. Membership of the Steering Committee will include balanced representation from both the Scientific Committee and the WKM&WI WG. The Scientific Committee Chair (or his/her appointee) and the WKM&WI WG Chair (or his/her appointee) and the Chair of the Conservation Committee (or his/her appointee) will be permanent members. The Secretariat, Stranding Coordinator and Chair of the SEP will be *ex officio* members. The Steering Committee will be asked to select a Chair.

The SEP met virtually in July 2017, electing a Chair (Dr. Sandro Mazzariol, Italy), who will serve for the next 3 years, revising the Terms of Reference (ToR). The revised terms of Reference and *modus operandi* for the SEP are given in detail in the Strandings Initiative Progress Report, in Appendix 2. The ToR may be reviewed by the SEP and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

The Secretariat, in consultation with the ISG and the SEP appointed Karen Stockin (New Zealand) for a one year 0.5

FTE position as the Stranding Coordinator. The Coordinator is a member of, and provides support to, the SEP. This support will include: contacting the SEP for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the SEP members; and development of an annual report for submission to the Steering Committee, Scientific Committee, WKM&WI WG and Commission. These reports will also be made available on the IWC website.

Two sub-committees related to training and emergency response were established. These groups discussed protocols and best-practice, as well as a prioritisation system in order to efficiently use limited funding. Concerning this relevant issue, both sub-committees agreed upon a semi-flexible system to guide discussion. Both sub-committees prioritise IWC SEP support to the locations (Africa, Middle East and Asia, Central and South America) that lack an already established stranding network with existing expertise and facilities. Specific criteria are: (a) for onsite training, regions where emergencies has been already occurred are welcome, in particular those involving threatened species; (b) for onsite emergency response and intervention, the (sub)committee would like to prioritise those events representing most concern to species conservation and/or compromised animal welfare (i.e. threatened species, diseases of concern, mass strandings, unusual stranding events and oil spills; live stranding for which significant welfare concerns exist). The degree of financial support will be evaluated against these criteria. Reports from the SEP meetings and details of the governance structure are given in Appendix 2.

The sub-committee welcomed the appointment of the Stranding Coordinator and the excellent progress that has been made in the Strandings Initiative, and **agreed** that this work should continue with the support of the sub-committee.

The sub-committee discussed the budget for the strandings initiative, as well as the need to identify priorities for expenditure related to the emergency fund and the contribution to this from the scientific committee. The first emergency stranding response to a mass stranding event in Argentina has essentially expended the currently available budget. There was extensive discussion about how to prioritise responses to future stranding events, recognising that a response could have two components: a rescue response component (in the event of live strandings), and an investigative component, the former being within the purview of the WKM&WI WG. From the investigative perspective, the stages of the decision-making process should ensure that the interests of the scientific committee are taken into consideration, including: (a) identification of the causal factors responsible for the stranding event; and (b) obtaining new information on the biology and ecology of the species involved that may be obtained from the event. A draft, high level, decision-making tree was provided for the sub-committee as a point of discussion and to guide the steering group and expert panel in constructing their final decision-making tree, bearing in mind the aims and objectives of the sub-committee. It was also noted that, regardless of decision response, tracking mass mortality events provides important information about ocean health. It was acknowledged that standardisation of event reporting will be important, beginning with identifying the information on any particular event that may be of interest to the scientific committee and the Commission.

The sub-committee also discussed communication and commonalities between the efforts of the stranding initiative and other similar initiatives. The sub-committee has compiled a list of stranding networks worldwide, which will serve as a useful resource, and cooperation with other organisations that have similar initiatives will be crucial. Identifying information about stranding events could be achieved through personnel contacts, or actively, through searching news reports, social media, etc. Public engagement will be important (and could also benefit from rescue advice), and utilising crowd-sourcing platforms

The sub-committee also discussed membership on both the expert panel and the steering group. The interim steering committee was comprised primarily of Committee members participating in the intersessional efforts to launch the stranding initiative, but membership will change as the expert panel and steering group are formalised. Currently, there are gaps on the expert panel from certain regions, such as Australia and Africa (other than South Africa), and efforts are underway to identify appropriate candidates. Finally, it was noted that within the Committee, there is also a bycatch 'expert group', and it will be important to clearly distinguish between similar groups conducting separate activities. The sub-committee **agreed** that priority should be given to developing the protocols for diagnostic approaches, including developing a database of laboratories and expertise beyond the Expert Panel that could assist in an emergency and that field protocols should be easily accessible by cell phone in the field.

Attention: C-R, S

The sub-committee ***recommended*** *that the Commission: (a) endorse the Strandings Initiative governance structure in Annex K, Appendix 2; and (b) endorse the continuation of the Strandings Coordinator position for another two years (until IWC/68) subject to available funding and requests the Secretariat make the necessary arrangements.*

Attention: SC, S

The sub-committee also ***recommended*** *that the Strandings Initiative Steering Committee and Expert Panel, with the support of the Secretariat, should explore the best ways to gather information on strandings events and what basic data about these events should be recorded, focussing on what is useful for the sub-committee and the Commission. A phased approach to this, starting with an initial pilot project, would assist in this endeavour.*

Attention: SC

The sub-committee ***agreed*** *that the criteria for allocating Scientific Committee funds for emergency responses should be developed by the Steering Committee and the Expert Panel. It also noted that the rescue and welfare aspect of live strandings will be addressed by the Strandings Initiative but this aspect is not within the purview of the Scientific Committee.*

4.2 New information on unusual mortality events

SC/67b/E14 reported on the first outbreak of cetacean morbillivirus in the South Atlantic Ocean. The outbreak started in November 2017 in Ilha Grande Bay and spread to Sepetiba Bay, Rio de Janeiro, Brazil. At least 263 Guiana dolphins died through February 2018. Reverse transcription polymerase chain reaction analysis confirmed that 48 of 64 tested animals were positive to Guiana Dolphin Cetacean Morbillivirus. Since March 2018, the number of Guiana dolphin mortalities has returned to pre-outbreak levels. The authors suggest that the morbillivirus is a factor affecting the dolphin populations and should be included in all Guiana Dolphin Conservation Plans. In view of the seriousness of the situation the Aquatic Mammal Center, National Center for Research and Conservation of Aquatic Mammals/Chico Mendes Institute for Biodiversity Conservation (CMA/ICMBio) and the Brasilian Ministry of the Environment (MMA) recommended a number of measures including restrictions on boat anchor areas overlapping boto aggregations; restrictions on fishing activities and net heights; monitoring of illegal fishing; the creation of protected areas and the need for the strandings network to undertake surveillance for cetacean morbillivirus. In January 2018, the Laboratório de Mamíferos Aquáticos/Universidade do Estado do Rio de Janeiro, and CMA/ICMBio, started an intensive monitoring program in Sepetiba Bay, to collect data on the boto population to understand the impact of this atypical mortality on boto population dynamics.

The sub-committee welcomed the information and congratulated the researchers for the response to this outbreak and the quick diagnosis of the etiological agent.

Attention: CG-R Brazil, SC

The sub-committee commended the impressive rapid and comprehensive response to the cetacean morbillivirus outbreak in Brazilian Guiana dolphins and ***encouraged*** *further work on the longer term impact of the outbreak and the investigation of the occurrence and impact of this disease in cetaceans across different geographical areas.*

Considering the large number of animals that died during the outbreak (particularly mature females) and the historical high levels of human impacts affecting Guiana dolphins in Rio de Janeiro state, such as bycatch, chemical and noise pollution, the sub-committee ***recommended*** *that immediate actions should be taken to protect affected populations in order to increase the chances of population recoveries. In the weeks following the onset of the cetacean morbillivirus outbreak in Rio de Janeiro, an increase in Guiana dolphins deaths were reported in Sao Paulo and Espirito Santo states. The sub-committee therefore* ***encouraged*** *monitoring the virus presence in neighbouring coastal dolphin populations, particularly those in which immunosuppressive conditions or cumulative threats are identified.*

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5. NOISE

SC/67b/E16 provided an update to the sub-committee on several activities related to new progress on international strategies to address ocean noise. The IWC engaged on this topic with both the United Nations (UN) and the International Maritime Organisation (IMO) this past year. The United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea will hold its 19th meeting in June 2018, the focus of which will be anthropogenic underwater noise. The IWC submitted a letter (IWC.ALL.307) to the Division for Ocean Affairs and the Law of the Sea of the Office of Legal Affairs, summarising the recommendations by the Scientific Committee on the topic of Anthropogenic Underwater Noise. Additionally, the IWC submitted a letter to the IMO Marine Environmental Protection Committee (MEPC) 72 (MEPC 72/INF.9). The letter was drafted by a group formed at SC/67a to provide the Secretariat with a summary of the relevant material and discussions within the Committee on shipping noise. New initiatives by a number of other international bodies are also mentioned in SC/67b/E16, including the European Commission decision (2017/848) to require EU Member States to establish threshold values to ensure that levels of anthropogenic noise do not adversely affect populations of marine animals. Finally, several new topics were brought to the Committee's attention, including recent studies documenting the responses of cetaceans to shipboard echo-sounders, and a compilation of studies evaluating the effects of noise on marine fish and invertebrates.

The sub-committee welcomed the update on international efforts addressing anthropogenic noise, and encouraged expanded international coordination regarding assessment and protection of acoustic habitat quality.

Attention: CG-R

The sub-committee ***recommended*** *that levels of anthropogenic noise and its effects on marine species be explicitly considered in the management of sanctuaries and marine protected areas.*

SC/67b/E07rev1 presents guidelines developed by the Convention on Migratory Species (CMS) Secretariat, also on behalf of the ASCOBANS and ACCOBAMS Secretariats, for Environmental Impact Assessments for noise-generating offshore industries. These guidelines were endorsed through CMS Resolution 12.14 on Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species, and provide a pathway to implementing the Best Available Techniques (BAT) and Best Environmental Practice (BEP). Prideaux (2017) presents technical support information for the CMS guidelines, including information on assessment criteria and noise considerations for multiple groups of marine species.

Attention: SC

The sub-committee welcomed the international efforts addressing the effects of anthropogenic noise on cetaceans, and ***encouraged*** *expanded international coordination regarding assessment and protection of cetacean acoustic habitat quality.*

Van Opzeeland and Boebel (2018) reported a conceptual framework exploring the potential of soundscape planning in reducing (mutual) acoustic interference between hydroacoustic instrumentation and marine mammals is presented. This framework is based the idea of acoustic niches, namely the partitioning the acoustic environment on the basis of time, space, frequency and signal structure. This study explores how the principle of acoustic niches could be used to reduce potential acoustic interference by employing marine soundscape planning strategies (e.g. shifting the timing or position of hydroacoustic experiments, or adapting signal structure or frequency). The paper examines acoustic data from three recording locations in polar oceans, and illustrates the potential efficacy of smart planning for four different hydroacoustic instrumentation types: multibeam echo-sounders, air guns, RAFOS (Ranging and Fixing of Sound) and tomographic sound sources.

In discussion, it was noted that this approach may be useful not only to reduce the overlap in frequency range and timing between hydroacoustic activities and marine mammal acoustic activity, but also for the hydroacoustic community, to plan data collection activities at times when there are fewer interfering biological signals.

Attention: G

The sub-committee welcomed the information on using marine soundscape planning strategies to reduce interference between hydroacoustic instrumentation and marine mammals, and ***encouraged*** *work to further develop this approach.*

Attention: CG-A, SC

The sub-committee recognised the commonalities identified among the concurrent efforts of multiple international bodies to develop national guidance on noise strategies, and ***encouraged*** *continuing to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise. This work is ongoing.*

Attention: SC

The sub-committee welcomed and ***drew attention*** *to the Convention on Migratory Species Family Guidelines on Environmental Impact Assessments for Marine Noise-Generating Activities* (https://www.cms.int/en/guidelines/cms-family-guidelines-EIAs-marine-noise)*, noting that these guidelines will help improve global standards for environmental impact assessments.*

Cholewiak *et al*. (2018), presented a study utilising modelling approaches to evaluate relative levels of communication masking for four baleen whale species in the Stellwagen Bank National Marine Sanctuary, in Massachusetts Bay, U.S. An agent-based modelling framework was used to calculate changes in communication space in comparison to reference conditions (10 dB lower than current ambient noise). The model included current background ambient noise, as well as noise layers from three classes of vessels: large vessels carrying AIS transmitters; smaller, local fishing vessels, and whale-watching vessels. Acoustic data were collected using bottom-mounted recorders, source levels for animals and vessels were calculated empirically and sound propagation was modelled throughout the study area. Results from this study suggest that the area over which multiple species of baleen whales communicate is severely decreased by the presence of vessels. In general, this study provides a framework by which to comparatively quantify communication masking, allowing for important insights on the relative contributions of different anthropogenic sound sources.

In discussion, it was noted that there are multiple parallel efforts using agent-based modelling to evaluate the interactions between cetaceans and anthropogenic activities. The sub-committee also noted that this work demonstrates that noise is not being appropriately mitigated within the waters of marine protected areas, and expressed concern regarding the long-term health effects on cetaceans. The sub-committee also discussed strategies that have been initiated by certain ports, such as the Port of Vancouver, to encourage noise reduction of ships through reductions in port fees.

Attention: G

The sub-committee welcomed the work on modelling cetacean communication space, and ***encouraged*** *scientists engaged in the development of modelling techniques that address multiple anthropogenic impacts, such as noise and entanglement in fishing gear to bring these forward to the Scientific Committee.*

Attention: CG-R

The sub-committee ***recommended*** *that levels of anthropogenic noise and its effects on marine species be explicitly considered in the management of marine protected areas.*

Attention: S

The sub-committee ***recommended*** *that a pre-meeting on noise be organised for SC/68b and that an intersessional email group be convened to develop the agenda for that pre-meeting.*

6. STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER)

SC/67b/E01 presented the State of the Cetacean Environment Report (SOCER). This report is the result of several Commission resolutions, which directed the Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 requested the annual submission of this report to the Commission. SOCER has a cycle of focusing on the following regions: Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean and Mediterranean and Black Seas. Each SOCER also includes a Global section. The 2018 SOCER (Appendix 3) focuses on the Mediterranean and Black Seas, summarising key papers and articles published within the past two years. Next year will focus on the Atlantic Ocean. This year's regional SOCER represents the final year of the most recent cycle, which will be combined in a five-year compendium (2014: Atlantic Ocean through 2018: Mediterranean and Black Seas) to present to the Commissioners. SOCER will soon have its own dedicated page on the IWC website and the compendium will be sent as a circular to all Contracting Governments. Response from the Committee to this year's SOCER solicitation was excellent, and members of the Committee are directed to Appendix 3 for the complete summary of global information.

The UN's 'First Global Integrated Marine Assessment' reported the major threats in the Mediterranean to be habitat loss and degradation, followed by fishing, climate change, pollution, eutrophication and invasive species. The 'Ocean Health Index' showed the lowest score for Libya (44 out of 100) and the highest for Malta (79). Six of the nine Mediterranean countries evaluated lie below the global average (70). Climate change strongly affects the Mediterranean due to 'tropicalisation' (e.g., exponential increase in subtropical Red Sea species). The Mediterranean also had the fourth highest concentration of floating debris in the world. Values are comparable to those in the major subtropical gyres, but the proportion of large objects is even higher. In some areas, whale distribution overlaps highly with marine debris and ship traffic, including in the Pelagos Sanctuary. Seismic survey noise affects 27% of the surface of the Mediterranean. The EU Directive on Marine Strategy is seeking to mitigate noise ('noise budget'; future 'European Motorways of the Sea'). Conservation agreements are currently too weak to adequately address underwater noise, collisions with ships, bycatch in fishing gear and ingestion of plastic litter. Protected areas here are very unevenly distributed, reflecting uncoordinated conservation efforts. The Mediterranean remains a pollution hotspot (e.g. PCBs, heavy metals).

Alien species in the Black Sea are a major threat (e.g. ctenophores (comb jellies) led to the collapse of 26 commercial fish stocks and caused a major ecosystem shift), as are harmful algal blooms. Critical status has been recognised for 13 out of 37 benthic habitats, including coastal lagoons, estuaries and deltas. These developments, along with illegal fishing (gillnet entanglement), pose the greatest threats to the three cetacean species here (all listed as Endangered or Vulnerable). The most recent of several large-scale mortalities may have killed thousands of neonate and juvenile harbour porpoises. Vessel traffic in the Istanbul Strait, one of the busiest international waterways in the world, significantly affected dolphin behaviour. The pollutants in Black Sea waters, sediments and organisms have become a matter of great concern.

The sub-committee welcomed the information provided in the SOCER report and thanked the editors for the report and for providing tables with recently published contaminant concentration data for cetaceans that will be added to the contaminant mapping website. The sub-committee **encouraged** the continuation of compiling contaminant data tables in future SOCER reports. Next year SOCER will be focussing on the Atlantic and the editors welcome input from the community for that region.

7. UPDATE ON OTHER STANDING TOPICS AND PREVIOUS RECOMMENDATIONS

7.1 Marine debris [litter]

Papers SC/67b/E10 and SC/67b/E15 were originally drafted at the request of the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) and as part of a process that led its workshop on marine debris, which was held in April 2018 in La Spezia, Italy just a few weeks prior to this meeting.

SC/67b/E10 is a new review of the literature that relates to interactions between cetaceans and marine debris. One conclusion is that whilst there has been an increase in relevant information (published works show that almost 80% of cetacean species are known to be affected), a quantifiable assessment of effects, specifically on cetaceans, remains elusive. In terms of whether particular types of marine debris should be targeted to help mitigate the threat to cetaceans, there seems to be no clear signal in the current literature pointing towards a focused action beyond urgently trying to stop all forms of plastics entering the seas and oceans. However, the available information does suggest that some types of marine debris may be especially problematic. For example, items linked to fishing activities, such as portions of ropes, nets, lines, and hooks constitute a substantial portion of ingested debris. Similarly, there are a number or reported lethal cases, where plastic bags fully occluded gastrointestinal passages or filled up stomach cavities. Recent publications (e.g., Lusher *et al*., 2015; 2018) reconfirm the earlier suggestion that deep-diving offshore species ingest much plastic and may be especially vulnerable.

SC/67b/E15 considers what data might be usefully collected to better understand the interactions between cetaceans and marine debris. Recommendations include that: (a) Post-mortem examinations should be conducted using a classical differential diagnostic approach when possible and, when not, efforts to document the presence of marine debris, both ingested and entangled, should still be put into place; and (b) debris should be characterised by material, size, colour, shape, mass and volume and, where possible, identified to source. A standard list of litter items is provided.

SC/67b/E13 is the preliminary report for the joint ACCOBAMS/ASCOBANS/Specially Protected Areas Regional Activity Center (SPA-RAC) workshop on marine debris and cetacean stranding that was held in April 2018 in La Spezia, Italy. Cetaceans are known to be affected by marine litter through ingestion and entanglement in fishing nets. The phenomenon is well-known in the ACCOBAMS area, and information exists mainly from the monitoring of strandings in the Mediterranean and the Black Seas. Strengthening collaboration between global and regional intergovernmental organisations and non-governmental organisations interested in this issue was an objective of this workshop, in order to ensure better synergy and to optimise efforts. More than eighty attendees from 21 different countries participated in the workshop. The workshop provided the opportunity: (a) to further develop effective cooperation with the ongoing regional initiatives on marine debris, including ghost nets; (b) to assess the impact of plastic materials on cetaceans; and (c) to discuss requirements for the development of a common approach and joint guidelines.

SC/67b/E11 investigated the occurrence of microplastics in the food web of cetaceans to assess the risk of microplastic uptake in baleen whales. Common minke whale was chosen as an example because most data are available, and it has similar feeding behaviour to many other baleen whales. A two-step procedure was used. First, the common minke whale diet in different regions was evaluated; and second, available evidence of microplastic ingestion by these prey species was reviewed. The results suggest that minke whales feeding in different geographic areas are exposed to different risks of ingesting microplastics. Specifically, the highest levels of microplastic contamination were reported for Scombridae and Gadidae. Generally, prey species in coastal areas show higher levels of microplastic contamination than those in offshore areas, putting common minke whale feeding in these areas at higher risk of microplastic ingestion than those feeding in offshore areas. Research on microplastics ingestion by prey species belonging to many of the families are urgently needed; and collaborations with scientists having access to fisheries research vessels to investigate microplastics ingestion, especially in the Northern Pacific, are recommended.

The sub-committee discussed what information on impacts of microplastics in prey is available in the literature. The issues regarding contradictory results and the limitations of lab experiments (e.g., higher doses and shorter durations than in the field) were also discussed. The sub-committee noted that microplastics is an important emerging issue. It was also noted that standardisation of how the measurements are made and identifying the types of plastics present are both important. Assessing the absorption of POPs from plastics is also important. There is a movement to standardise protocols, including the size of microplastics analysed, but the cost of analysis increases as the size of the microplastics decrease. It was also discussed that microplastics might be more difficult to find in large whales, but that is why investigating microplastics in the prey is a good approach. Furthermore, the trophic level of the predators will influence whether microplastics are observed. Variability in microplastics across different geographic locations and variations in patterns due to climate c hange (e.g. Polar Regions) was also discussed. It was concluded that exposure to microplastics might be widespread, difficult to detect, and the impacts are also challenging to determine.

The sub-committee discussed the need to collect better information on this issue as well as identify the data that should be collected. The sub-committee also discussed that different organisations may categorise debris differently and it was the proposed that IWC could identify best practice protocols for categorisation. It was also suggested that it would be prudent to liaise with others that are working with sea turtles since marine debris is an issue with sea turtles. The sub-committee commented that these papers, along with discussions at the ACCOBAMS workshop, and the discussions of the intersessional marine debris correspondence group, indicated that the collection and sharing of information related to marine debris requires attention. This led to one of the focuses of the workshop proposal. The sub-committee thanked the authors for the information on plastics and microplastics.

Attention: C-A

The sub-committee ***drew attention*** *to the fact that marine debris remains a threat, and that in particular, exposure to plastics (including microplastics) is a rapidly emerging area of concern.*

Attention: S

The sub-committee ***recommended*** *the organisation of an intersessional workshop on Marine Debris, preferably to coincide with the World Conference on the Biology of Marine Mammals in Barcelona in December, 2019.*

7.2 Climate change

Climate change was highlighted at SC/67a as being an overarching issue that is important to various topics, and that where relevant its impact should be discussed in conjunction with that topic. Notwithstanding that, sub-committee may want to initiate a specific activity related to climate change in future. It was noted that 'State of the Cetacean Environment Report (SOCER) 2018' (Appendix 3), featuring the Mediterranean and Black Seas, identified climate change as a major threat. Climate change is a particular issue for enclosed seas, where organisms cannot migrate to higher latitudes. SOCER summarised results of several studies on climate change. For example, Bianchi *et al*. (2018) reported that the Mediterranean Sea may be doubly affected because it is increasingly being inhabited by (sub) tropical non-indigenous species ('tropicalisation'). Moreover, warm-water native species previously restricted to southern sectors are now establishing themselves in the colder northwest basin ('meridionalisation'). If the present seawater warming continues, the Mediterranean would undergo a generalised process of biotic homogenisation. Such major ecosystem changes will probably ultimately affect the entire food web, including top predators such as cetaceans. The authors point to the need for sustained monitoring in the region.

Attention: C-A, CG-A, SC

The sub-committee ***drew attention*** *to the fact that climate change remains a threat that interacts with other threats and stressors impacting cetacean populations.*

7.3 Cetacean diseases of concern

SC/67b/CMP13 reported on use of Unmanned Aerial Vehicle (UAV) health assessment techniques undertaken as a trial study during recent surveys for tagging of humpback whales off the coast of Oman. Studies were undertaken to address concerns of previously reported body condition (Willson *et al*., 2014), interaction with fisheries (Minton *et al*., 2011), and increasing prevalence of skin lesions considered to be related to poxviruses (Van Bressem *et al*., 2015). Research and monitoring of health assessment metrics have been recommended by the Convention for Migratory Species Concerted Action Plan for Arabian Sea humpback whales. Photogrammetry based body condition assessment of seven whales revealed that two fell into a lower margin for length width relationship. Lesion coverage ranged between 0.5% and 75% coverage of the dorsal surface of the animal, with the highest coverage on males. Respiratory condensate blow samples are still awaiting analysis at Woods Hole Oceanographic Institution. Based on success of the trial the team is making plans to include the work as a standard feature of surveys to build long term datasets of these health assessment metrics.

General health information for post-mortem examinations on 2017 landed bowhead whales was provided in SC/67b/AWMP08 highlighting results from several major retrospective screening survey studies and pathological findings. Key results included decreasing levels of organic pollutant in archived blubber and muscle samples, limited detection of anthropogenic radionuclides at low levels in bowhead muscle, and continued absence of major viral and bacterial pathogens that could impact bowhead health. In addition, marked interannual variation of *Giardia spp*. with presence of human host associated giardia assemblages was also observed, suggesting environmental marine contamination with human faeces. Highly variable presence of marine biotoxins in bowhead whale faeces was also found, suggesting complex environmental drivers of harmful algae blooms in the Arctic. Pathological findings observed in 2017 landed bowhead whales were consistent with previous years' findings with a low prevalence of fatty tumours and gastric nodules associated with *anisakis* infection. Kidney worm infection with associated kidney lesions were detected in 10/13 bowhead whales. Molecular characterisation of kidney worm specimens for species identification has been inconclusive and further efforts are underway to characterise the species. Arctic climate change (e.g., diminishing sea ice, increased sea surface temperature, prey shifts) may be setting the stage for an evolving host-parasite relationship in the Bering-Chukchi-Beaufort Sea bowhead whale stock.

The investigation of trichinellosis of 53 landed gray whales and 246 Pacific walruses off Chukotka (Russia) conducted in 2006, 2010 and 2017 by Kirov Agricultural Academy was reported in SC/67b/E02. The authors found that *trichinella* transmission in the coastal ecosystem off Chukotka can occur due to trophic-ecological factors, necrophagy and predation. The role of mechanical vectors in invasion is governed by numerous invertebrates and some vertebrates. The gray whale samples were negative to trichinellosis but the infestation of walruses was 1.45% in 2006. For the Native people of the Arctic, there is currently no alternative to marine mammal subsistence hunting. Taking into account that the threat of trichinellosis infection persists, periodical and critical studies of trichinellosis infestation in harvested whales, walruses, and seals in the Chukotka region will continue.

For the first time, baleen samples from a large number of gray whales (n=24) that were harvested for subsistence in Chukotka (Russia) were tested for glucocorticoid hormones and the findings are reported in SC/67b/E04. Samples were collected by Chukotka scientists for the 6-year study period and were analysed by Severtsov Institute of Ecology and

Evolution in Moscow in 2018. Sex hormones were also analysed but the results were not included in this report. Samples tested were collected primarily from young animals, the size of their baleens being highly positively correlated with the animals' size and age. Reliable sex differences in the cortisol concentration in different parts of the baleens were not observed. The trend of increasing of cortisol concentration in the proximal part of the baleen was found. Some correlations suggest that larger whales have a lower cortisol level, which can be an indicator of both lower stress and a lower metabolic rate in larger whales. Analysis of sex and stress hormones is a very efficient tool for characterising the internal features of animals, which depend on external factors. Hormone investigations of harvested whales, walruses and seals from Chukotka waters will continue, with logistical and financial support by the Governor of the region, Department of Agricultural and Industrial Development.

The sub-committee thanked all the presenters for the updates on diseases in cetaceans and **agreed** that the work on the Arabian Sea humpback whales using blow sampling and photogrammetry should continue and if possible be expanded to include analyses of the blow beyond the microbiome work. Standardisation efforts (such as those being pursued by the photo-ID sub-committee), for measuring body condition using UAVs for photogrammetry, and for collecting blow samples, should progress to ensure this useful tool can provide comparable data across studies, taking into account the differences between the various platforms available. Cross-validation with current methods for assessing body condition from visual health assessments are essential.

Paper SC/67b/E05, which reported progress on the development of liquid chromatography-tandem mass spectrometry (LC-MS/MS) methods to analyse steroid hormones in gray whales, was not presented due to schedule conflicts with the presenter.

Attention: S, SC

*The sub-committee **agreed** to hold a focussed session next year (SC/68a) on our understanding of the pathology and epidemiology of morbillivirus and Brucella and the potential for identifying and understanding cumulative effects of exposure to other immunosuppressive stressors in cetaceans.*

7.4 Progress on previous recommendations

7.4.1 Pollution

The SC/67a recommendations: to make the effect of contaminants on cetacean populations (SPOC) model available to the public; to review mercury in cetaceans; and to include new data into the contaminant mapping tool, have all been completed. Modifications to the SPOC model and estimating the half-life of persistent organic pollutants in cetacean populations following mitigation will be completed at SC/68a.

7.4.2 Cumulative effects

A workshop on understanding the cumulative effects of multiple stressors was held as a pre-meeting to SC/67b. A summary of the findings and recommendations are given in this report (see Item 3) and a separate workshop report will be published shortly.

7.4.3 Diseases of concern

The content on the Cetacean Diseases of Concern (CDoC) website will now be utilised and merged with the Strandings Initiative, in particular the Hot Topics and Laboratory List. The current content will be reviewed by the Strandings Initiative Expert Panel and additional topic experts (for example those working on harmful algal blooms) within the intersessional steering group and will be used in the training and background materials for the stranding responders.

The quarterly CdoC updates are still of interest to the sub-committee but a means of progressing this on a voluntary basis was not identified. Endeavours to find assistance for this work are ongoing.

7.4.4 Strandings

The strandings initiative has progressed as recommended at SC/67a and a full progress report can be found in Appendix 2. This work will continue with the new IWC Stranding Coordinator now in post.

7.4.5 Noise

In response to a previous recommendation, that the sub-committee receive the recently developed seismic survey guidelines by the New Zealand government as these would be a useful example for other countries, a link to the technical working group reports created during the NZ seismic guidelines review is now available (*http://www.doc.govt.nz/our-work/seismic-surveys-code-of-conduct/work-of-the-technical-working-groups/*).

These guidelines are provided for reference and were not discussed by the sub-committee. It should be noted that the technical working group was tasked with determining 'biologically relevant sound levels' but that this part should be considered to be a 'draft' as the group did not agree on final text and recommendations.

As recommended, the intersessional group presented a summary of the IWC recommendations on shipping noise for the IMO Marine Environment Protection Committee in 2018.

8. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

8.1 Work plan for 2019-20

The sub-committee **agreed** that the work plan summarised in Annex K, Appendix 4 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.

8.2 Budget requests for 2019-20

Table 1

Summary of the 2-year budget request for Environmental Concerns.

	2019 (£)	2020 (£)
Meetings/Workshop		
Marine Debris Workshop		20,000
Noise Pre-meeting		12,000
Modelling/Computing		
Research		
Strandings initiative	4,500	4,500
Database/Catalogues		
SOCER	3,000	3,000
Total request	**7,500**	**39,500**

8.3 Intersessional groups

For intersessional groups see Annex Y.

8.4 Work plan

Table 2
Work plan for Environmental Concerns.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Marine debris	Plan workshop (organiser: Simmonds)	Report on Workshop Plan	Hold workshop (organiser: Simmonds)	Workshop report
Strandings Initiative	Respond to emergency requests, carry out training, standardisation of protocols	Report on activities and progress	Respond to emergency requests, carry out training, standardisation of protocols	Report on activities and progress
Pollution 2020	Complete model update, contaminant map, estimation of PCB degradation rates, report on PCB mitigation measures	Report on completion of Pollution 2020 and PCB mitigation measures		
Diseases of Concern	Identify and invite IPs for morbillivirus and *Brucella* focus session	Hold focus session and report recommendations to sub-committee		
SOCER	Atlantic Ocean focus	SOCER report	Pacific Ocean focus	SOCER report
Noise	Identify the priority topics, Steering Committee, and IPs for workshop in 2020; identify topics for noise update in 2019	Report on Workshop Plan and noise updates	Plan workshop, compile relevant documents, conduct workshop (Organiser: Cholewiak)	Workshop report

9. ADOPTION OF REPORT

The report was adopted at 14:02hrs on 1 May 2018.

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Appendix 1

AGENDA

1. Introduction
    - 1.1 Introductory remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of Rapporteurs
    - 1.4 Adoption of agenda
    - 1.5 Review of available documents
2. Pollution
    - 2.1 Review on intersessional progress on the Pollution 2020 initiative
    - 2.2 Report on mercury in cetaceans
    - 2.3 Impact of heavy fuel oils on cetaceans
    - 2.4 Other pollution issues
3. Cumulative effects
4. Strandings and mortality events
    - 4.1 Update on the IWC strandings initiative
    - 4.2 New information on unusual mortality events
5. Noise
6. State of the Cetacean Environment Report – SOCER
7. Update on other standing topics and previous recommendations
    - 7.1 Marine debris
    - 7.2 Climate change
    - 7.3 Cetacean diseases of concern
    - 7.4 Progress on previous recommendations
        - 7.4.1. Pollution
        - 7.4.2. Cumulative effects
        - 7.4.3. Disease of concern
        - 7.4.4. Strandings
        - 7.4.5. Noise
8. Work plan and budget requests for 2019-20
    - 8.1 Work plan for 2019-20
    - 8.2 Budget requests for 2019-20

Appendix 2

SHORT REVIEW ON STRANDINGS INITIATIVE INTERSESSIONAL PROGRESS AND PLANS FOR 2019

The Commission had 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 Stranding Expert Strandings Panel (SEP) and Coordinator post at the IWC/66 Commission meeting. An Intersessional Steering Group (ISG) on Strandings was tasked with selecting the SEP, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate.

Nominations were solicited, taking into consideration the Terms of Reference recommended during SC/66b that the SEP 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. While under-representation was overcome during the SC/67a for Asia, this was not done for African nations (except South Africa). The ISG proposed a draft governance structure for the IWC Initiative on Strandings which included a Stranding Coordinator position description. At SC/67a, the Standing Working Group (SWG) on Environmental Concerns presented a list of recommendations included in Annex K of the Scientific Committee report. Presented here, are progress updates on these points.

An ISG comprising of members of Scientific Committee, Conservation Committee, and Whale Killing Methods and Welfare Issues Working Group was established with Dr. Claire Simeone and Dr. Sandro Mazzariol as co-convenors. The Chair of the Conservation Committee and the Chair of the Whale Killing Methods and Welfare Issues Working Group were invited to join the ISG. Furthermore, the ISG finalised the including two representatives for Asia from the list of nominees, although unfortunately as yet, no representation for Africa outside South Africa. In time for the next meeting, the ISG will be substituted by a Steering Committee. This committee would guide and assist the work of the SEP and coordinate work on strandings amongst the SEP, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and Commission. This work will include the: (a) development of an initial budget and review of subsequent budgets proposed by the SEP for recommendation to the Commission; (b) appointment of Panel Members (with advice from the Chair and Co-ordinator) to ensure appropriate turnover of membership and continuity; and (c) provision of conduit for communication amongst the SEP, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and Commission.

Membership of the Steering Committee will include representatives nominated by the Scientific Committee and the Whale Killing Methods and Welfare Issues Working Group. The Scientific Committee chair (or his/her appointee) and the Whale Killing Methods and Welfare Issues Working Group Chair (or his/her appointee) and the Chair of the Conservation Committee (or his/her appointee) will be permanent members. The Secretariat, Stranding Coordinator and Chair of the SEP will be *ex officio* members. The Steering Committee will be asked to select a Chair. The final SEP composed experts with different skills and expertise related to strandings and includes Claire Simeone (USA), Sandro Mazzariol (Italy), Milton Marcondes (Brazil), Ursula Siebert (Germany), Rob Deaville (UK), Lindsay Porter (Malaysia/China), Nantarika Chansue (Thailand), Aviad Sheinin (Israel), Daren Grover (New Zealand), Katie Moore (USA), Frances Gulland (USA), Raphaela Stimmelmayr (USA), Doug Coughran (Australia), Gabriela Hernandez (Costa Rica), Marcy Uhart (Argentina), Michael Meyer (South Africa).

The selection was made by the Steering Committee on the basis of the following criteria, revisited and confirmed also by the SEP: (a) regional experts in stranding response; (b) experts from diverse agencies and organisations (e.g. governmental, NGO, academia); multi-disciplinary experts; and (d) Stranding Coordinator. Panel membership terms have been proposed to be flexible, with an annual review of membership. This shall be decided by the Chair and the Steering Committee based upon availability of members, expertise, performance and if necessary, lottery. Unfortunately, in March 2018 one of the panelist from Oceania, Doug Coughran, passed away. Discussion about an additional representation for Oceania (specifically Australia) has been raised by Daren Grover (New Zealand). The SEP met virtually in July 2017, electing a Chair (Dr. Sandro Mazzariol – Italy), who will serve for the next 3 years, revising the ToR and agreeing on the establishment of two sub-committees on training and emergency response in order to best facilitate the necessary work. Here below we report the revised terms of Reference and *modus operandi* for the SEP:

(1) Identify and, as appropriate, develop: (a) advice documents for Principles and Guidelines on stranding response, including how to respond effectively; (b) advice documents for Principles and Guidelines on sampling, including how to conduct scientific investigations to meet the needs of the Committee; and (c) advice on how to communicate stranding science and management decisions.
(2) Assist member states and regional or national networks to build strandings response capacity, in general and specifically, through: (d) the development of curricula for training (live and dead strandings response and scientific investigation) and a plan for the delivery of training events; (e) a strategy for handling requests received by the Secretariat, including assistance in coordination of emergency response; (f) a strategy for the development of information through a variety of avenues including consideration of a centralised data repository and the reporting of unusual cetacean events; (g) opportunities for communication and collaboration.
(3) Provide an annual report on activities to the Steering Committee on Strandings, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and the Commission. This will include: (a) incidents of unusual cetacean events and responses to these; and (b) an estimated budget for each biennium for review by the Steering Committee before submission to the Commission. These Terms of Reference may be reviewed by the SEP and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

The ISG and the EP finalised a job description and person specification to recruit the Strandings Coordinator to the IWC secretariat. The recruitment was finalised in February 2018, with the appointment of Karen Stockin (New Zealand) for a one year 0.5 FTE position. The Coordinator is a member of and provide support to the SEP. This support will include: contacting the ESP for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the SEP members; and development of an annual report for submission to the Steering Group on Strandings, Scientific Committee, Working Group on Whale Killing Methods and Welfare Issues and Commission. These reports shall also be made available on the IWC website. The Coordinator shall be also responsible for arranging all support services to the SEP, and for contacting the SP for guidance concerning any event which might be occurring. The Coordinator shall provide quarterly reports of activities to the SEP members, and an annual report to both the Scientific Committee and Commission. The Chair and the Coordinator shall organise at least one SEP meeting every biennium, possibly in- person or in a mixed form. When possible, in-person meetings will be planned in conjunction with other workshops or conferences. Virtual meetings will be also organised every other year. The SEP may establish Committees of members, or their representatives, on an *ad hoc* or standing basis as it deems necessary. Such Committees shall report to the SEP. The Coordinator shall support any such committee. In this regards, in July 2017, the SEP decided to establish 2 different sub-committees related to training and emergency response. These working groups discussed protocols and best-practice and a prioritisation system in order to efficiently use limited funding. Concerning this relevant issue, both subcommittees agreed upon a semi-flexible system to guide discussion. Both subcommittees prioritise IWC SEP support to the locations (Africa, Middle East and Asia, Central and South America) without an already established stranding network with existing expertise and facilities involved. Specific criteria are here below reported: (a) for onsite training, regions where emergencies has been already occurred are welcome, in particular those involving threatened species. Here, the involvement of Governmental bodies and presence of co-funding are both encouraged and appreciated. (b) for onsite emergency response and intervention, the (sub)committee would like to prioritise those events representing most concern to species conservation and/or compromised animal welfare (i.e. threatened species, diseases of concern, mass strandings, unusual stranding events and oil spills; live stranding for which significant welfare concerns exist). The degree of financial support will be evaluated against these criteria. Since July 2017, the SEP received requests of support for training and emergency response support, with each application evaluated on a case by case scenario, with the IWC Secretariat. Specifically, the SEP was invited to support a joint training activity organised in autumn 2018 in Chile and Peru. A successful project proposal was submitted to the Welfare Intersessional Steering Group for financial support from welfare voluntary funds (£10,000). Funding has also been provided by the host governments and further funding requests was additionally submitted to the Conservation Management Plan (CMP) fund.

Regarding emergencies, the SEP was contacted for technical advice on emergencies involving large cetacea (Russia) or mass stranded animals (Yemen – Socotra). In addition, for this activity the SEP has recently supported a request for funding from Argentina (£5,000) to support postmortem analyses relating to the recent mass stranding of common dolphins that occurred March/April 2018. Future efforts are required to finalise the selection processes necessary to efficiently respond to training and emergency response requests, as well as identify how best to optimise available funds. As emergencies and training activities are expensive, a specific fundraising stategy should be prioritised and implemented in order to respond most effectively to unusual mortality events. The SEP should also work to increase its visibility and profile since many stranding events were not directly reported. Finally, the Strandings Coordinator in conjunction with the SEP and the ISG, should work to collaborate with CITES regarding procedures for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations.

Report of the First IWC Expert Panel on Strandings (Virtual Meeting)

5 July 2017, 13:00-16:00 GMT

Members present: Simeone (co-Convenor), Mazzariol (co-Convenor), Chansue, Coughran, Deaville, Grover, Gulland, Hernandez, Marcondes, Moore, Porter, Scheinin, Siebert, Stimmelmayr, Uhart. *Ex officio* members present: Fortuna, Greig, Matilla, Rendell, Rowles, Smith.
Not in attendance: Meyer, Hall, Donovan

I. Welcome, introductions Mazzariol and Simeone welcomed the Expert Panelists to the meeting.

A. Appointment of Co-Chairs and Rapporteurs: Mazzariol and Simeone were appointed Co- Chairs of the meeting. Greig was appointed Rapporteur.
B. Review and adopt agenda: the agenda was adopted without changes.

II. Background

Simeone reviewed the historical context of the Strandings Initiative, including Annex K of SC/67a. As the Commission will not meet until 2018 to approve the Strandings Initiative structure, an interim structure has been implemented by the Intersessional Steering Group (ISG). The Expert Panel (EP) noted that if the goal is to develop worldwide protocols for live and dead stranding response, regional concerns and standards would need to be recognised and incorporated (e.g. European rules on welfare and hygiene). The EP stressed that best practices should be recommendations and guidance advice from the specialised group rather than governance documents.

III. Governance structure

Simeone reviewed the draft governance structure (Adjunct A). Based on previous discussions, the EP recommended changing the word ‘protocols’ to ‘advice documents’ for best practices on stranding response. The current Terms of Reference (TOR) includes only ‘live strandings response’ (Section 2.d) and the EP suggested that a provision also be made for dead strandings in the TOR. It was noted that ‘establishing stranding networks’ worldwide is beyond the scope and capacity of the IWC, but that developing best practices for countries to reference and utilise is an attainable goal. The EP also recommended replacing ‘Unusual Mortality Events’ with ‘Unusual Cetacean Events’ for clarity, and renaming ‘Best Practices’ to ‘Principles and Guidelines’ to allow for flexibility across regions. The EP tasked the Committee with developing a flow chart to describe specific tasks that will to guide the work of the initiative, taking care not to be too restrictive. The EP noted the importance of standardised reporting, and collation of cases into a database to promote information sharing and learning. The EP will collaborate with the IWC Working Group on Global Databases and Repositories on this work. The EP recommended that notes on the TOR will be circulated among the EP, and a final vote will take place anonymously online to finalise the TOR. The vote was conducted by 24 July 2017.

III.a Discussion on term lengths and rotation of panelists

As currently proposed, Panelists would serve 2-4 year terms. The EP noted that in certain regions there may be challenges in securing regional representation, and that memberships should not be restricted to two years. Several members felt that two years was too short of a term, particularly as the initiative is beginning. It was noted that for the SC, only the Chair and Vice-Chair have fixed terms. Several options were recommended, including: Chair: (a) Fixed term limit, 2 years; (b) Fixed term limit, 3 years; (c) Fixed term limit, 4 years Members: (a) Fixed term limit, 4 years; (b) Minimum term limit, 2 years, with no upper term limit; (c) Review of membership every 2 years, with flexible terms at the Chair’s discretion; (d) No set terms, with annual review. The EP recommended voting on these options to finalise Chair and Member terms. Voting took place by 25 July 2017.

III.b. Discussion on frequency of meetings

Simeone reviewed the current recommendations of the ISG that include meeting every biennium. During SC/67a, the ISG determined that the funds currently allocated towards an in-person meeting may be better utilised for an emergency response fund. Several panelists noted the importance of face-to-face discussion and proposed alternating between virtual and in-person meetings. The EP noted that global/regional conferences or workshops for other societies/groups may provide opportunities to have ad hoc in-person meetings. Several options were suggested, including:

(a) One in-person meeting every biennium (every 2 years);
(b) One in-person meeting every biennium, with virtual meetings every other year;
(c) One initial in-person meeting to start, followed by virtual meetings; and
(d) In-person meetings for smaller Committees, virtual meetings for larger EP group.

The EP recommended voting on these options to finalise meeting frequency. The EP also suggested surveying EP members attending the upcoming Society for Marine Mammalogy biennial conference in October as a potential meeting time. Voting was conducted by 25 July 2017.

III.c. Solicit nominations for Expert Panel Chair
The EP recommended requesting anonymous nominations and voting for the EP Chair. Voting was conducted by 25 July 2017.

IV. Strandings Initiative Work – Emergency Response
Simeone reviewed the proposed funding for emergency response. The EP determined that many aspects of emergency response are in need of definition and clarification, including:

(a) definition of 'emergency';
(b) development of criteria for evaluating requests;
(c) development of a flow chart/decision tree for coordination of requests and emergency response: (i) flow chart for evaluating the event; and (ii) flow chart for determining the level of response needed;
(d) requirements for requests for assistance – governments vs. NGOs;
(e) criteria for support – response *vs* investigation;
(f) criteria and protocols for virtual advice requests to the EP;
(g) reporting/database recommendations to centralise reporting of stranding events, and list of species-specific expertise (regional); and
(h) finalisation of budget for an emergency response.

The EP recommended that a Committee on Emergency Response be formed to work on these topics. Committee on Emergency Response: Chansue, Coughran, Grover, Hernandez, Marcondes, Matilla, Meyer, Moore, Porter, Scheinin, Siebert. Coordinated by Mazzariol/Simeone.

V. Strandings Initiative work – in-country trainings
Simeone reviewed the proposed funding for in-country trainings. Moore summarised the Global Marine Animal Stranding Training toolkit (GMAST), a project that has developed basic-level training materials for global stranding response (*http://gsinteractive.net/GMAST/*). The SC has previously recommended collaboration with this project for the development of more advanced training materials. The GMAST training materials have been used in Belize, Russia, and will be used at an upcoming training in Oman. It was noted that a variety of materials exist, and that the EP should decide which avenues are most appropriate to pursue. The EP determined that many aspects of trainings are in need of definition and clarification, including:

(a) development of criteria for evaluating requests for training;
(b) identification of existing training materials;
(c) development of structure for regional training (i.e. curricula, follow-up, contact lists); and
(d) evaluation of potential requests (Chile/Peru).

The EP recommended that a Committee on Trainings be formed to work on these topics. Committee on Trainings: Deaville, Grover, Gulland, Hernandez, Matilla, Moore, Scheinin, Siebert, Stimmelmayr, Uhart. Coordinated by Mazzariol/Simeone.

VI. Budget
Smith reviewed the current allocation of funds for the strandings initiative. The initiative fund totals £25,000, with a potential for allocating additional existing funds from the Whale Killing Methods and Welfare Initiative (WKM&WI). Determining the level of funding requested as early as possible will be helpful for this process. The EP recognised that a finalised 2-years budget is a priority, which will be submitted to the ISG for review. In addition, the ISG could request science funds through the Environmental Concerns Sub-Committee. Longer term, the ISG should consider external fundraising sources, including governments, non-governmental organisations, trusts, and grant-giving bodies. The IWC finance and administration committee is investigating the financing of conservation initiatives in general and the Secretariat can help identify additional funding sources. The entanglement initiative has had success with a variety of small funding sources. The EP recommended that both the Training and Emergency Response Committees prioritise actions and timelines in order to facilitate the fundraising process, and work to develop a realistic budget for their work as soon as possible. The ultimate development and approval of the budget for the Strandings Initiative lies with the ISG, and the Committees will submit their budgets to the ISG.

VII. Next steps
The EP recommended the following steps for continued work.

(a) Reporting: notes from this meeting will be circulated for review by the EP, and a final report will be submitted to the ISG.
(b) Voting: a virtual platform will be used to allow EP members an anonymous vote on issues raised. A simple majority will be used to resolve issues, unless otherwise specified by the EP.
(c) Budget: the EP recommended that a 2-year budget be submitted to the ISG for review as soon as possible, within 1-2 months. The ISG will submit a final budget to the Secretariat.
(d) Next Meeting: The SMM biennial meeting will be investigated as a potential for an in-person meeting of the EP. Committees will begin their work virtually as soon as possible.
(e) Strandings Coordinator position posting: Mazzariol discussed that this item would be discussed off-line, and a Committee formed to finalise the posting and submit to the ISG and Secretariat.

Adjunct A. Draft Governance Structure of the IWC Strandings Initiative

Updated 25 July 2017

1. Introduction
At IWC/66 in October 2016 the Commission considered and endorsed recommendations on strandings developed at Scientific Committee annual meetings (SC/66a and SC/66b) and from the Whale Killing Methods and Welfare Issues Working Group. These had taken into account recommendations from two recent IWC workshops on strandings response: (1) The Investigations of Large Mortality Events, Mass Strandings and International Stranding Response Workshop, San Francisco, December 2015, focused on response and investigations of cetacean strandings, with a focus on unusual or large scale mortality events; and (2) The Workshop to Develop Practical Guidance for the Handling of Cetacean Stranding Events, Kruger National Park, May 2016, focused on building global capacity for effective cetacean stranding response, in particular highlighting relevant actions in the Commission's Welfare Action plan. In particular, the Commission endorsed a recommendation to establish a Strandings Coordinator post, and an Expert Panel on strandings to provide guidance on strandings response and investigations. This document

provides proposals on Governance of the Strandings Initiative, including proposed Terms of Reference for the Expert Panel and Steering Group arrangements. These take into account the interest of several Commission subcommittees in this topic, including both the Scientific Committee and the Whale Killing Methods and Welfare Issues Working Group.

2. Terms of Reference and *modus operandi* for the Expert Panel on Strandings

The Expert Panel will undertake the key activities given below.

(1) Identify and, as appropriate, develop:
  (a) advice documents for Principles and Guidelines on stranding response, including how to respond effectively;
  (b) advice documents for Principles and Guidelines on sampling, including how to conduct scientific investigations to meet the needs of the Committee; and
  (c) advice on how to communicate stranding science and management decisions.

(2) Assist member states (and regional or national networks) to build strandings response capacity, in general and specifically, through:
  (a) the development of curricula for training (live and dead strandings response and scientific investigation) and a plan for the delivery of training events;
  (b) a strategy for handling requests received by the Secretariat, including assistance in coordination of emergency response [*support services for the activities of the Expert Panel are outlined in a separate budget document*];
  (c) a strategy for the development of information through a variety of avenues including consideration of a centralised data repository and the reporting of unusual cetacean events; and
  (d) Opportunities for communication and collaboration.

(3) Provide an annual report on activities to the Steering Committee on Strandings, Scientific Committee.

Whale Killing Methods and Welfare Issues Working Group and the Commission. This will include: (a) incidents of unusual cetacean events and responses to these; and (b) an estimated budget for each biennium for review by the Steering Committee before submission to the Commission.

These Terms of Reference may be reviewed by the Expert Panel and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

2.1 Membership

The Expert Panel should include the following representation and areas of expertise:

(a) regional experts in stranding response, including those leading the work on the Global Marine Animal Stranding Toolkit (GMAST);
(b) experts from diverse agencies and organisations (e.g. governmental, NGO, academia);
(c) multi-disciplinary experts (e.g. logistics, biology, medicine, pathology, epidemiology, toxicology, database management, stranding management); and
(d) International Stranding Response Coordinator.

The Expert Panel shall select a Chair to serve a three-year term of office.

The Co-ordinator shall be a member of and provide support to the Expert Panel. This support will include: contacting the Expert Panel for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the Expert Panel members; and development of an annual report for submission to the Steering Group on Strandings, Scientific Committee, Working Group on Whale Killing Methods and Welfare Issues and Commission. These reports shall also be made available on the IWC website. The initial membership of the Panel will be decided by the Steering Committee. Panel membership terms will be flexible, with an annual review of membership. This shall be decided by the Chair and the Steering Committee based upon availability of members, expertise, performance and if necessary, lottery.

Should a vacancy arise mid-term, the Chair will recommend a replacement to the Steering Committee who shall decide. If the Chair feels that a member of the Panel is not contributing to the work as expected over a two-year period, he/she may recommend to the Steering Committee that the person is removed from the Panel. The Steering Committee shall decide.

2.2 Modus operandi

The Chair in co-operation with the Co-ordinator shall organise at least one Expert Panel meeting every biennium, with virtual meetings every other year. When possible, in-person meetings will be planned in conjunction with other workshops or conferences. The report of the meeting shall be prepared by the Coordinator and the agreed report will be distributed to the Expert Panel, Steering Committee, Scientific Committee and Commission, as well as placed on the IWC website. The website will also host all associated papers and reports.

Work in between meetings will be undertaken electronically. The Co-ordinator shall be responsible for arranging all support services to the Expert Panel, and for contacting the Expert Panel for guidance concerning any event which might be occurring. The Coordinator shall provide quarterly reports of activities to the Expert Panel members, and an annual report to both the Scientific Committee and Commission.

The Expert Panel may establish Committees of Expert Panel members, or their representatives, on an *ad hoc* or standing basis as it deems necessary. Such Committees shall report to the Expert Panel. The Coordinator shall support any such committee.

Appendix 3

STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2018

Editors: M. Stachowitsch*, N.A. Rose¥ and E.C.M. Parsons+

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 and 1998-5, directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 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 presented in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean and Mediterranean and Black Seas. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2018 SOCER features the **Mediterranean and Black Seas,** summarising key papers and articles published from ca. 2016 through 2018 to date. This year's regional SOCER represents the final year of the most recent cycle, which will be combined in a 5-year compendium (2014: Atlantic Ocean through 2018: Mediterranean and Black Seas) to present to the Commissioners at IWC/67 in Florianopolis, Brazil.

MEDITERRANEAN AND BLACK SEAS

General

THE EUROPEAN MARINE STRATEGY FRAMEWORK DIRECTIVE AND CETACEAN CONSERVATION

The European Marine Strategy Framework Directive seeks to implement a precautionary and holistic ecosystem-based approach for managing European marine waters. A questionnaire survey was distributed to nations bordering the Mediterranean and Black Seas to investigate implementation of the Framework, specifically with respect to cetaceans. Those reporting (50% return rate) noted that their national implementation of the Framework did refer to cetaceans, but the specifics of these various implementations were heterogeneous. This unevenness in implementation may hinder transboundary collaboration and, therefore, cetacean conservation. ACCOBAMS could help stimulate collaboration amongst scientists involved in cetacean monitoring and develop transboundary conservation initiatives. The authors note that 'Transboundary conservation is most cost-efficient when there is true coordination between countries', which is currently lacking. The authors also suggest that 'Marine mammal experts should promote to their respective governments the monitoring of cetaceans at regional, rather than national scales'.

(SOURCE: Authier, M., Descroix Commanducci, M.F., Genov, T., Holcer, D., Ridoux, V., Salivas, M., Santos, M.B., and Spitz, J. 2017. Cetacean conservation in the Mediterranean and Black Seas: Fostering transboundary collaboration through the European Marine Strategy Framework Directive. *Mar. Pol.* 82: 98-103).

NEW CONSERVATION ACTION PLAN FOR CETACEANS IN ISRAELI WATERS

Israel has 180 km of coast on the Mediterranean Sea and has legal influence over 26,000 km^2 of ocean surface area, with 12 species of cetaceans recorded from this area. An Action Plan for 2017-2022 seeks to 'ensure that marine mammal populations in the waters of Israel enjoy a 'favourable conservation status'… arising from a combination of legislative, management, research, education and awareness initiatives'. The plan notes bycatch, underwater noise and prey depletion as the highest priority threats to Israeli cetaceans. Chemical pollution, climate change and habitat degradation are possible major threats, and marine debris, directed takes, ship strikes, oil pollution and disturbance are possible minor threats. The plan outlines numerous legislative, institutional and research initiatives, as well as proposals for local capacity building, cetacean conservation and public outreach.

(SOURCE: Bearzi G. 2017. *Action Plan for Marine Mammals in Israel*, 2017-2022. Israel Marine Mammal Research & Assistance Center (IMMRAC), Michmoret, Israel).

THE RECENT DECLINE OF THE BLACK SEA HARBOUR PORPOISE – A HISTORICAL CONTEXT

An analysis of archaeological specimens of cetaceans from the Black Sea (from 800 to 1600 years ago) suggests that cetaceans were subjected to fisheries bycatch, as well as directed hunting, in the past. Therefore, there has been a long history of anthropogenic takes of cetaceans in the Black Sea, from the late Classical through the medieval era. Genetic analyses of harbour porpoise specimens suggest that, despite these removals, there was an expansion of porpoise numbers in the Black Sea, followed by a dramatic decline over the past century. This decline illustrates that recent anthropogenic removals of porpoises greatly exceed the historical impact of fisheries bycatch and directed takes.

(SOURCE: Biard, V., Gol'din, P., Gladilina, E., Vishnyakova, K., McGrath, K., Vieira, F.G., Wales N., Fontaine, M. C., Speller, C., and Olsen, M.T. 2017. Genomic and proteomic identification of Late Holocene remains: Setting baselines for Black Sea odontocetes. *J. Archaeol. Sci.: Rep.* 15: 262-71).

A DISTINCT HARBOUR PORPOISE POPULATION IN THE AZOV SEA

The Azov Sea is a small enclosed body of water (37,000 km^2) that connects to the Black Sea via the narrow Kerch Strait. The sea is seasonally occupied by harbour porpoises. Analyses of porpoise skulls showed that the Azov and Black Sea porpoises are distinct from North Atlantic skulls, i.e., supporting their status as part of the subspecies *Phocoena phocoena relicta*. However, the skulls of Azov Sea porpoises were distinct from Black Sea porpoises, suggesting that the Azov Sea porpoise is a genetically distinct population, which would warrant special conservation consideration.

(SOURCES: Gol'din, P. and Vishnyakova, K. 2016. Habitat shapes skull profile of small cetaceans: Evidence from geographical variation in Black Sea harbour porpoises (*Phocoena phocoena relicta*). *Zoomorphology* 135(3): 387-93; Gol'din, P.E. and Vishnyakova, K.A. 2015. Differences in skull size of harbour porpoises, *Phocoena phocoena* (Cetacea), in the Sea of Azov and the Black Sea: Evidence for different morphotypes and populations. *Vestn. Zool.* 49(2): 171-80).

FIRST GLOBAL INTEGRATED MARINE ASSESSMENT: MEDITERRANEAN SEA

A major UN overview of the world's oceans noted that the Mediterranean Sea is a marine biodiversity hotspot (ca. 17,000 species). This includes nine species of marine mammals (five of the family Delphinidae and one each of Ziphiidae, Physeteridae, Balaenopteridae and Phocidae). Its habitats and ecosystem types are also diverse. At present, habitat loss and degradation, followed by fishing, climate change, pollution, eutrophication and the establishment of invasive species are the major threats to most of the taxonomic groups and habitats. These threats are all expected to increase in the future, especially climate change and habitat degradation.

(SOURCE: Inniss, L. and Simcock, A. (Joint coordinators); Rice, J. (Lead member of 14 contributors). 2016. The first global integrated marine assessment: World ocean assessment I. *United Nations, Chapter 36A:* p. 18-20, *http://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_36A.pdf*).

SURVEY GAPS FOR CETACEANS IN THE EASTERN AND SOUTHERN MEDITERRANEAN

An analysis of cetacean surveys found there were serious gaps in survey coverage in the eastern and southern Mediterranean Sea. This means that there is a gap in our understanding of cetacean distribution, abundance and environmental factors in these regions of the Mediterranean.

(SOURCE: Mannocci, L., Roberts, J.J., Halpin, P.N., Authier, M., Boisseau, O., Bradai, M.N., Cañadas, A., Chicote, C., David, L., Di-Méglio, N., Fortuna, C.M., Frantzis, A., Gazo, M., Genov, T., Hammond, P.S., Holcer, D., Kaschner, K., Kerem, D., Lauriano, G., Lewis, T., Notarbartolo di Sciara, G., Panigada, S., Raga, J.A., Scheinin, A., Ridoux, V., Vella, A., and Vella, J. 2018. Assessing cetacean surveys throughout the Mediterranean Sea: A gap analysis in environmental space. *Sci. Rep.-UK* 8: 3126, 1-14, [DOI:10.1038/s41598-018-19842-9]).

MARINE ISSUES IN THE MEDITERRANEAN SEA

This book on Mediterranean marine mammals is a valuable contribution to conservation efforts, presenting the latest information on cetaceans and their habits, as well as attempting to bridge the gap between scientific insights and policy. The Mediterranean Sea is a hotspot of marine and coastal diversity. Although no cetacean species is endemic here, unique populations have formed, requiring special conservation consideration. Of the 12 common marine mammal species, six are considered Mediterranean 'subpopulations' and are listed as Threatened on the IUCN's Red List. Many decision-makers are apparently unaware of 'how serious the predicament is for these species and their fragile habitat'. The first chapter outlines the Mediterranean regions and the overall status and threats of their marine mammals. The remaining chapters are devoted to key species such as sperm, fin and Cuvier's beaked whale, killer whales, long-finned pilot whales, and Risso's, rough-toothed and bottlenose dolphins, as well as to selected regions. The overall threats are identified as naval sonar, seismic exploration, whale watching disturbance, ship strikes, epizootics, fisheries, pollution, coastal development and climate change. The final chapter discusses international legal conservation frameworks, regional agreements (e.g., ACCOBAMS) and specific treaties (e.g., Pelagos Sanctuary). The authors conclude by underlining that 'what is probably lacking are specific provisions having a legally binding nature that directly address a number of threats affecting Mediterranean marine mammals, such as underwater noise, collisions with ships, bycatch in fishing gear and ingestion of plastic litter'.

(SOURCE: Notarbartolo di Sciara, G., Podestà, M., and Curry, B.E. (eds). 2016. *Advances in Marine Biology Vol. 75: Mediterranean Marine Mammal Ecology and Conservation.* Elsevier, London. 428pp.).

OCEAN HEALTH INDEX AND THE MEDITERRANEAN SEA

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, economical and societal categories or 'goals', each of which is measured and scored based on four dimensions (status, trend, pressures and resilience). By country, the values diverge considerably around the Mediterranean, from a low ranking for Libya (ranking 220 out of 220, index score 44 out of 100) to a high for Malta (rank 19, score 79). For comparison, the overall health of the oceans globally is 70 out of 100 points. Six of the nine Mediterranean countries evaluated lie below this global average (although some only marginally so).

(SOURCE: *http://www.oceanhealthindex.org*).

MARINE PROTECTED AREAS IN THE MEDITERRANEAN SEA

CBD Aichi Target 11 seeks to protect at least 10% of important marine and coastal habitats, with MPAs being the main global strategy for the conservation of marine biodiversity. The Mediterranean Sea contains variously designated protected areas: Natura 2000 sites, national sites, Ramsar sites, Specially Protected Areas of Mediterranean Importance, the Pelagos Sanctuary and Biosphere Reserves. Mediterranean MPAs are very unevenly distributed, with 80% concentrated in just three countries in the northwest part of the basin. This geographic distribution can be improved, although size, spacing and shape of existing MPAs are favourable: one third, for example, are bigger than the average ecological threshold of 20 km^2. However, these reasonably good MPA designs are apparently 'accidental', i.e., the result of largely independent national and regional nature conservation processes. Efforts to consolidate an ecologically coherent network of Mediterranean MPAs are clearly required.

(SOURCE: Rodríguez-Rodríguez, D., Rodríguez, J., Blanco, J.M., and Malak, D.A. 2016. Marine protected area design patterns in the Mediterranean Sea: Implications for conservation. *Mar. Pollut. Bull*. 110:335-42, *https://doi.org/10.1016/j.marpolbul.2016.06.044*).

Habitat degradation

General

CETACEAN ABUNDANCE AND ECOSYSTEM TRENDS IN THE NORTHWEST MEDITERRANEAN

Trends in cetacean abundance were investigated via sighting data from ship-board surveys (1990-2014) covering an area of approximately 29,000 km^2 in the northwest Mediterranean, and via strandings data collected from the Ligurian coast (1986-2014). The analysis revealed a significant annual increasing trend in sightings of striped dolphins and sperm whales but a significant decrease in encounters with fin whales and Risso's dolphins. No trends were found for Cuvier's beaked whales. Striped and Risso's dolphin strandings decreased over time, but fin whale strandings increased. The decrease in striped dolphin strandings was influenced by a spike in mortality from a morbillivirus outbreak early in the period. Examining strandings both spatially and temporally, fin whales and striped dolphins appeared to be shifting northwards into more coastal waters, while Risso's dolphins shifted into more oceanic waters. No trends were found for sperm or Cuvier's beaked whales. Risso's dolphin and sperm whale encounter rates appeared to be associated with sea surface temperature and surface water chlorophyll levels. Striped dolphin and fin whale encounter rates were correlated, respectively, to the number of fishing boats (negatively) and number of ferries (positively), the former suggesting a conflict between cetaceans and fishing vessels. Moreover, sperm whale group size was inversely correlated to the number of boats. The relative abundance of striped and Risso's dolphins and sperm and fin whales might be correlated with the concurrent decreasing productivity in the region (as measured by decreasing chlorophyll and fishery productivity).

(SOURCE: Azzellino, A., Airoldi, S., Lanfredi, C., Podestà, M. and Zanardelli, M. 2017. Cetacean response to environmental and anthropogenic drivers of change: Results of a 25-year distribution study in the northwestern Mediterranean Sea. *Deep Sea Res. Pt. II: Topic. Stud. Oceanogr.* 141: 104-117)

NARROW ECOLOGICAL NICHE OF MEDITERRANEAN FIN WHALES MAKES THEM VULNERABLE TO ANTHROPOGENIC CHANGE

An isotopic analysis was conducted to investigate the diet and ecological niche of fin whales in the Mediterranean Sea and North Atlantic. The analysis showed that Mediterranean fin whales, which are known to feed mainly on krill, had a much narrower dietary niche than the Atlantic whales, which have a more diverse diet. The authors suggest that a narrow ecological niche makes Mediterranean fin whales 'more susceptible to ecosystem fragmentation and other anthropogenic impacts'.

(SOURCE: Das, K., Holleville, O., Ryan, C., Berrow, S., Gilles, A., Ody, D. and Michel, L.N. 2017. Isotopic niches of fin whales from the Mediterranean Sea and the Celtic Sea (North Atlantic). *Mar. Environ. Res.* 127: 75-83).

Fisheries interactions

SICILIAN FISHING CAPACITY DECREASE IS CORRELATED WITH DOLPHIN STRANDINGS DECREASE

This analysis compared strandings of bottlenose and striped dolphins in Sicily with values of engine power, based on fishing vessels registered in 48 Sicilian ports, from 1995 through 2012. Fishing capacity decreased during this period, as did strandings; this correlation was statistically significant. Strandings tended to be clustered near ports with high fishing capacity. Bottlenose dolphin strandings were more frequent where bottom otter trawls were more frequently used. Therefore, while fishing capacity can be an indicator of the level of threat to cetaceans, it can also predict decreases in dolphin mortality.

(SOURCE: Crosti, R., Arcangeli, A., Romeo, T. and Andaloro, F. 2017. Assessing the relationship between cetacean strandings (*Tursiops truncatus* and *Stenella coeruleoalba*) and fishery pressure indicators in Sicily (Mediterranean Sea) within the framework of the EU Habitats Directive. *Eur. J. Wildlife Res.* 63: 55-68, *https://doi.org/10.1007/s10344-017-1111-8*).

SEASONAL CLOSURE OF GILLNET FISHERIES IN THE AZOV SEA MIGHT REDUCE BYCATCH LEVELS

Stranding and bycatch data for harbour porpoises from 1999 to 2013 in the Azov Sea showed a peak in strandings in July and August, a period when females are lactating and very young animals are newly foraging independently. The stranding peak did not coincide with the regional peak of the turbot, shad and sturgeon fisheries, which is in the spring. Bycatch reduction could therefore be achieved by closing coastal gillnet fisheries in the peak stranding period. Because this is not peak fishing season, such time-area closures would minimise the economic impact on local fisheries.

(SOURCE: Vishnyakova, K. and Gol'din, P. 2015. Seasonality of strandings and bycatch of harbour porpoises in the Sea of Azov: The effects of fisheries, weather conditions and life history. *ICES J. Mar. Sci.* 72(3): 981-91).

Marine Debris

COASTAL MACRO-LITTER IN THE TURKISH MEDITERRANEAN SEA

Thirteen beaches along the northeast Mediterranean shores of Turkey yielded an average density of 0.9 litter items/m^2. Eight of these beaches were classified either as 'dirty' or 'extremely dirty'. Litter from convenience food consumption and smoking made up more than half of the litter collected. Agricultural, industrial and fisheries-related items contributed only 6%. Plastic items made up over 89%. Less than 4% had been transported from neighbouring countries. The researchers identified direct deposition as the main source of this litter and underlined poor local awareness and the need for educational programs to help reduce coastal litter.

(SOURCE: Aydin, C., Güven, O., Salihoglu, B., and Kideys, A.E. 2016. The influence of land use on coastal litter: An approach to identify abundance and sources in the coastal area of Cilician Basin, Turkey. *Turk. J. Fish. Aquat. Sci.* 16: 29-39, [DOI: 10.4194/1303-2712-v16_1_04]).

MICROPLASTICS FOUND IN PREY FISH OF CETACEANS

Three commercially relevant demersal fish species – the lesser spotted dogfish, European hake and red mullet – are currently used as biomonitors for marine pollution in Spain. The stomachs of 212 specimens revealed that about 18% contained microplastics. Red mullet had the highest abundance (33%) in the Mediterranean (Barcelona). Most of the documented material was fibres, with potential sources being hygiene and cosmetic products, textiles and industrial fishing gear (especially neutrally or negatively buoyant nylon). Laboratory studies have shown that microplastics may have the ability to enter and propagate through the marine food web. Hake and mullet are prey of Mediterranean cetaceans, pointing to a potential direct transfer of marine debris to dolphins and porpoises.

(SOURCE: Bellas, J., Martínez-Armental, J., Martínez-Cámara, A., Besada, V., and Martínez-Gomez, C. 2016. Ingestion of microplastics by demersal fish from Spanish Atlantic and Mediterranean coasts. *Mar. Pollut. Bull.* 109: 55-60, *https://doi.org/10.1016/j.marpolbul.2016.06.026*).

PLASTIC IN THE MEDITERRANEAN SEA

The Mediterranean Sea is heavily affected by marine debris. The average density of plastic (1 item/4 m^2) and its frequency (100% of all sites sampled) are comparable to the accumulation zones described for the five subtropical gyres (e.g., Great Pacific Garbage Patch), and the proportion of large objects is even higher than in those gyres. The authors attribute this to high human pressure and the semi-enclosed geography of the Mediterranean.

(SOURCE: Cózar, A., Sanz-Martin, M., Marti, E., Gonzalez-Gordillo, J.I., Ubeda, B., Galvez, J.A., Irigoien, X., and Duarte, C.M. 2015. Plastic accumulation in the Mediterranean Sea. *PLOS ONE*, [DOI:10.1371/journalpone.0121762]).

FLOATING MACRO-LITTER AND CETACEANS: THEY WILL MEET

This is one of the first studies to directly compare the distribution of marine debris with cetacean presence. The researchers recorded 1993 floating items (overall density: 15 items/km^2) along the coast of France between Marseille and Monaco (281 transects, more than 5000 km travelled). Most items were plastic bags/packaging. Sightings (n = 259, of 2194 individuals) of six species of cetaceans corresponded by ca. 50% with plastic distribution. Considering the ingestion, entanglement and strangulation risk of cetaceans in marine litter, this high overlap and thus potential for interaction is cause for concern, particularly for endangered sperm whales. Importantly, this study's transects partially overlapped with the Pelagos Sanctuary, revealing a sensitive situation. The authors note that they monitored only the 'tip of the iceberg' because, in the Mediterranean, litter densities on the seafloor are higher than for floating litter. They call for actions to reduce the presence of macro-litter at sea.

(SOURCE: Di-Méglio, N. and Campana, I. 2017. Floating macro-litter along the Mediterranean French coast: Composition, density, distribution and overlap with cetacean range. *Mar. Pollut. Bull.* 118: 115-66, *https://doi.org/10.1016/j.marpolbul.2017.02.026*).

MICROPLASTICS POSE A THREAT TO MEDITERRANEAN FIN WHALES

The level of microplastics, as well as the toxicology of fin whale populations, were compared between the Gulf of

Table 1
Mean (± SD) values of plastics biomarkers and organochlorines in sampled fin whales. (Units: CYP1A1=pmol/mg protein; CYP2B=pmol/mg protein; LPO=nmol TBARS/mg protein; MEHP=ng/g f.w.; HCB=ng/g l.b.; DDT=ng/g l.b.; PCB=ng/g l.b.; OC=ng/g l.b.)

	N	CYP1A1	CYP2B	LPO	MEHP	HCB	ΣDDT	ΣPCBs	ΣOC
Mediterranean	30	71.9 ± 25.9	41.5 ± 22.9	11.0 ± 6.4	54.8 ± 27.7	29.9 ± 12.0	10,480 ± 7,480	13,330 ± 8,550	23,830 ± 15,060
Gulf of California	10	61.4 ± 28.4	52.9 ± 23.4	6.7 ± 3.8	40.0 ± 23.2	38.5 ± 33.6	3,110 ± 2,250	8,754 ± 6,540	11,900 ± 6,760

California and the Pelagos Sanctuary in the Mediterranean Sea. Concentrations of microplastics in the Gulf of California ranged up to 0.14 items/m^3, while the Mediterranean had levels several times higher (up to 9.67 items/m^3, mean: 0.31 ± 1.17 items/m^3). Furthermore, phthalate and organochlorine contaminant levels, as well as biomarker responses, were significantly higher in Mediterranean fin whales. There was a clear overlap between areas with fin whales feeding and microplastic high density in the Ligurian and Sardinian seas. The authors conclude that 'Mediterranean fin whales appear to be exposed to absorbed and constituent contaminants of plastic, as a result of direct and indirect ingestion of microplastic, macroplastic and contaminated prey. These results represent a warning for the vulnerable Mediterranean fin whale population'. See Table 1 for biomarker and contaminant values.

(SOURCE: Fossi, M.C., Marsili, L., Baini, M., Giannetti, M., Coppola, D., Guerranti, C., Caliani, I., Minutoli, R., Lauriano, G., Finoia, M.G., Rubegni, F., Panigada, S., Bérubé, M., Urbán Ramírez, J., Panti, C. 2016. Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios. *Environ. Poll.* 209: 68-78).

LASTIC DEBRIS IN WHALE PROTECTED AREA

Modelling of ocean currents with field data confirmed that the Pelagos Sanctuary, a Specially Protected Area of Mediterranean Importance, suffers heavy impacts from micro- and macro-plastics. The most abundant polymer was polyethylene, suggesting fragmentation of larger packaging as the primary source. There was a large overlap between marine litter hotspots and fin whale feeding habitat. This is an important contribution for risk assessment of fin whale exposure to microplastics.

(SOURCE: Fossi, M.C., Romeo, T., Baini, M., Panti, C., Marsili, L., Campani, T., Canese, S., Galgani, F., Druon, J.-N., 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 modelling approach. *Front. Mar. Sci* 4: 167, *https://doi.org/10.3389/fmars.2017.00167*).

HIGH SEA SURFACE MICROPLASTIC DENSITIES IN NORTHERN ADRIATIC SEA

Seventeen trawls over a 20-month period revealed abundant microplastics in the Slovenian part of the northern Adriatic. The average concentration was 406 x 10^3 particles/km^2, equivalent to 5.41 particles/m^3. Most of the analysed particles were polyethylene. This is amongst the highest concentrations reported in the Mediterranean, further corroborating the Mediterranean as one of the world's marine litter hotspots.

(SOURCE: Gajšt, T., Bizjak, T., Palatinus, A., Liubartseva, S., and Kržan, A. 2016. Sea surface microplastics in Slovenian part of the Northern Adriatic. *Mar. Pollut. Bull.* 113:392-99, *https://doi.org/10.1016/j.marpolbul.2016.10.031*).

FISHING ACTIVITY AND MERCHANT SHIPS ASSOCIATED WITH MACRO-LITTER IN SPAIN

The Mediterranean Sea region produces the highest amounts of municipal waste per person per year in the world. Marine litter densities are more than 100,000 items/km^2 on the seafloor close to metropolitan areas (mass occasionally greater than that of megafauna) and the fourth highest concentration of floating debris in the world. This study revealed increasing densities in the Gulf of Alicante (Spain) from the open sea to the coast. By weight, 76% was plastic, metal and glass. Fishing activity was identified as being the source of nearly 30% of this litter. Overall, likely sources were merchant ships in open waters and recreational and fishing vessels in coastal waters. The latter reflects (a) the practice of discarding old or damaged gear and tackle overboard and (b) unintentional losses due to snagging, especially on rocky grounds closer to shore. This type of debris poses an entanglement threat to cetaceans. The authors encourage 'marine retention programmes' on trawlers to reduce marine litter.

(SOURCE: García-Rivera, S., Sánchez Lizaso, J.L., and Bellido Millán, J.M. 2017. Composition, spatial distribution and sources of macro-marine litter on the Gulf of Alicante seafloor (Spanish Mediterranean). *Mar. Pollut. Bull.* 119: 110-18, *https://doi.org/10.1016/j.marpolbul.2017.06.022*).

BULGARIAN BLACK SEA COAST HEAVILY POLLUTED WITH LITTER

The Bulgarian Black Sea has received little attention regarding marine litter. The eight beaches studied along the Bulgarian coastline were classified as being highly polluted with litter. Artificial polymer materials made up nearly 85% of this material. Cigarette butts, followed by plastic caps/lids and cups, were the most abundant items. Litter densities were highest on urban beaches, indicating that recreational activities associated with tourists and campers were key sources. The data collected in this and other studies in European seas are important for the European Marine Strategy Framework Directive, designed to achieve or maintain 'Good Environmental Status' for all European seas by 2020. Marine litter is one of 11 'descriptors' considered for determining this status.

(SOURCE: Simeonova, A., Chuturkova, R, and Yaneva, V. 2017. Seasonal dynamics of marine litter along the Bulgarian Black Sea coast. *Mar. Pollut. Bull.* 119: 110-118, *https://doi.org/10.1016/j.marpolbul.2017.03.035*).

FIRST MARINE LITTER STUDY ON THE SOUTHEAST BLACK SEA COAST

Nine beaches along the Turkish southeast coast of the Black Sea yielded a mean density of 0.16 litter items/m^2 by number and 3.6 g/m^2 by weight. Plastic marine debris is known to be the most abundant litter category in Turkish waters and was also the most abundant along the southeast coast of the Black Sea, followed by Styrofoam and fabric. Although the values were at the lower end of the range reported from other regions, the authors identify the source as inappropriately stored or disposed-of wastes and underline the role of major rivers and streams that empty into the Black Sea.

(SOURCE: Terzi, Y. and Seyhan, K. 2017. Seasonal and spatial variations of marine litter on the south-eastern Black Sea coast. *Mar. Pollut. Bull.* 120: 154-158, *http://dx.doi.org/10.1016/j.marpolbul.2017.04.041*).

Ship strikes

SPERM WHALES AT RISK OF SHIP STRIKES IN NORTHWEST MEDITERRANEAN SEA

Collisions with large vessels may be a conservation issue for the endangered Mediterranean sperm whale population.

Comparing the sightings of sperm whales with ship traffic density yielded maps of collision risk in relation to vessel speed. The calculations show that the whales were more at risk from merchant vessels along the French and Italian continental coasts, and by conventional ferries on the east side of the islands of Corsica and Sardinia in the Pelagos Sanctuary. The authors estimated that 74 animals could be at risk of being struck by ships during the summer months in the Pelagos Sanctuary. The authors also noted that 9% of photo-identified sperm whales had scars attributed to ship strikes. These results provide a basis for defining high-risk areas and initiating mitigation measures that encompass commercial vessels, leisure boats and naval boats. While enforced shipping lanes avoid areas of high whale density, observers to detect whales (with infra-red vision at night), early warning systems and training for ships' crews could also be mitigation measures to reduce ship strike risk.

(SOURCE: Di-Meglio, N., David, L., and Monestiez, P. 2018. Sperm whale ship strikes in the Pelagos Sanctuary and adjacent waters: assessing and mapping collision risks in summer. *J. Cetacean Res. Manage.* 18: 135-147).

Chemical pollution

PYRETHROID INSECTICIDE FOUND IN STRIPED DOLPHINS FROM THE ALBORÁN SEA

Insecticide pyrethroid levels were determined from the liver of striped dolphins in the Alborán Sea. Pyrethroids were detected in 87% of the specimens, with a mean total concentration of 300 μg/kg lipid weight. The bioaccumulation of these insecticides was unlike that of POPs: the concentration increased slightly from calves to juveniles, but there was little difference between juveniles and adults. These levels are a cause for concern, although their toxicological impact is currently unknown. See Table 2 for values.

(SOURCE: Aznar-Alemany, Ò., Giménez, J., de Stephanis, R., Eljarrat, E. and Barceló, D. 2017. Insecticide pyrethroids in liver of striped dolphin from the Mediterranean Sea. *Environ. Pollut.* 225: 346-53).

HIGH HEAVY METAL CONCENTRATIONS IN THE EASTERN BLACK SEA

The contamination of Black Sea waters, sediments and organisms with a wide range of pollutants has become a matter of great concern. The main metal pollution problem in the eastern Black Sea coast of Turkey is related to agricultural run-off, sewage effluents with deficient or no treatment, and river-borne wastes from mines. The levels of metals in a bivalve and snail species were significantly above tolerable levels. Due to the bioaccumulation potential of heavy metals, such high levels are a potential cause for concern for higher-level predators such as cetaceans.

(SOURCE: Baltas, H., Sirin, M., Dalgic, G., Bayrak, E.Y., and Akdeniz, A. 2017. Assessment of metal concentrations (Cu, Zn, and Pb) in seawater, sediment and biota samples in the coastal area of Eastern Black Sea, Turkey. *Mar. Pollut. Bull.* 122: 475-82, *http://dx.doi.org/10.1016/j.marpolbul.2017.06.059*).

ENDOCRINE-DISRUPTING CHEMICALS FOUND IN FISH OFF SICILY

Endocrine-disrupting chemicals can show harmful effects on the reproduction and development of aquatic animals by interfering with normal hormonal levels and processes. This study used an improved method to detect three such compounds in all samples of red mullet collected from two sites (characterised by different degrees of pollution) off Sicily. The similar levels in both sites point to background values attributable to the global distribution of these contaminants rather than a local source. The three pollutants belong to category 1 (clear evidence of endocrine-disrupting activity) of Endocrine Disruptor Chemicals. The levels were sufficiently high to prompt the researchers to point to a potential risk for the health of aquatic animals, the Mediterranean Sea ecosystem, and the local human population for whom red mullet is a food source. Red mullet is also a prey species for dolphins.

(SOURCE: Errico, S., Nicolucci, C., Migliaccio, M., Micale, V., Mita, D.G., and Diano, N. 2017. Analysis and occurrence of some phenol endocrine disruptors in two marine sites of the northern coast of Sicily (Italy). *Mar. Pollut. Bull.* 120: 68-74, *http:///dx.doi.org/10.016/j.marpolbul.2017.04.061)*.

HIGH LEVELS OF PCBS FOUND IN THREE MEDITERRANEAN CETACEANS

PCB levels in bottlenose and striped dolphins in Europe were amongst the highest recorded levels in cetaceans globally, exceeding all known PCB toxicity thresholds for marine mammals. In the western Mediterranean Sea (1990-2009), PCB concentrations in striped dolphins showed a marked decline after 1990 and then stabilised from 2003 to 2008, but still consistently exceeded all mammalian toxicity thresholds. Although they were not as high as PCB levels in the UK and Ireland, levels in killer whales from the Strait of Gibraltar were also potentially toxic. PCBs can lead to immune system suppression and it was noted that, for example, distemper due to cetacean morbillivirus infection was frequently seen in Mediterranean striped dolphins, and various lesions were observed in bottlenose dolphins and killer whales. The Mediterranean Sea is a global PCB hotspot and most of its cetacean species have declined over decades. The authors state that 'Without significant mitigation, PCBs will continue to drive population declines or suppress population recovery in Europe for many decades to come'. Despite regulations and mitigation measures to reduce PCB pollution, their biomagnification in marine food webs continues to cause severe impacts amongst cetacean top predators in European seas. See Table 3 for values.

(SOURCE: Jepson, P.D., Deaville, R., Barber, J.L., Aguilar, À., Borrell, A., Murphy, S., Barry, J., Brownlow, A., Barnett, J., Berrow, S., Cunningham, A.A., Davison, N.J., ten Doeschate, M., Esteban, R., Ferreira, M., Foote, A.D., Genov, T., Giménez, J., Loveridge, J., Llavona, Á., Martin, V., Maxwell, D.L., Papachlimitzou, A., Penrose, R., Perkins, M.W., 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.-UK* 6:18573).

GENETIC ANALYSES OF SKIN SAMPLES REVEAL CONTAMINATION HOTSPOTS

Skin samples of stranded specimens of four cetacean species (bottlenose, striped and Risso's dolphins, fin whales) were examined for genetic markers specific to contaminants of emerging concern. Animals from three basins (Ionian, Tyrrhenian and Adriatic) were sampled. Three of four markers tested showed higher expression in the samples collected from the Adriatic. The researchers highlighted the

Table 2

Maximum insecticide pyrethroid values in the livers of striped dolphins from the Alborán Sea (μg/kg lipid weight).

Tetramethrin	Bifenthrin	Cyhalothrin	Permethrin	Deltamethrin	ΣPyrethroid
3,400	36	18	1800	78	5,200

Table 3

Maximum PCB levels (ΣPCB mg/kg lipid).

Bottlenose dolphin		Striped dolphin	Killer whale
Strait of Gibraltar 879.3	Western Mediterranean 601.39	Western Mediterranean 2,668.64	Strait of Gibraltar 857.92

role freshly stranded specimens can play in determining the region from which individual cetaceans come and the pollution levels there.

(SOURCE: Mancia, A., Lunardi, D., and Abelli, L. 2018. The chronicles of the contaminated Mediterranean seas: A story told by the cetaceans' skin genes. *Mar. Pollut. Bull.* 127: 10-14, *https://doi.org/10.1016/j.marpolbul.2017.11.037*).

HIGH HEAVY METAL CONCENTRATIONS IN HUMAN FOOD (AND DOLPHIN PREY) IN THE AEGEAN SEA

The levels of Hg, Cd, Pb, Cr, Cu and Zn were measured in four species of fish – annular seabream, common pandora, European hake and red mullet – along the Turkish coast of the Aegean Sea. In one of the two bays sampled, the levels of Cd and Pb were above the FAO's tolerable limits for three species, and the levels of Hg were at the maximum permitted limits for two species. Accordingly, the consumption of red mullet and common pandora in this area is potentially hazardous to human health due to Hg concentrations. Dolphins are also known to prey on these species.

(SOURCE: Pazi, I., Gonul, L.G., Kucuksezgin, F., Avaz, G., Tolun, L. Unluoglu, A., Karaaslan, Y., Gucver, S.M., Orhon, A.K., Siltu, E., and Olmuz, G. 2017. Potential risk assessment of metals in edible fish species for human consumption from the Eastern Aegean Sea. *Mar. Pollut. Bull.* 120: 409-13, *https://doi.org/10.1016/j.marpolbul.2017.05.004*).

CHEMICALS ASSOCIATED WITH PLASTICS CONCENTRATED IN SEA TURTLES

Sea turtles (one leatherback, 12 loggerhead) stranded along the Sicilian coast were examined for phthalates, chemicals used in the plastics industry. The total concentrations of the four phthalates examined were high in all tissues. The levels in fat were comparable to those found in marine mammals, underlining that these chemicals leach from plastics and enter the food chain. This supports the potential of monitoring these substances as tracers for microplastic ingestion, and the authors call for efforts to adopt a common plastics waste management policy amongst all Mediterranean countries.

(SOURCE: Savoca, D., Arculeo, M., Barreca, S., Buscemi, S., Caracappa, S., Gentile, A., Persichetti, M.F., and Pacem A. 2018. Chasing phthalates in tissues of marine turtles from the Mediterranean Sea. *Mar. Pollut. Bull*. 127: 165-69, *https://doi.org/10.1016/j.marpolbul.2017.11.069*).

TRACE ELEMENTS IN MEDITERRANEAN STRIPED DOLPHINS

The examination of trace elements (Hg, Se, Cd, Cu, Zn, Fe, Mn and As) in seven specimens of striped dolphin stranded along the Israeli coast from 2006-2011 showed no change from an earlier series beginning in 2001. The Hg values were high (and higher than in other seas), but might reflect the relatively high natural background level of Hg in the Mediterranean. The pathology findings included meningoencephalitis, pneumonia and hepatitis (but no DMV). Striped dolphins have suffered four DMV epidemics (1990-1992, 2006-2008, 2011 and 2013) in this area. This suggests a prolonged DMV circulation in the Western Mediterranean along with an inadequate level of antiviral immunity. This compromised immunity may be caused or aggravated by pollutants. This would impact the health and conservation status of Mediterranean striped dolphins (currently listed as Vulnerable on the IUCN Red List), calling for continued monitoring of the concentrations of heavy metals and other pollutants in this species.

(SOURCE: Shoham-Frider, E., Goffman, O., Harlavan, Y., Kress, N., Morick, D., Roditi-Elasar, M., Shefer, E., and Kerem, D. 2016. Trace elements in striped dolphins (*Stenella coeruleoalba*) from the Eastern Mediterranean: A 10-years perspective. *Mar. Pollut. Bull*. 109: 624-32, *http://doi.org/10.1016/j.marpolbul.2016.05.021*).

TRACE ELEMENT LEVELS IN MEDITERRANEAN CETACEANS AS ECOLOGICAL INDICATORS

See Table 4 for values measured in sperm whales and bottlenose dolphins.

(SOURCES: Monteiro, S.S., Torres, J., Ferreira, M., Marçalo, A., Nicolau, L., Vingada, J.V. and Eira, C. 2016. Ecological variables influencing trace element concentrations in bottlenose dolphins (*Tursiops truncatus*, Montagu 1821) stranded in continental Portugal. *Sci. Total Environ.* 544: 837-844; Squadrone, S., Brizio, P., Chiaravalle, E. and Abete, M.C. 2018. Sperm whales (*Physeter macrocephalus*), found stranded along the Adriatic coast (Southern Italy, Mediterranean Sea), as bioindicators of essential and non-essential trace elements in the environment. *Ecol. Indic.* 58: 418-25).

POP LEVELS HIGHER IN MEDITERRANEAN THAN IN NORTH ATLANTIC OR SOUTHERN HEMISPHERE CETACEANS

See Table 5 for values in three species of cetacean.

(SOURCE: Pinzone, M., Budzinski, H., Tasciotti, A., Ody, D., Lepoint, G., Schnitzler, J., Scholl, G., Thomé, J.-P., Tapie, N., Eppe, G., and Das, K. 2015. POPs in free-ranging pilot whales, sperm whales and fin whales from the Mediterranean Sea: Influence of biological and ecological factors. *Environ. Res.* 142: 185-96).

Disease and mortality events

General

MASS MORTALITY OF JUVENILE AND NEWBORN HARBOUR PORPOISES IN THE BLACK SEA

The endemic harbour porpoise subspecies in the Black Sea has experienced several large-scale mortalities in the 21st

Table 4

Maximum trace element values recorded in cetaceans from the Mediterranean (mg/kg wet weight). Mercury levels in bottlenose dolphins were extremely high, although exceeded by levels in the Mediterranean and Adriatic Seas.

		n		Al	As	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Se	Sn	V	Zn
Sperm whale	Italian coast, Adriatic Sea	3	Brain	2.73	0.73	0.06	0.02	3.35	56.57	-	0.56	0.02	0.04	-	9.14	0.23	0.02	16.5
			Muscle	7.05	5.54	0.03	0.05	0.56	198.2	-	1.02	0.01	0.03	-	3.10	0.01	0.06	48.5
			Liver	2.79	6.71	2.84	0.12	7.62	1554	-	1.16	0.30	0.17	-	94.0	0.60	0.03	53.5
			Kidney	11.36	1.75	2.60	0.14	1.97	235.6	-	1.48	0.03	0.06	-	6.40	0.18	0.05	13.5
Bottlenose dolphin	Portuguese coast, entrance of the Mediterranean	10	Muscle	-	2.72	0.31	-	3.46	-	3.14	4.65	-	1.93	0.22	2.03	-	-	24.2
			Liver	-	0.94	0.47	-	30.6	-	208	4.68	-	0.27	0.26	117	-	-	94.9
			Kidney	-	1.58	2.81	-	8.28	-	40.1	1.48	-	0.21	0.11	11.9	-	-	46.9

Table 5

Persistent organic pollutants detected in Mediterranean cetaceans. Pollutant levels were higher than comparative populations in the North Atlantic and southern hemisphere. The levels of organic contaminants frequently exceeded an estimated 17 mg/kg lipid weight toxicity threshold.

		Contaminant concentrations in mg/kg lipid weight									Contaminant concentrations in µg/kg lipid weight				
	n	ΣPCBs	ΣICES7	ΣPBDE	DDE	DDD	DDT	ΣDDT	ΣHCH	HBCD	ΣPCDD	ΣPCDF	Σnon-ortho PCB	Σortho PCB	WHO-TEQ/g lipid weight
Long-finned pilot whale	49	103	68	1.76	165	6.09	3.86	185	0.095	0.401	0.12	0.3	3.7	3,627	472
Sperm whale	43	68.5	45.9	0.78	147	7.63	9.77	170	0.33	0.214	0.13	0/74	12.0	4,735	1,833
Fin whale	70	25.07	17.98	1.19	19.2	2.32	0.80	26.70	-	0.043	-	-	-	-	-

century. In 2016, unusually large numbers of newborns and juveniles washed up on beaches along the Black Sea coasts of Bulgaria and Turkey (in Turkey: 7.2 individuals/km, with 150 individuals along one 22 km stretch in July alone). In total, 443 stranded cetaceans (435 of them harbour porpoises) were reported in Turkey (coastline length: 300 km), and 234 cetaceans (218 harbour porpoises) in Bulgaria (coastline length: 238 km). Most were newborns less than 70 cm long. Öztürk et al. estimate that thousands of juveniles died during this mortality event. Such successive high mortalities of young animals could be a serious impediment to the recovery of this endangered subspecies.

(SOURCES: Sanders, N. 2016. Mass mortality event of Black Sea harbour porpoises. IUCN – SSC Cetacean Specialist Group. *http://www.iucn-csg.org/index.php/2016/08/25/mass-mortality-event-of-black-sea-harbour-porpoises*; Öztürk, A.A., Tonay, A.M., Dede, A., Danyer, I., and Popov, D. 2017. Unusual mass mortality of harbour porpoises on the coast of the western Black Sea (Bulgaria and Turkey) in summer 2016. Abstract submitted to 31st European Cetacean Society Conference, Middlefart, Denmark).

STRANDING RATE OF PORPOISES CORRELATES WITH FISH STOCK DYNAMICS IN THE AZOV SEA

In 1999-2014, harbour porpoise stranding rates were regularly monitored on the southern coast of the Azov Sea, particularly at the uninhabited abraded coast of the Tarkhan Cape. Specifically, the general trends and annual fluctuations in strandings were compared to the catch reports of the Azov Sea anchovy, an important prey for porpoises. The fluctuations in stranding rates correlated with the population dynamics of the anchovy stock. A cosine function, based on the data from 1999-2012, correctly predicted maximum strandings in 2013 and their substantial decline in 2014. The function worked particularly well when biases affecting carcass preservation, such as discovery rate and drift conditions, were reduced. In certain environments and over established time periods, the cetacean stranding rate can be an indicator of population trends which may be verified by external factors, including the dynamics of prey stocks.

(SOURCE: Vishnyakova, K. and Gol'din, P. 2015. Cetacean stranding rate correlates with fish stock dynamics: Research of harbour porpoises in the Sea of Azov. *Mar. Biol.* 162: 359-66).

Harmful Algal Blooms (HABs)

FIRST GLOBAL INTEGRATED MARINE ASSESSMENT: BLACK SEA

The upper layer of water (ca. 150 m) in the Black Sea supports unique marine, freshwater, brackish and relic species (approximately 5000). The deeper layers are saturated with hydrogen sulphide and largely devoid of multi-cellular invertebrates. The eastern sector is a recognised biodiversity hotspot. A UN report identifies invasion by alien species as a key threat to the Black Sea ecosystem, with two species being of particular importance. The first is an American filter-feeding comb jelly, which has led to the collapse of pelagic fish populations (26 commercial fish stocks) and caused a major shift in the marine ecosystem (partially offset by the invasion of another, predatory comb jelly). The second is algae that produce harmful algal blooms and can further deplete the oxygen in the water. Temperature increases at the surface mixing with cold intermediate water layers have further accelerated species shifts. Critical status has been recognised for 13 out of 37 benthic habitats, including the neritic water column, coastal lagoons, estuaries and deltas. These developments, along with illegal fishing (gillnet entanglement), pose the greatest threats to the three cetacean species inhabiting the Black Sea, all of which are listed as Endangered or Vulnerable on the IUCN Red List.

(SOURCE: Inniss, L. and Simcock, A. (Joint coordinators); Rice, J. (Lead member of 14 contributors). 2016. The first global integrated marine assessment: World ocean assessment I. *United Nations, Chapter 36A:* p. 16-18. *http://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_36A.pdf*).

Climate change

CLIMATE CHANGE A 'DOUBLE ISSUE' IN THE MEDITERRANEAN SEA

Climate change is a particular issue for enclosed seas, where organisms cannot migrate to higher latitudes. The Mediterranean is doubly affected because it is increasingly being inhabited by (sub) tropical non-indigenous species ('tropicalisation'). Moreover, warm-water native species previously restricted to southern sectors are now establishing themselves in the colder northwest basin ('meridionalisation'). The authors report that 20 southern species have been found for the first time at Genoa, including zebra seabream, parrotfish and juvenile Indo-Pacific bluespotted cornetfish. The linear increase in the number of warm-water native species and the exponential increase in the number of non-indigenous species point to a tropicalisation (rather than a meridionalisation) even in the northern sectors of the Mediterranean basin. If the present seawater warming continues, the Mediterranean would undergo a generalised process of biotic homogenisation. Such major ecosystem changes probably ultimately affect the entire food web, including top predators such as cetaceans. The authors point to the need for sustained monitoring as 'a major concern for scientists and environmental managers alike'.

(SOURCE: Bianchi, C.N., Caroli, F., Guidetti, P., and Morri, C. 2018. Seawater warming at the northern reach for southern species: Gulf of Genoa, NW Mediterranean. *J. Mar. Biol. Assoc. UK* 98:1-12, [DOI:10.1017/S0025315417000819]).

CLIMATE CHANGE COULD REDUCE COMMON DOLPHIN HABITAT IN THE ALBORÁN SEA

A special volume of the journal *Deep Sea Research Part II: Topical Studies in Oceanography* was devoted to Atlantic and Mediterranean megafauna. Papers addressed abundance, distribution and habitats; one paper highlighted climate change (see also Azzellino et al., 2017, in this

SOCER). Short-beaked common dolphin distribution and environmental variables recorded in the Alborán Sea were used to project the impacts of climate change via changes in sea surface temperatures on dolphin habitat. The authors conclude that increasing sea surface temperatures will lead to a decrease in common dolphin habitat.

(SOURCE: Cañadas, A. and Vázquez J.A. 2017. Common dolphins in the Alborán Sea: Facing a reduction in their suitable habitat due to an increase in sea surface temperature. *Deep Sea Res. Pt. II: Topic. Stud. Oceanogr.* 141: 306-18)

Noise impacts

VESSEL TRAFFIC ALTERS THE BEHAVIOUR OF BOTTLENOSE DOLPHINS AND HARBOUR PORPOISES IN THE ISTANBUL STRAIT

The Istanbul Strait is one of the busiest international waterways in the world. The effect of marine traffic, location and season on the behavioural transitions, behavioural budget and bout duration (average time in each behavioural state) of bottlenose dolphins was investigated and modelled. Marine vessels were the main driving force for behavioural transitions, leading to significant changes in behavioural budget and bout durations. There was a significant decrease in socialising, surface-feeding and resting behaviour in the presence of boats, whilst diving behaviour increased. Moreover, dolphins spent less time surface-feeding, resting, socialising and diving once disrupted. The current level of vessel-dolphin interaction in this area (51% of observation time) was sufficient to significantly alter the dolphins' cumulative behavioural budget. Finally, speed and distance of vessels played a considerable role in the directional responses of dolphins. The authors argue for creating protected zones in order to mitigate vessel-dolphin interactions, because the population is already classified as 'at risk' and still lacks a species-specific conservation plan. In a second study, high-speed ferries and boats were identified as the major cause of disturbance. Accordingly, the authors recommend that the proposed protected zones (three different seasonally managed areas) should limit the speed and density of marine traffic. A third study on the endangered Black Sea harbour porpoise in the strait showed similar results: vessel presence, speed and distance affected behavioural bout length and swimming direction, but there was no significant cumulative (diurnal) behavioural budget change. Nonetheless, exposure to high-speed vessels resulted in a strong response, which could lead to porpoise displacement from large areas. Porpoise density was higher in areas with less traffic (northern strait) and lower in areas of high traffic (southern and central strait). The authors argue for species-specific conservation actions, especially in the northern sections of the strait, including vessel exclusion zones, enforced speed limits and the designation of specific channels for ferries.

(SOURCES: Bas, A.A., Christiansen, F., Öztürk, B., Öztürk A.A., Erdoğan, M.A., and Watson, L.J. 2017. Marine vessels alter the behaviour of bottlenose dolphins *Tursiops truncatus* in the Istanbul Strait, Turkey. *Endang Species Res* 34:1-14; Bas A.A., Öztürk A.A., and Öztürk B. 2015. Selection of critical habitats for bottlenose dolphins (*Tursiops truncatus*) based on behavioral data, in relation to marine traffic in the Istanbul Strait, Turkey. *Mar. Mamm. Sci.* 31: 979-997; Bas, A.A., Christiansen, F., Öztürk, A.A., Öztürk, B., McIntosh, C. 2017. The effects of marine traffic on the behaviour of Black Sea harbour porpoises (*Phocoena phocoena relicta*) within the Istanbul Strait, Turkey. *PLoS ONE* 12(3): e0172970. [DOI:10.1371/journal.pone.0172970]).

LOWER CETACEAN ABUNDANCE IN AREAS OF HIGH VESSEL TRAFFIC IN THE WESTERN MEDITERRANEAN

Shipping vessel number and cetacean abundance, determined via line transect surveys, were examined in the western Mediterranean Sea region. In locations with cetacean sightings, shipping traffic was 20% lower compared to random locations where no sightings were made. Most cetacean species, common bottlenose dolphins excepted, were observed in locations with lower levels of vessel traffic. Line transects in the Pelagos Sanctuary found reduced abundances of fin whales and striped dolphins in areas with more vessel traffic in the southeast region, and of large whales in the western portion of the sanctuary, where there is more vessel traffic. In the central part of the sanctuary – with moderate vessel traffic yet important feeding habitat locations – there were minor differences in the abundance of species (specifically Cuvier's beaked whales, sperm whales, fin whales and striped dolphins). It is possible that feeding habitats are so important that cetaceans still use these areas despite boat disturbance.

(SOURCE: Campana, I., Crosti, R., Angeletti, D., Carosso, L., David, L., Di-Méglio, N., Moulins, A., Rosso, M., Tepsich, P. and Arcangeli, A. 2015. Cetacean response to summer maritime traffic in the Western Mediterranean Sea. *Mar. Environ. Res.* 109: 1-8)

ITALY INTRODUCES MONITORING SCHEME FOR MARINE MAMMAL PRESENCE FOR SEISMIC EXPLORATION

Anthropogenic noise (e.g., naval sonar, pile driving, geophysical surveys) has now been recognised as a threat to marine fauna. Current oil and gas industry and navy protocols, as well as other guidelines based on 'best practise' or precautionary approaches for civil and industrial activities, are not standardised. In 2015, the Italian Environmental Impact Assessment Commission issued new criteria for obtaining permits for oil and gas exploration. It mandated that seismic operators apply a standardised protocol to compare the presence of marine mammals before, during and after offshore seismic surveys (see *http://www.va.minambiente.it/it-IT*). It established a 60-day monitoring period using both visual and acoustic methods. The authors underline that this approach, if used internationally, would improve the study of far-reaching intense low-frequency noise. The collected data are to be stored and made public by the Italian Ministry of the Environment.

(SOURCE: Fossati, C., Mussi, B., Tizzi, R., Pavan, G., and Pace, D.S. 2017. Italy introduces pre and post operation monitoring phases for offshore seismic exploration activities. *Mar. Pollut. Bull.* 120: 376-378, *https://doi.org/10.1016/j.marpolbul.2017.05.017*)

RESIDENT POPULATION OF BOTTLENOSE DOLPHIN AFFECTED BY VESSEL NOISE

Vessel traffic is known to affect the resident bottlenose dolphin's distribution and habitat use in the Cres-Losinj archipelago (Croatia, Adriatic Sea, a Natura 2000 site). This study found that the acoustic behaviour of the population is also affected by vessel noise. Dolphins significantly changed their whistle structure at high levels of ambient noise and in the presence of boats. These waters are visited consistently by sensitive mother-calf groups. The researchers called for an improved understanding of the overall acoustic repertoire of bottlenose dolphins and for determining potential population-level changes in the presence of these disturbance factors.

(SOURCE: Gospic, N.R. and Picciulin, M. 2016. Changes in whistle structure of resident bottlenose dolphins in relation to underwater noise and boat traffic. *Mar. Pollut. Bull.* 105: 193-98, *https://doi.org/10.1016/j.marpolbul.2016.02.030*)

UNDERWATER NOISE HOTSPOTS IN THE MEDITERRANEAN SEA AND THE EXTENT OF SEISMIC SURVEYING

A number of noise-producing activities might threaten cetaceans in the Mediterranean Sea, including coastal and offshore activities, seismic surveys, naval exercises and vessel traffic. Between 2005 and 2015, 1446 harbours, 228 oil/gas drilling platforms, 52 windfarm projects, 830 seismic exploration areas and a number of military exercise areas were identified. In July 2014, 7 million maritime vessel positions were recorded every 10 minutes. On average, there were 1500 vessels present in the area at any time, with the heaviest density of traffic in northern and western parts of the Mediterranean Sea and in Greek waters. The maximum and minimum areas where seismic surveys were being conducted were calculated: 27% of the surface of the Mediterranean (675,000 km^2) in 2013 and 3.8% (67,000 km^2) in 2005. Hotspots of underwater noise that overlapped key cetacean habitat included the Pelagos Sanctuary, the Strait of Sicily and the Hellenic Trench. The authors conclude that 'these results provide strong evidence of multiple stressors acting on the marine environment and of the need for urgent management and conservation actions'.

(SOURCE: Maglio, A., Pavan, G., Castellote, M., and Frey, S. 2016. *Overview of Noise Hotspots in the ACCOBAMS Area.* Report for the ACCOBAMS Secretariat).

RECOMMENDATIONS FOR REDUCING THE IMPACTS OF SEISMIC SURVEYS AND UNDERWATER NOISE IN THE EASTERN MEDITERRANEAN SEA

A workshop was held in Croatia on mitigating the impacts of underwater noise, particularly from seismic surveys, in the eastern Mediterranean Sea. The workshop was attended by 65 participants from 15 countries. Recommendations from the meeting included taking a precautionary approach to noise management; developing a 'noise budget' for eastern Mediterranean waters; considering potential cumulative or synergistic impacts on cetaceans, including the impacts of climate change; and assessing the effectiveness of mitigation measures and monitoring activities. Better communication and sharing of information was also suggested, in particular information on the distribution of sensitive species. Strategic Environmental Assessments should be conducted by governments and analysed before any locations are licensed to the oil and gas industry. The *Convention on Migratory Species (CMS) Guidelines on Environmental Impact Assessments for Marine Noise Generating Activities* should be incorporated into national legislation and species management plans. The number of seismic surveys should be limited and their timing should be planned to avoid key periods for sensitive species. Duplication of seismic surveys should be avoided and the use and development of the best-available quieting technologies (e.g., marine vibroseis) should be pursued. The lack of training of (and capacity for) marine mammal observers and acoustic monitoring staff on seismic survey vessels should be addressed. A global report should be prepared on the best available technology and environmental practises for the mitigation of underwater anthropogenic noise, and should be made available to all government agencies in the region. Education and awareness-raising of the need to reduce noise in the marine environment was also recommended. Finally, subsidies for the oil and gas industry should be removed and public funds should be spent in line with the objectives of the 2015 Paris Agreement on Climate Change, i.e., in a way to reduce greenhouse gas emissions.

(SOURCE: NRDC, OceanCare, DBU. 2017. *Mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the south eastern European waters in the Mediterranean Sea.* Workshop held November 22-23, 2017. Split, Croatia.).

OVERLAP BETWEEN CETACEANS AND SHIPPING IN THE PELAGOS SANCTUARY

A spatial analysis was conducted of shipping and the distribution of striped and bottlenose dolphins and fin whales in the southern part of the Pelagos Sanctuary. Overlap with vessel traffic occurred for all three species, with the greatest degree of overlap for striped dolphins, followed by bottlenose dolphins, then fin whales. Importantly, despite their lower overlap with shipping, fin whales might be particularly vulnerable to this source of disturbance because the overlap was associated with productive feeding areas, and animals focusing on feeding might be less reactive to approaching vessels.

(SOURCE: Pennino, M.G., Arcangeli, A., Prado Fonseca, V., Campana, I., Pierce, G.J., Rotta, A., and Bellido, J.M. 2017 A spatially explicit risk assessment approach: Cetaceans and marine traffic in the Pelagos Sanctuary (Mediterranean Sea). *PLoS ONE* 12(6): e0179686, *https://doi.org/10.1371/journal.pone.0179686*).

FIN WHALES SILENT WHEN SEISMIC SURVEY NOISE DETECTED IN THE IONIAN SEA

Acoustic recordings made in the Ionian Sea detected 20 Hz calls from fin whales and pulses from seismic survey airguns. Airgun pulses were recorded in four of the 10 analysed months and occurred daily between 25 November 2012 and 21 February 2013 – this period coincided with an absence of recorded fin whale calls. The daily airgun pulses led to an increase in low frequency background noise (below 50 Hz) of 10 dB. The received levels of airgun pulse noise indicated that the sound originated several hundreds of kilometres from the recording site. This suggests a significant impact from seismic surveys on fin whale vocalisations in this area.

(SOURCE: Sciacca, V., Viola, S., Pulvirenti, S., Riccobene, G., Caruso, F., De Domenico, E. and Pavan, G. 2017. Shipping noise and seismic airgun surveys in the Ionian Sea: Potential impact on Mediterranean fin whale. *Proceed. Mtgs Acoust.* 27, 040010: 1-10, *https://doi.org/10.1121/2.0000311*).

THE POTENTIAL IMPACT OF SEISMIC SURVEYS IN THE MEDITERRANEAN SEA

This review assessed sources of underwater noise that might pose a problem for cetaceans in the Mediterranean Sea. Potential sources included: (a) shipping traffic; (b) military exercises; (c) seismic surveys; (d) development projects, both coastal and offshore; and (e) marine tourism. Over the past 10 years, seismic surveys have increased in the southeast Mediterranean, especially in the Adriatic Sea and the Hellenic Trench. Concern about the impacts of underwater noise extends also to essential prey species such as zooplankton. However, the author notes that 'the full extent of the impact of seismic surveys at the population level is mostly unknown, partially due to the lack of baseline knowledge about the abundance and distribution of [cetaceans]'. A number of mitigation measures was recommended, including: (a) improved cetacean surveys; (b) the establishment of strandings detection programmes; (c) more research on the impacts of seismic surveys; (d) no-go zones for seismic surveys; (e) increased capacity in Mediterranean nations to conduct effective environmental impact assessments; (f) the use of new technologies, such as marine vibroseis; (g) better funding and training (e.g., for marine mammal observers on seismic survey vessels); and (h) improved communication amongst stakeholders.

(SOURCE: Štrbenac, A. 2017. *Overview of Underwater Anthropogenic Noise, Impacts on Marine Biodiversity and Mitigation Measures in the South-Eastern European Part of the Mediterranean, Focussing on Seismic Surveys*. Report from Stenella Consulting, Croatia, for OceanCare, Switzerland).

COMPARING MONITORED AND MODELLED NOISE LEVELS IN ITALIAN WATERS AS A STRATEGY FOR PLANNING FUTURE SHIPPING TRAFFIC ROUTES

Acoustic noise levels were measured in waters off Sicily and compared with the results of a model based on AIS data. The hydrophones were installed at a depth of over 2000 m, 25 km off Catania, Sicily. The measured values correlated well with the passage of ships tracked by AIS. This monitoring was requested by the EU Directive on Marine Strategy in an effort to achieve 'Good Environmental Status'. The data are essential in planning new routes for shipping traffic (as anticipated for the future 'European Motorways of the Sea'). They will also be helpful in elaborating mitigation measures for protected species that could be threatened by high noise levels at low frequencies; e.g., fin whales. Comparing noise distribution with animal density will help identify noise hotspots for the most sensitive species.

(SOURCE: Viola, S., Grammauta, R., Sciacca, V., Bellia, G., Beranzoli, L., Buscaino, G., Caruso, F., Chierici, F., Cuttone, G. D'Amico, A., De Luca, V., Embriaco, D., Favali, P., Giovanetti, G., Marinaro, G., Mazzola, S., Filiciotto, F., Pavan, G., Pellegrino, C., Pulvirenti, S., Simeone, F., Speziale, F., and Riccobene, G. 2017. Continuous monitoring of noise levels in the Gulf of Catania (Ionian Sea). Study of correlation with ship traffic. *Mar. Pollut. Bull.* 121: 97-103, *https://doi.org/10.1016/j.marpolbul.2017.05.040*).

GLOBAL

General

MONITORING WHALE HEALTH VIA DRONES

A small hexacopter drone was used to collect the blow from humpback whales off the east coast of the USA. Genetic analysis of the blow samples allowed identification of an array of microbes, identifying the normal microbial flora of the whale respiratory tract. No known respiratory pathogens were detected. This new technique allows the non-invasive monitoring of the respiratory health of whales.

(SOURCE: Apprill, A., Miller, C.A., Moore, M.J., Durban, J.W., Fearnbach, H., and Barrett-Lennard, L.G. 2017. Extensive core microbiome in drone-captured whale blow supports a framework for health monitoring. *mSystems* 2: e00119-17, *https://doi.org/10.1128/mSystems.00119-17*).

GLOBAL THREAT MAPS FOR MARINE MAMMALS

More than 1780 publications (published between 1991 and 2016) were reviewed to determine the threats to 121 marine mammal species. From these data, risk maps were produced and compared with mapped distributions of marine mammals. Almost all species were reported to be facing at least one threat. Bycatch had the greatest impact for the most species (112 species), followed by pollution (99 species), direct harvesting (89 species) and ship strikes (86 species). Threats such as urban development, tourism, directed catches and fishing affected more than 60 species. Threats were associated with more than 51% of marine mammal core habitat. Particular threat hotspots included the coastal waters of temperate and polar areas, notably the Baltic and Mediterranean Seas. Risk patterns for odontocetes and mysticetes were similar, with high-risk areas for both being concentrated on the east coasts of North America and Asia, with additional risk zones for mysticetes off the west coast of South America and off southern Australia. Humpback and sperm whales were exposed to the greatest area of risk, and common bottlenose dolphins were exposed to the highest diversity of risks. Species with restricted distributions had the greatest risks with respect to the proportion of their core habitat affected (e.g., Hector's, Heaviside's and Chilean dolphins, vaquita, franciscana and gray and North Atlantic right whales). The authors note that 'human activities in coastal waters worldwide impose previously unrecognised levels of cumulative risk for most of marine mammal species'. They also suggest that these risk maps might be useful for planning marine protected areas for marine mammals.

(SOURCE: Avila, I.C., Kaschner, K. and Dormann, C.F. 2018. Current global risks to marine mammals: Taking stock of the threats. *Biol. Conserv.* 221: 44-58).

ENVIRONMENTAL CHANGES AND ANTHROPOGENIC DISTURBANCE COULD HAVE SIGNIFICANT POPULATION-LEVEL EFFECTS

A model was constructed to investigate the effects of environmental changes and anthropogenic disturbances on the energetics of blue whales in the eastern North Pacific. The model predicted that unprecedented environmental changes (such as in 2005, when the annual California Current-induced upwelling was delayed by several months) affecting female reproductive success will cause a decline in recruitment rates (dropping from 95% to 69%), with reproductive failures increasing (aborted calf rate will increase from 2% to 26%). Modelling intense local disturbances (such as an exercise using naval sonar, seismic surveys or similar) revealed that if whales stayed in the disturbed location, the abortion rate for calves rose to 12.5% and the proportion of calves starving rose to 18.5%, with the recruitment rate dropping to 63%. Modelling a widespread but weak level of disturbance (such as from whale watching or shipping traffic) showed a small drop in recruitment rate (to 94%), partly because of a calf starvation rate of 0.2%, on average. This modelling exercise demonstrates the significant effect major environmental changes (from climate change, for example) or intense anthropogenic disturbances could have on threatened whale populations.

(SOURCE: Pirotta, E., Mangel, M., Costa, D.P., Mate, B., Goldbogen, J.A., Palacios, D.M., Hückstädt, L.A., McHuron, E.A., Schwarz, L., and New, L. 2018. A dynamic state model of migratory behavior and physiology to assess the consequences of environmental variation and anthropogenic disturbance on marine vertebrates. *Am. Nat.* 191(2): E40-E56, *https://doi.org/10.1086/695135*).

Habitat degradation

General

LANDMARK CONVENTION ON BALLAST WATER ENTERED INTO FORCE IN 2017

The IMO has crafted a convention that requires ships to manage their ballast water to remove, render harmless or avoid the uptake or discharge of aquatic organisms and pathogens with ballast water and sediment. The goal is to avoid the spread of invasive species, which is threatening 'the ecological and economic well-being of the planet'. These clear and robust new standards require all ships to carry a ballast water record book and an International Ballast Water Management Certificate. Most ships will have to install onboard systems to treat ballast water and eliminate unwanted organisms. The entry into force involved ratification by 30 States (total 52 contracting Parties), representing 35% of world merchant shipping tonnage. This is an important step forward in checking the spread of, amongst others, harmful algae that cause mass mortalities of marine organisms (e.g., fish kills), promote oxygen depletion, and affect all levels of the food chain, including cetaceans.

(SOURCE: The Maritime Executive. Ballast water convention to enter into force in 2017, *https://www.maritime-executive.com/article/ballast-water-convention-to-enter-into-force-in-2017#gs.nb0nIE8*).

Fisheries interactions

FISHERIES DISCARDS REMAIN A GOBAL ISSUE

A global marine fisheries bycatch reconstruction project estimated that fish discarded by commercial fisheries peaked at 18.8 million tons in 1989, declining afterward to current levels of less than 10 million tons/year. Most discards were generated by industrial (i.e., large-scale) fisheries. More recently, fleets operating in northwest Pacific and western central Pacific waters have generated the most discards (reflecting a shift from Atlantic waters). The fact that essentially marketable species are involved suggests ‘a combination of poor fishing practices and poor management procedures’. The discards amount to approximately 10% of the world’s marine fishery catches, pointing to a major, wasteful exploitation that potentially affects the entire marine ecosystem, including top predators such as cetaceans.

(SOURCE: Zeller, D., Cashion, T., Palomares, M., and Pauly, D. 2017. Global marine fisheries discards: A synthesis of reconstructed data. *Fish and Fisheries* 19: 30-9, *https://doi.org/10.1111/faf.12233*).

Marine Debris

MARINE DEBRIS RECOGNISED AND ADDRESSED BY HIGHEST INTERNATIONAL ORGANISATION

Marine debris has been recognised as a crucial issue by the UN Environment Assembly, which seeks by 2025 to ‘prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and microplastics’. The recent actions related to this ‘Sustainable Development Goal 14’ include a 2017 commitment by Member States to the ‘Our Ocean, Our Future: Call for Action’ declaration, as well as the ‘Group of 20 Action Plan on Marine Litter’, also adopted in 2017. The UN Environment Assembly has, amongst eight other points of action, invited the ‘relevant international and national organizations and conventions…to increase their action to prevent and reduce marine litter and microplastics and their harmful effects and to coordinate where appropriate to achieve that end’. The first meeting of the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics will be held in late May 2018 in Nairobi, Kenya, and the ministers of all Member States are invited to submit position papers.

(SOURCE: Marine litter and microplastics. United Nations. UNEP/EA.3/Res.7. 2018).

Disease and mortality events

Harmful Algal Blooms (HABs)

TOXIC ALGAL BLOOMS ON THE RISE IN NORTHERN HEMISPHERE

High-resolution sea-surface temperature records over the last three decades were used to model the trends in HABs in the North Atlantic and North Pacific Oceans. The model shows that increasing ocean temperatures have facilitated the expansion of two harmful dinoflagellates, *Alexandrium fundyense*, which produces saxitoxin (causing paralytic shellfish poison in humans) and *Dinophysis acuminata*, which produces okadaic acid (causing diarrheic shellfish poisoning in humans). The temperature effect meant increased growth rates of these organisms and increased durations of HAB events (bloom season). Beyond the human health threat, HABs also affect ecosystems (e.g., fish kills) and cetaceans. The authors predict that continued ocean warming will ‘promote the intensification and redistribution of these, and likely other HABs, around the world’.

(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. *PNAS*. 201619575, *https://doi.org/10.1073/pnas.1619575114*).

Oil spills

IMMUNE SYSTEM RESPONSES IN DOLPHINS EXPOSED TO THE DEEPWATER HORIZON (DWH) OIL SPILL

To investigate the effect of the DWH oil spill on living common bottlenose dolphins in Barataria Bay, Louisiana, blood samples were analysed from live-captured animals. Potentially oil-exposed animals demonstrated an increase in T white blood cells (in 2011) and B white blood cells (in 2011 and 2013). Certain cytokine levels were notably different from levels in a control population (and perhaps indicative of bacterial infections by pathogens such as *Brucella* – one of the pathogens that was implicated in the high rate of young dolphin mortalities post-oil spill). The white blood cell responses were similar to ‘those documented in other species following exposure to oil or [polyaromatic hydrocarbons] and were most pronounced in [Barataria Bay in] 2011, at the place and time most affected by oil’.

(SOURCE: De Guise, S., Levin, M., Gebhard, E., Jasperse, L., Hart, L.B., Smith, C.R., Venn-Watson, S., Townsend, F., Wells, R., Balmer, B., Zolman, E., Rowles, T., and Schwacke, L. 2017. Changes in immune functions in bottlenose dolphins in the northern Gulf of Mexico associated with the *Deepwater Horizon* oil spill. *Endanger. Species Res.* 33: 291-303)

OIL-DISPERSANT MIX CAUSES DOLPHIN WHITE BLOOD CELL SUPPRESSION

The immunotoxicity of the oil released in the DWH oil spill and the chemical dispersant Corexit was examined by investigating dolphin white blood cell responses to exposure *in vitro*. Oil exposure caused a proliferation of white (T and B) blood cells, but exposure to the oil mixed with the dispersant led to a decrease. The authors conclude that ‘The immunosuppression of [lymphocyte cells] at environmentally relevant concentrations of oil and dispersant suggests that marine mammals may be unable to mount an adequate defence against xenobiotic threats following exposure to oil and dispersant, leaving them more susceptible to disease’.

(SOURCE: White, N.A., Godard-Codding, C., Webb, S.J., Bossart, G.D. and Fair, P.A. 2017. Immunotoxic effects of in vitro exposure of dolphin lymphocytes to Louisiana sweet crude oil and Corexit™. *J. Appl. Toxicol.* 37: 676-82).

Climate change

COLLAPSE OF THE WEST ANTARCTIC ICE SHEET MIGHT BE INEVITABLE

As a result of climate change-related melting, warm seawater inundation underneath the ice sheet and shearing stresses, there are concerns that the Western Antarctic Ice Sheet will collapse. Satellite images indicate that there is currently a high level of seawater undermining the ice sheet, increasing this likelihood. At present, most moderate (and worst-case) climate change models predict the collapse of the ice sheet. This could lead to a 20 cm rise in sea level per decade by 2100, in addition to major associated Antarctic ecosystem changes.

(SOURCE: Hulbe. C. 2017. Is ice sheet collapse in West Antarctica unstoppable? *Science* 356: 910-11).

CLIMATE CHANGE-INDUCED REDUCTION IN KRILL BIOMASS PREDICTED

A study estimating the effects of ocean warming on krill biomass in the Scotia Sea (the northern part of the Antarctic Peninsula and adjacent areas to the northeast) noted considerable declines. In particular, krill biomass in the northern Scotia Sea could potentially decline by 40%. This would likely have impacts on Antarctic predators – for example, a decline in penguin abundance of 30% was predicted, and there was a high risk of these animals becoming depleted. The study also noted that if current krill fishing ceased immediately, the impacts on the krill population could be mitigated. Although in this model the impacts on mysticetes were slight in this particular region (there was an impact upon pinnipeds), this study nonetheless does project a decline in krill biomass and ecosystem change in at least part of the Southern Ocean because of climate change. This calls for an investigation of the impacts of krill biomass reduction in regions more critical for mysticetes.

(SOURCE: Klein, E.S., Hill, S.L., Hinke, J.T., Phillips, T., and Watters, G.M. 2018. Impacts of rising sea temperature on krill increase risks for predators in the Scotia Sea. *PLoS ONE* 13(1): e0191011, 1-21).

MAJOR DECREASE IN BIOLOGICAL PRODUCTIVITY PREDICTED DUE TO CLIMATE CHANGE

A new study predicted that fish populations may decline by as much as 20% globally and 60% in the North Atlantic due to a decline in ocean mixing, a result of climate change. The model assumes a ‘business-as-usual’ scenario, i.e., carbon emissions continue at the same rate as present. In particular, a combination of changing winds and warmer upper waters in the Southern Ocean will cause more nutrients to sink into the deeper layer of the ocean and become trapped there, substantially decreasing the productivity of Antarctic waters. The authors suggest that these changes could mean that fisheries will be reduced for a thousand years or more. This will have major impacts on the prey base of cetaceans.

(SOURCE: Moore, J.K., Fu, W., Primeau, F., Britten, G.L., Lindsay, K., Long, M., Doney, S.C., Mahowald, N., Hoffman, F., and Randerson, J.T. 2018. Sustained climate warming drives declining marine biological productivity. *Science* 359: 1139-43).

RECORD LEVELS OF ATMOSPHERIC CARBON DIOXIDE LEVELS RECORDED

Atmospheric carbon dioxide levels exceeded 410 ppm in March 2018, the highest levels ever recorded in human history. Predicted levels in carbon dioxide will likely exceed 412 ppm in May 2018, which is 47% higher than pre-industrial carbon dioxide levels.

(SOURCE: Scripps Institution of Oceanography. 2018. The Keeling curve. *https://scripps.ucsd.edu/programs/keelingcurve*).

CLIMATE CHANGE PREDICTED TO INCREASE NUTRIENT POLLUTION

Nutrient pollution (which in turn would result in ecosystem degradation and oxygen-deprived ‘dead zones’) is predicted to increase due to climate change-induced precipitation (which could increase nutrients in river systems by approximately 19% in the USA alone). To prevent this, the amount of nitrogen input into the environment (e.g., via fertilisers) would have to be reduced by a third (thereby affecting food production). In particular, greater precipitation will increase nutrient pollution in the waters of India, China and southeast Asia.

(SOURCE: Sinha, E., Michalak, A.M., and Balaji, V. 2017. Eutrophication will increase during the 21st century as a result of precipitation changes. *Science* 357: 405-8).

Noise impacts

BEAKED WHALES RESPOND TO MID-FREQUENCY SONAR UP TO 100 KM AWAY

The behaviour of tagged Cuvier’s beaked whales was observed in response to mid-frequency military sonar exposure during naval exercises off the coast of southern California. During sonar-exposed deep dives, subsequent shallow dives and surface intervals were longer than normal. The longer interval between deep dives suggested disrupted foraging. Longer deep (foraging) dive intervals were noted even when the sonar sources were approximately 100 km away.

(SOURCE: Falcone, E.A., Schorr, G.S., Watwood, S.L., DeRuiter, S.L., Zerbini, A.N., Andrews, R.D., Morrissey, R.P. and Moretti, D.J. 2017 Diving behaviour of Cuvier’s beaked whales exposed to two types of military sonar. *Roy. Soc. Open Sci.* 4: 170629, 1-21).

HARBOUR PORPOISES RESPOND WHEN EXPOSED TO A SINGLE SEISMIC AIRGUN

Tagged harbour porpoises were exposed to a single seismic airgun for one minute (at a distance of 0.42-0.69 km and sound exposure levels of 135-147 dB re 1 μPa^2) and their reactions recorded. Two animals demonstrated shorter and shallower dives (normal behaviour resumed after 17 hours) and one animal rapidly swam away from the sound source (normal diving/swimming behaviour resumed after 35 hours), avoiding the area of the sound source for six days. This study demonstrates a significant behavioural reaction by harbour porpoises to just a single seismic airgun (seismic surveys typically have an array of many airguns).

(SOURCE: van Beest, F.M., Teilmann, J., Hermannsen, L., Galatius, A., Mikkelsen, L., Sveegaard, S., Balle, J.D., Dietz, R., and Nabe-Nielsen, J. 2018 Fine-scale movement responses of free-ranging harbour porpoises to capture, tagging and short-term noise pulses from a single airgun. *Roy. Soc. Open Sci.* 5: 170110, 1-14, *http://dx.doi.org/10.1098/rsos.170110*).

‘RAMP-UP’ MAY NOT BE AN EFFECTIVE MITIGATION MEASURE FOR PROTECTING CETACEANS FROM MILITARY SONAR

‘Ramp-up’ or ‘soft start’, a gradual increase in volume of an intense anthropogenic sound source, is a frequently touted mitigation measure for intense sound-producing activities, such as seismic surveys or military sonar exercises. The assumption is that the initial low sound level will warn cetaceans that there will be an acoustic event, so that they can move out of the area of impact. However, only a few studies have tested whether this indeed occurs. A study on the reaction of a tagged humpback whale to a ramp-up of mid-frequency sonar (1.3-2.0 kHz) found that there was some response to the ramped-up signal, but the whale was at times unresponsive to the low levels of sound during the soft start. It was suggested that naïve, non-feeding or more skittish animals (such as mothers with calves) might react more readily to the initial low levels of sound, making this method more effective for these classes of animals. Overall, however, ‘ramp-up may not be effective’ as a mitigation measure for intense sound activities.

(SOURCE: Wensveen, P.J., Kvadsheim, P.H., Lam, F.-P. A., von Benda-Beckmann, A.M., Sivle, L.D., Visser, F., Curé, C., Tyack, P.L., and Miller, P.J.O. 2017. Lack of behavioural responses of humpback whales (*Megaptera novaeangliae*) indicate limited effectiveness of sonar mitigation. *J. Exp. Biol.* 220: 4150-4161. [DOI:10.1242/jeb.161232]).

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Adjunct 1. Glossary

Species glossary

Blue whale	*Balaenoptera musculus*
Chilean dolphin	*Cephalorhynchus eutropia*
Common bottlenose dolphin	*Tursiops truncatus*
Common bottlenose dolphin (Black Sea)	*Tursiops truncatus ponticus*
Cuvier's beaked whale	*Ziphius cavirostris*
Fin whale	*Balaenoptera physalus*
Franciscana	*Pontoporia blainvillei*
Gray whale	*Eschrichtius robustus*
Harbour porpoise	*Phocoena phocoena*
Harbour porpoise (Black Sea)	*Phocoena phocoena relicta*
Heaviside's dolphin	*Cephalorhynchus heavisidii*
Hector's dolphin	*Cephalorhynchus hectori*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
North Atlantic right whale	*Eubalaena glacialis*
Risso's dolphin	*Grampus griseus*
Rough-toothed dolphin	*Steno bredanensis*
Short-beaked common dolphin	*Delphinus delphis*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
Vaquita	*Phocoena sinus*
Leatherback sea turtle	*Dermochelys coriacea*
Loggerhead sea turtle	*Caretta caretta*
Annular seabream	*Diplodis annularis*
Black Sea (Azov Sea) anchovy	*Engraulis encrasicolus*
Black Sea shad	*Alosa maeotica*
Black Sea turbot	*Scophthalmus maeoticus*
Common Pandora	*Pagellus erythrinus*
European hake	*Merluccius merluccius*
European sturgeon	*Huso huso*
Indo-Pacific bluespotted cornetfish	*Fistularia commersonii*
Lesser spotted dogfish	*Scyliorhinus canicula*
Parrotfish	*Sparisoma cretense*
Red mullet	*Mullus barbatus*
Turbot	*Psetta maeotica*
Zebra seabream	*Diplodus cervinus*
Antarctic krill	*Euphausia superba*
Comb jelly (filter-feeding)	*Mnemiopsis leidyi*
Comb jelly (predatory)	*Beroe ovata*

Heavy metals

Al – Aluminium
As – Arsenic
Cd – Cadmium
Cr – Chromium
Cu – Copper
Fe – Iron
Hg – Mercury
Mn – Manganese
Mo – Molybdenum
Ni – Nickel
Pb – Lead
Se – Selenium
Sn –Tin
V – Vanadium
Zn – Zinc

Glossary of terms

Abraded: Abrasion is the mechanical scraping of a rock surface by friction between rocks and moving particles during their transport by wind, glacier, waves, gravity, running water or erosion. An abraded coastline is formed by this action.

ACCOBAMS: Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area.

AIS: Automatic Identification System (automatic vessel-tracking system).

Benthic: Referring to the ocean bottom.

Bifenthrin: An insecticide in the pyrethroid family. It is highly toxic to aquatic organisms.

Bioaccumulation: Increase in concentration of a pollutant within an organism compared to background levels in its diet.

Biomagnification: Increase in concentration of a contaminant from one link in a food chain to another.

Biomarker: A biological indicator, e.g., blood chemical levels, of health status or pollutant level.

Biomonitor: Species used to track toxic chemical compounds, elements or their metabolites in the environment. These compounds are typically measured in the biomonitor's blood and urine.

Biosphere Reserves: Areas comprising terrestrial, marine and coastal ecosystems that promote solutions reconciling the conservation of biodiversity with its sustainable use, managed by UNESCO.

Bivalve: An aquatic mollusc with a flattened body enclosed by a hinged shell, e.g., clam, oyster.

Bottom otter trawls: A form of bottom trawl net that 'ploughs' up to 15 cm into the sea floor, using flat boards ('otter boards') to keep the mouth of the net open.

Brucella: Various species of bacteria that cause the disease brucellosis.

CBD Aichi Target: The Conservation on Biological Diversity's biodiversity targets, as determined at the Tenth Conference of the Parties in 2010, in Nagoya, Japan (Aichi Prefecture) – see *https://www.cbd.int/sp/targets/*

Comb jelly: A free-swimming representative of the invertebrate phylum Ctenophora.

CYP1A1: Also referred to as cytochrome P450 1A, a gene whose expression serves as a biomarker for plastics exposure.

CYP2B: Also referred to as cytochrome P450 2B, a gene whose expression serves as a biomarker for plastics exposure.

Cyhalothrin: An insecticide in the pyrethroid family.

Cytokine: Any of a number of substances, such as interferon, interleukin, and growth factors, that are secreted by certain cells of the immune system and have an effect on other cells.

dB: Decibel – a logarithmic measure of sound pressure level.

DDD: The organochlorine pesticide dichlorodiphenyl-dichloroethane, a breakdown product of DDT.

DDE: The organochlorine dichlorodiphenyldichloro-ethylene, a breakdown product of DDT.

DDT: The organochlorine pesticide dichlorodiphenyl-trichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Deltamethrin: An insecticide in the pyrethroid family.

Dinoflagellate: A large group of unicellular algae belonging to the phytoplankton.

Dioxin: Toxic organic chemicals that can accumulate in the blubber of cetaceans. These chemicals are carcinogenic and can cause reproductive defects.
DMV: Dolphin morbillivirus
Endemic: Native or restricted to a certain country, area or region.
Endocrine disruptor: The endocrine system is a system of ductless glands producing hormones that control and moderate metabolic processes in the body. Chemicals that mimic these hormones or otherwise interfere with their activity are known as endocrine disruptors.
Epizootic: A disease outbreak in non-human animals, equivalent to an epidemic in human populations.
Eutrophication: Input of nutrients into an aquatic system, typically associated with excessive plant growth and oxygen depletion.
FAO: Food and Agriculture Organization, an inter-governmental organization with 194 Member Nations.
Gyre: Large system of rotating ocean currents.
HBCD: Hexabromocyclododecane, a brominated flame retardant.
HCB: Hexachlorobenzene, an organochloride compound.
HCH: Hexachlorocyclohexane, a polyhalogenated compound.
Hexacopter: An unmanned helicopter (drone) with six rotors.
Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hertz).
IMO: International Maritime Organisation.
IUCN: International Union for Conservation of Nature.
Lipid weight: A basis of measurement whereby concentrations of a substance are compared to the lipid (fat) content of a material.
LPO: Lipid peroxidation, the oxidative degradation of *lipids*. It is the process in which free radicals 'steal' electrons from the *lipids* in cell membranes, resulting in cell damage.
Lymphocyte cells: Small white blood cells that play a large role in defending the body against disease. Lymphocytes are responsible for immune responses. There are two main types of lymphocytes, B cells and T cells.
μg: Microgram
μPa: Micropascal, a unit of pressure.
MEHP: Monoethylhexylphthalate, a metabolite of the most common phthalate in the environment.
Meningoencephalitis: Inflammation of the membranes of the brain and the adjoining cerebral tissue.
Microplastics: Plastic particles 0.3-5 mm in diameter, often the result of larger plastic pieces breaking down over time.
Morbillivirus: A family of viruses that are typically highly infectious and pathogenic – the family includes measles, dog distemper and dolphin morbillivirus. A number of cetacean mass mortality events have been associated with viruses from this family.
MPA: Marine Protected Area.
Natura 2000: A network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types that are protected in their own right, under the European Commission.
Neritic: Relating to the shallow part of the sea near a coast and overlying the continental shelf.
nmol: Nanomole (equivalent to 10^{-9} moles).
OC: Organochlorine compound.
Organochlorine: Organic compound that contains 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.
Ortho and non-ortho PCBs: Chemical variants of PCBs, relating to their toxicity.
PBDE: Polybrominated diphenyl ether.
PCB: Polychlorinated biphenyl.
PCDDs: Polychlorinated dibenzo-p-dioxins.
PCDFs: Polychlorinated dibenzofurans
Permethrin: An insecticide (and skin medication for scabies and lice) in the pyrethroid family.
Phthalate: A class of substances added to plastics to increase their flexibility, transparency, durability, and longevity.
Polyaromatic hydrocarbons: Organic compounds containing only carbon and hydrogen, composed of multiple aromatic rings (organic rings in which the electrons are delocalized), found in coal and tar deposits.
Polyethylene: The most common form of plastic.
POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.
pmol: Picomole (equivalent to 10^{-12} moles).
ppm: Parts per million
Pyrethroid: An organic compound similar to the natural pyrethrins produced by flowers. Pyrethroids constitute the majority of commercial household insecticides.
Ramsar: The Convention on Wetlands (also known as the Ramsar Convention).
Relic species: A species more widespread or numerous in the past.
TBARS: Thiobarbituric acid reactive substances. The TBARS assay is one of the oldest laboratory measures of oxidative stress in serum or tissues. The assay measures the concentration of malondialdehyde produced due to degradation of unstable lipid peroxides.
TEQ: Toxic equivalent.
Tetramethrin: An insecticide in the pyrethroid family.
UN: United Nations.
UNESCO: United Nations Education, Scientific and Cultural Organization.
WHO: World Health Organisation.
Xenobiotic: Of or relating to substances, typically synthetic, that are foreign to the body or ecosystem.
Zooplankton: Free-floating marine animals.

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Appendix 4

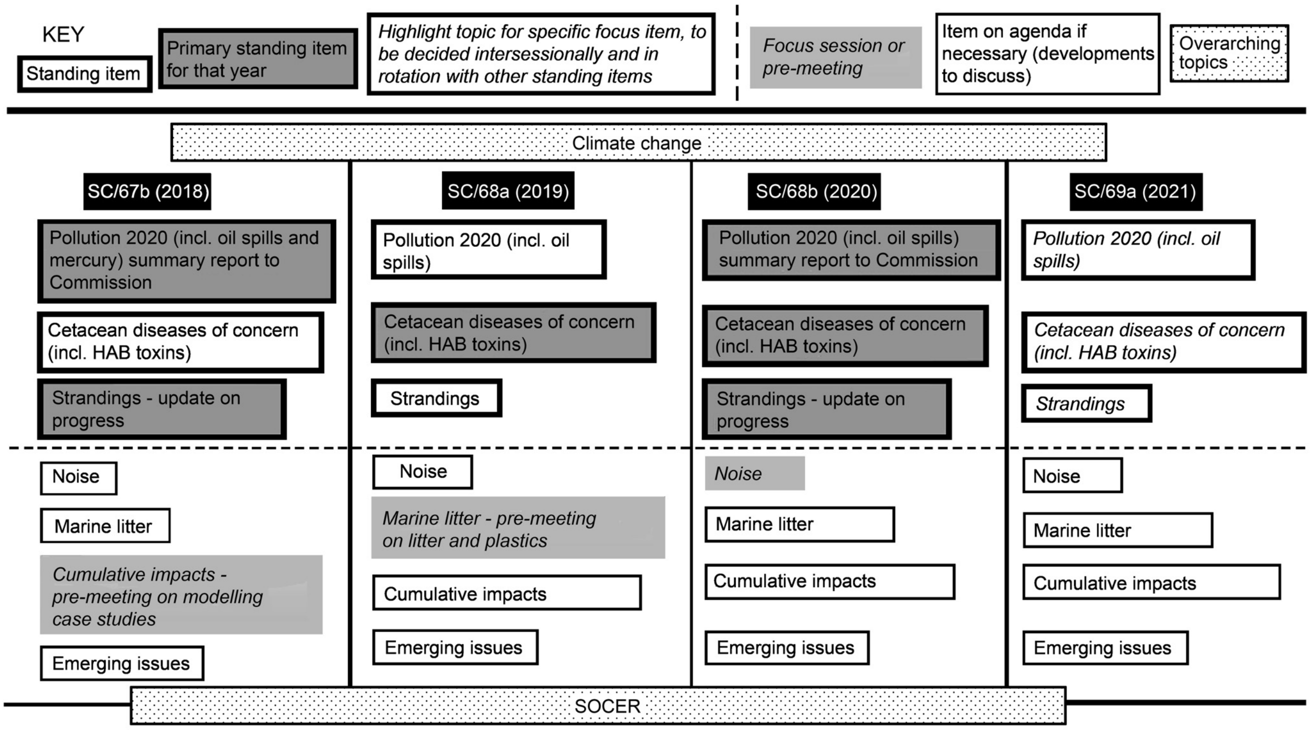

Fig.1. The Work Plan has three long-standing items: pollution, diseases of concern and strandings, three items that are dealt with on a cyclic basis: noise, marine litter and cumulative impacts and an emerging issue. Overarching these topics are SOCER and climate change.

Annex L

Report of the Working Group on Ecosystem Modelling

Members: Kitakado (Convenor), Al Harthi, Aoki, Baba, Bell, Brierley, Brownell, Burkhardt, Buss, Butterworth, Cañadas, Cooke, Dalla Rosa, de la Mare, de Moor, DeWoody, Di Tullio, Domit, Doniol-Valcroze, Donovan, Double, Ferguson, Ferriss, Fortuna, Galletti Vernazzani, Gunnlaugsson, Haug, Hielscher, Irvine, Kim, E., Konishi, Lang, Lundquist, Mallette, McKinlay, Miller, Morita, Moronuki, Mosquera Guerra, Murase, New, Noren, Øien, Palka, Panigada, Pastene, Pierce, Punt, Reeves, Reyes Reyes, Ritter, Rowles, Santos, Simmonds, Skaug, Slugina, Solvang, Strasser, Svoboda, Taguchi, Tamura, Taylor, Torres, Víkingsson, Wade, Walløe, Willson, Yasokawa, Yasunaga, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Introductory 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 Rapporteur
New was appointed rapporteur.

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/67b/EM01-08, SC/67b/SP09, Cunen *et al.* (2018) and de la Mare *et al.* (2018).

2. BODY CONDITION ANALYSES

2.1 Review progress of analyses for Antarctic minke whales

2.1.1 Review of analyses
SC/67b/EM03 reported updated analyses of minke whale body condition using data collected under the JARPA special permit whaling programme. Generalised additive models (GAMs) using penalized regression splines were used to develop models of body weight and blubber thickness (BT11), with a focus on examining the likely shape and variability in any time trends in the accumulation of weight and BT11 over the main part of the summer feeding season. In order to ameliorate space-time confounding introduced by the biennial nature of the JARPA sampling program, separate analyses were conducted for animals taken in the West and the East sampling regions. As all female animals sampled were pregnant, and different bioenergetic relationships might be expected between males and females, separate analyses were also conducted for each of the sexes in order to completely separate sex effects. The long-term trend in condition was examined using model predictions conditioned to evaluate the difference in body weight and BT11 for early- and late-season animals. This provided biennial estimates (with uncertainty) of a relative index of accumulated weight or BT11 over the main part of the summer feeding season. Results indicated very little trend or variability in the improvement in body condition attributable to the period of summer feeding sampled by JARPA, for males or females from the West or East sampling regions. Some slight evidence of a consistent decline for females in the West was reported, but the total decline over eight sampling seasons for this portion of the population was no more than the year-to-year variability found in other segments of the population sampled under JARPA. Results from models of body weight and BT11 were consistent, and models fitted well by all usual criteria. Models also revealed an important, previously unreported relationship between body length, blubber thickness and body weight, showing that blubber thickness proportionately decreases with increasing body length, provided models account for body weight. This relationship was also demonstrated using plots of the raw data, independently of the model results. In addition, the authors demonstrated that average catch lengths have increased over the period of JARPA and that, combined, the implication of these results is that failing to correctly model the length-weight-BT11 relationship will result in false signals of changing condition. The authors posit that misspecifying this important relationship is one of the reasons that other researchers have erroneously concluded body condition is declining.

SC/67b/EM02 presents an updated version of the results section from Cunen *et al.* (2017). Compared to the report that was presented last year, the authors have made some extensions and refinements of the FIC method, and also certain moderate changes to the wide model for the JARPA data. Some of the changes are motivated by the discussions in the Scientific Committee last year. The main conclusion of the analyses is that blubber thickness, fat weight and three other similar variables have declined significantly and substantially over the 18yrs of the JARPA survey. There are some differences between regions, but not between the two sexes.

Due to comments by McKinlay and de la Mare, the authors of SC/67b/EM02 have also investigated the effect of including both body length and body weight or only body weight as covariates in the analyses. The analyses gave year effect estimates a bit closer to zero, but they are all significantly different from zero.

In SC/67b/EM01Rev1 the authors provide their assessment of the work presented in Cunen *et al.* (2018) and SC/67b/EM02 in relation to analyses of minke whale body condition conducted by Norwegian and Japanese scientists. The main issues of concern were: (i) how to correctly account for spatio-temporal confounding inherent to the biennial JARPA sampling program; (ii) how the length-weight-blubber relationship should be modelled, and how omitting weight as a covariate in models of blubber will be likely to induce spurious trends in condition; (iii) that Cunen *et al.* (2018) presents the JARPA data as if it were well-behaved, balanced data; (iv) the wide model, upon which the final result hinges, is chosen arbitrarily by the researcher without application of any objective model selection process; and (v) that models do not account for animal-specific indicators of time spent feeding in Antarctic waters. In relation to point (iv), results were presented that illustrated the dependency of the FIC selection on the choice of the 'wide' model, which lacks a formal criterion. The estimate of the focal parameter from the wide model acts as a strong attractor in the JARPA data because the variation in bias among candidate models is greater than changes in their variance. Some bootstrap results indicated that under hypothetical replication the probability of selecting the same best model could be low.

In SC/67b/EM08 the authors present arguments against the analyses and results presented in SC/67b/EM01 and SC/67b/EM03. Compared to analyses presented to the Scientific Committee by McKinlay *et al*. (2017) and in earlier years, they have this year used a new dependent variable for blubber thickness, that is the change in blubber thickness in each year 'that can be attributed to summer feeding in Antarctica'. To select whales that, in their opinion, fulfil this criterion they use only whales with low diatom load (males) or small foetuses (females) early in the summer season and animals with high diatom load or large foetuses late in the season. The difference in blubber thickness between these two groups was then used as a dependent variable in their analysis. However, there are large uncertainties connected to both of these indicators. Especially for the size of foetuses late in the feeding season, is possible that females with small foetuses have experienced bad feeding conditions resulting in a delayed oestrus and/or a slow growth of the foetus. The result could well have been that McKinlay *et al*. select away from their analyses whales that have experienced bad feeding conditions during the summer. Their analysis also excludes the possibility that whales that have experienced a bad feeding season in one year start out the next year with lower than average fat stores. Thus, their new dependent variable does not account for possible accumulated changes in fat stores over the years. Some of their plots of results from the GAM analyses show indications of overfitting. Even so, their results for blubber thickness are largely consistent with the results presented for blubber thickness (BT11) in SC/67b/EM02, thus indicating a decrease in blubber thickness from the beginning to the end of the JARPA period.

2.1.2 Discussion

Working Group participants were provided with a brief history on the debate surrounding the body condition analysis for Antarctic minke whales. Initial discussion began in 2014, with the conclusion that there had been a statistically significant (5% level) decline in blubber thickness and fat weight (IWC, 2015). Since then there has been some collaboration and considerable development in the types of models used, as well as in-depth discussions regarding the proper handling of data and the explanatory variables to be included in the analysis. Generally, the differences in results are due to the different use of data and models, as well as some areas of statistical debate. In addition, this year a new variable of primary interest was introduced in SC/67b/EM03 by McKinlay, de lar Mare and Welsh (MDW). Cunen, Walløe and Hjort (CWH) consider that this variable was not as appropriate as those used previously. Tables 1 and 2

Table 1

Comparison of the variables used by McKinlay, de la Mare and Walsh (MDW) and Cunen, Walløe and Hjort (CWH) in their 2018 analyses.

Variable	MDW	CWH
Response variable	BWt (revised), BT11 (new)	FW, BT11, BT7, AG, HG
Year	Continuous (NP, 7 df BS) [NP: nonparametric, hereafter] [BS: before shrinkage]	Linear + quadratic
Sex	Separate analyses Female/Male	On
Age	Continuous (NP, 8 df BS)	Off
Body length	Body weight	Body length
Body weight (as covariate in models of BT11)	Continuous (NP, 8 df BS)	Supplementary analyses including it as a linear covariate
Foetus length	Continuous (NP, 8df BS)	Linear
Diatom	Two level factor, Low/High	Two level factor, low/high
Date	Continuous (NP, 8 df BS)	Linear + quadratic
Region	Separate analyses west and east, combined for illustration	Factor; West/East/Ross Sea
Spatial location	Separate longitude effects for each level of ice (NP, 20 df BS)	Latitude as a Linear covariate (Longitude only via Region)
Distance from ice	Two level factor, near/far from ice edge	Supplementary analyses with Ice as a factor – no effect
Interactions	Year x Date; Year x FetusLength; Year x Age; Date x FetusLength; Age x Length; Year x Length; Weight x FetusLength	Diatom x Date; Diatom x Date^2; Latitude x Date; Latitude x Date^2; Year x Region; Year^2 x Region; Latitude x Region; Sex x Region; Diatom x Region; (implicitly via random effects: Date x Year); (have checked: Year x Sex; Year^2 x Sex; Year x Sex x Region; Year^2 x Sex x Region)

Table 2

Comparison of inference used by McKinlay, de la Mare and Walsh (MDW) and Cunen, Walløe and Hjort (CWH) in their 2018 analyses.

Inference	MDW	CWH	Notes
Model	Generalized additive models utilizing routines in R package mgcv.	Linear mixed-effect models.	
Contrasts used; implications	Treatment; results based on predictions that condition on treatment levels.	Sum-to-zero for FIC analyses, Treatment for presentation (in some cases). Two choices give the same fitted lines.	
Inferential method informing condition	Model predictions for early and late-season median length and median age animals, the difference of which provides a standardized relative index of the within season accumulation of weight or BT11.	REML. Look at the year effect directly: focus is the year coefficient (when there is only a linear year effect) or the mean of the derivatives of the response w.r.t year (when there is also a quadratic year effect).	This is the most critical, and significant difference between the two approaches.

provide summaries of the comparisons of the model specification and inferences for the models presented by MDW and CWH.

When discussing SC/67b/EM03, it was noted that there are two ways to implement the shrinkage approach when using generalized additive models. The one taken in SC/67b/EM03 would imply the shrinking of the linear (nullspace) components independently of the non-linear (range space) components (having different degrees of smoothing), while the alternate approach first removes the wiggly parts of the model, smoothing towards a straight line (or nullspace) then once wiggles are removed, the linear parts are removed, smoothing towards a zero effect. Either could be implemented with the models presented in SC/67b/EM03.

CWH reported on investigations of the question of possible decreases in body condition in Antarctic minke whales during the JARPA years using the focused information criterion (Claeskens and Hjort, 2008; Cunen *et al*., 2018). A total of five response variables were studied. Guided by previous comments in the Scientific Committee, the class of linear mixed models (LMM) was used, since these models made it possible to account for dependencies between the observations. The results showed that all five response variables had declined substantially over the JARPA years and that all declines were statistically significant at the 5% level. For blubber at the BT11 position the wide model (which was considered to include all possibly meaningful covariates) had an estimated year effect of -0.0178cm/year with standard error of 0.0071. As indicated in Table 3, the FIC model with optimal estimation capability had an estimated year effect of -0.0186cm/year with standard error of 0.0066. The decline in blubber thickness was somewhat larger in the West than in the East, but no difference in decline was found between males and females, neither in the West nor in the East.

MDW argued that the small increase in whale lengths during the JARPA years could explain the decrease in blubber thickness. Because of this possibility, CWH considered total fat weight, which is the sum of the weight of subcutaneous fat ('blubber') and the weight of the intestinal fat dissected out during the flensing of the whale to be a more reliable measure of storage of fat. This variable also showed a substantial and significant decline over the JARPA years when LMM were used. In the winning FIC model, with its selection of bias variance trade-off, there was an estimated year effect of -0.0073 tons/year with a standard error of 0.0023. Again, only small differences were found between the two sexes.

Table 3

Change in focus variable with years.

Variable*	Slope Estimate	SE	t	p-value#
Blubber at BT11	-0.0186 cm/year	0.0066	-2.83	0.0046
Fat Weight	-0.0073 tons/year	0.0023	-3.10	0.0019

*Similar result for the three other response variables. Only small difference between the two sexes. #P-value for both sides test.

CWH noted that in SC/67b/EM01 and SC/67b/EM03 a new variable of primary interest was introduced by MDW, namely the 'accumulated blubber thickness in each feeding season'. CWH considered that the prediction process used in these papers for estimation of summer improvement in condition relied on a number of uncertain assumptions and that the summer accumulation of blubber thickness did not fully reflect the potential year trend. For instance, if one season had been "bad" the whales would probably start the next season at a lower level, while the summer accumulation would stay the same or even increase. As a result, CWH considered this choice of focus variable to be less informative than looking directly at the effect of year.

In discussion it was noted that marine mammals use both fat stores and protein stores for energy when fasting. Therefore fat stores are not the only location from which mass will be lost during fasting or periods of low food availability. A participant suggested that this was a sufficient reason to include total body weight in the models for Antarctic minke whale condition, especially as blubber mass varies with body size and given the individual plasticity in fasting physiology. An additional suggestion was made that further progress may be made on this issue by inviting a larger group of physiologists to take part in the discussions.

MDW provided Table 4, which gives the inverse variance weighted linear regressions of the yearly estimates of accumulated blubber thickness that were presented in SC/67b/EM03. The response was accumulated blubber thickness between the 20th percentile of sampling data for low diatom animals and the 80th percentile of sampling data for high diatom animals. Thus the analyses examined the gain in condition that can be attributed to summer feeding and accounting for the interactions between body length and weight, which were shown to be an important feature of the data. Full details of conditioning for predictions are in SC/67b/EM03.

In summary, MDW noted that there were no substantial trends in three of the four subdivisions by sex and region (East or West). Only for females in the West was there evidence of a decline. The combined results had a negative trend, which was not significant. However, MDW considered that claims for a negative overall trend were misleading because the year trends were only negative and significant for females in the western half of the JARPA survey area. For the purpose of ecological modelling the authors consider that the regions and sexes should be treated separately.

There was general agreement between MDW and CWH that the choice of an initial model for any analysis should be as inclusive as possible, incorporating all relevant explanatory variables and interaction terms. However, MDW considered that the results of FIC analyses were dependent on the selection of the wide model. MDW considered that that an issue with the FIC method was that there appears to

Table 4

Inverse variance weighted linear regressions of the yearly estimates of accumulated blubber thickness.

Model	Year trend	SE	t	p-value
Females East	+0.0029	0.0099	+0.290	0.780
Males East	+0.0036	0.0101	+0.359	0.730
Females West	-0.0378	0.0004	-9.174	<0.001*
Males West	-0.0100	0.0142	-0.703	0.509
Combined	**-0.0097**	**0.0122**	**-0.789**	**0.436**

*The statistical significance is substantially overstated because the predictions come from a smoothed predictor that was nearly linear.
P-value for both sides test.

be no formal criteria for model selection of the wide model, presenting a difficulty given their belief that the results of the FIC selection were dependent on the wide model estimate of the 'focal parameter'.

The summaries of analyses by CWH and MDW are respectively given Appendices 2 and 3.

At the conclusion of the discussion, statements were made regarding the Data Availability Agreement related to the body condition analysis for the use of JARPA data. These statements can be found in Appendix 4.

2.1.3 Conclusions

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 in Antarctic minke whales over the 18 years of the JARPA surveys (IWC, 2015). Over subsequent years, multiple analyses have been presented to the Working Group supporting or arguing against this conclusion. Statistical estimation methods have been refined and some analysts have (giving reasons, though these are not universally accepted) changed the variables which they consider for the evaluation of whether or not there has been a decline. The Working Group **agreed** that for the data set considered as a whole, all approaches result in point estimates reflecting a decline when fit to a linear trend in time. However, the extent of the decline estimated differs amongst the methods and is not statistically significant at the 5% level for all approaches. Furthermore, for some approaches, when the data are disaggregated by gender and/or area, some point estimates of trend are not negative; in addition, there are some indications of temporal variation that is more complex than linear. The Working Group thanked the authors for their dedicated efforts towards refinement of their analyses and encouraged them to publish the results of their studies as soon as possible. The Working Group **agreed** that this matter need not be discussed further before the 2021 meeting at the earliest.

2.2 Review approaches used in body condition analyses for other stocks

The Chair welcomed the information that there would be a bowhead whale body condition analysis presented to the Working Group within the next two years. He also encouraged other members in the Working Group to bring forward relevant research.

3. REVIEW ISSUES RELEVANT TO ECOSYSTEM MODELLING WITHIN THE COMMITTEE

3.1 Individual-based energetic models

SC/67b/EM07 outlines enhancements to the individual-based energetics model (IBEM) developed since last meeting (also discussed in the RMP Sub-Committee, see Annex D). One of these changes enabled feeding on migration to be explicitly modelled. The model now also allows for more detailed foraging behaviour including the modelling of individual dives (de la Mare *et al.*, 2018) and searching for prey schools (SC/67b/EM04). Results presented for 'minke like' whales showed that carrying capacity and productivity were sensitive to the level of food available during migration. An important implication is the need for ecosystem models to cover the entire migratory range of the species.

The Working Group noted that contribution of SC/67b/EM07 with regards to the determination of species functional responses is a valuable contribution for ecosystem modelling. The explicit foraging behaviour also enables the investigation of varying costs of foraging over different ranges of prey density and species abundance.

3.2 Modelling of relationship between whales and prey

De la Mare *et al.* (In review) provided an update on the individual based model of feeding diving behaviour. The model is process based, using high-resolution data from suction cup tags that record the characteristics of dives and individual feeding lunges. These data enable the calculation of functional relationships, which describe food consumption and energy gain as functions of the density of locally available food. Functional responses are central to the development of ecosystem models. The model demonstrated likely differences in the functional responses of two species, blue whales and minke whales. These responses indicated that blue whales were more efficient at exploiting prey at lower densities. The analyses also demonstrated that functional responses can depend on length of daylight and the vertical distribution of prey, particularly when prey density is measured by integrating over depth (e.g. gm.m^{-2}).

The authors emphasised that the purpose of this exercise was to illustrate the properties of the model and determine what might be done to improve it. One such improvement was the inclusion of more realistic prey fields based upon empirical data. However, it is an advance over previous attempts to estimate functional response.

SC/67b/EM04 described a model that investigates the role of searching for suitable food patches when developing functional responses. The model relates large-scale prey average density (gm.m^2) to the probability that an animal transiting in a region will detect a prey school within a given distance of its track. The prey model is based on Brierley and Cox (2015) which shows that changes in large-scale density tend to arise from changes in the number of prey aggregations rather than changes in their characteristics (such as volume and density). The resultant functions are sensitive to the distance at which whales are able to detect prey aggregations. However, in relation to the density of krill in the Antarctic the large scale densities found in surveys are such that the model predicts that the time whales spend searching for krill swarms is unlikely to be the most important effect in defining the functional response.

Different areas of active research aimed at measuring blue whale's detection distance to krill swarms were discussed. These included the use of drones and photogrammetry, and the use of focal follows to determine the distance between periods of area restricted search. However, it was noted that both approaches would be more challenging for krill swarms at depth.

Foraging grounds of the Antarctic blue whale were surveyed in the austral summer of 2015 during the joint New Zealand-Australia Antarctic Ecosystems Voyage. Using this dataset, SC/67b/EM06 described the distribution of these rare whales in relation to their main prey species, Antarctic krill. A combination of passive acoustic technology and visual observations were used to locate Antarctic blue whales, whilst simultaneously using active underwater acoustics to characterise the distribution and density of krill swarms. Results suggested that Antarctic blue whales were more likely to be present within the vicinity of krill swarms detected at night, those of higher internal density, greater vertical height, and those found shallower in the water column. This study demonstrated that using complementary, multidisciplinary technologies can provide insights into sub meso-scale (i.e. <100 km) foraging behaviour of rare whales in a challenging environment. The nature of krill aggregations preferred by Antarctic blue whales is an important consideration, not only for the management of this endangered species in a changing environment, but also for the management of Antarctic krill fisheries.

It was clarified that the time and distance resolution used in SC/67b/EM06 (1hr and 12km) were based upon observer distance. In the future, different scales will be explored to determine at what point the observed relationship no longer holds. However, a more detailed exploration of the data is required before this aspect of the analysis can be addressed.

3.3 Modelling of competition among baleen whales

It was noted that multi-species individual based energetic models (IBEM) could be used to model direct and indirect competition of different whale species in the same environment. A version of the program to model competition between humpback and minke whales in the Antarctic was nearing completion. The Working Group expressed interest in this work and welcomed future submissions to the Scientific Committee.

3.4 Effects of long-term environmental variability on whale populations

The Working Group noted that this was an active area of research and was of particular interest to the Scientific Committee with regards to how long-term environmental variability might affect stock assessments. The need for a literature review on the subject was highlighted, and the Working Group **agreed** to form an intersessional correspondence group with Cooke as convenor.

3.5 Stable isotope analyses

SC/67b/SP09 reported the preliminary results of a stable isotope analysis on samples from the edge of baleen plates in Antarctic minke whales. The aim of this exercise was to estimate the duration of the time whales had spent in the Antarctic feeding grounds. The stable carbon (δ13C) and nitrogen isotope ratios (δ15N) were determined from the edge of baleen plates of ten pregnant females in the Ross Sea, and six immature females sampled in the NEWREP-A surveys in 2016 and 2017. In the pregnant females, about four fluctuations of δ15N were seen at each baleen plate. The trophic enrichment factor (TE) was estimated to be 3.48%. This TE and δ15N values in all parts of baleen plate suggested that the whales fed mostly on Antarctic krill for a long period. In the immature animals, the temporal change of δ15N was high after birth, and was followed by a rapid decrease, probably indicating high values δ15N drops when they feed on krill. The growing ratio of baleen plates is the most important data needed to estimate the duration of time whales spend in the feeding grounds, and to determine the meaning of the fluctuations observed in the pregnant females. Knowledge of the behaviour of δ15N when the whales are fasting could also help in understanding the observed fluctuation. Geographical variations will be examined by analysing additional samples in the future.

4. ECOSYSTEM MODELLING IN THE ANTARCTIC OCEAN

The Working Group expressed interest in the continuation of plans for joint workshops with CCAMLR on ecosystem modelling in the Antarctic Ocean. It was **agreed** that a two-year delay in the occurrence of the workshop would provide the Working Group with the opportunity to pursue and complete the relevant work, and that in the interim they would seek information and advice from CCAMLR as needed. As in previous years, the Working Group **recommended** that collaboration between SC-IWC/SC CCAMLR be on going and that the revised plan for the workshops be implemented by SC68b.

Attention: Scientific Committee

*The Working Group **recommended** that collaboration between SC-IWC/SC CCAMLR be on going and that the revised plan for the workshops be implemented.*

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5. APPLICATION OF SPECIES DISTRIBUTION MODELS (SDMS) AND ENSEMBLE AVERAGING

An update on the intersessional correspondence group on the applications of species distribution models (SDMs) was presented to the Working Group. While there was not significant progress between meetings, the Working Group **agreed** that developing guidelines for best practice for species distribution models (SDM) was important and that the correspondence group should be retained.

6. OTHER MATTERS

6.1 Review information on krill distribution and abundance by NEWREP-A

SC/67b/EM05 reported the results of the krill and oceanographic surveys during the third NEWREP-A survey in Areas V-E and VI-W. The surveys, which are associated with the main objective II of NEWREP-A, were conducted by two research vessels *Yushin Maru* No. 2 (YS2) and *Kaiyo Maru* No. 7 (KY7). The surveys were conducted along the zig-zag tracklines designed for the whale sighting survey. Acoustic data using quantitative echosounders EK80 (YS2) and EK60 (KY7) were recorded continuously for a total of 73 days (6,608 n. miles). Net sampling using small ring net (YS2 and KY7) and an Issak-Kid Midwater Trawl (IKMT) (KY7) was carried out to identify species and size composition of plankton echo signs at 47 stations and 11 stations, respectively. Oceanographic observations were also conducted at 112 stations using a Conductivity-Temperature-Depth profiler (CTD) and seawater sampling occurred at 16 stations. Calibration among EK80 and EK60 quantitative echosounders, and simultaneous samplings between small ring net and IKMT were also conducted. Krill and oceanographic data are currently being examined, and results will be reported to the relevant CCAMLR working group and the mid-term review of NEWREP-A.

In discussion of SC/67b/EM05 it was noted that an objective of the NEWREP-A survey is to study the variation in abundance of different krill species in order to define the prey landscape as relevant to the whales. Given the difficultly in distinguishing species acoustically, the authors are currently using net sampling to ensure species identification and are pursuing on-going research with experts to be able to identify species based solely upon the data collected by the echosounder. This information was welcomed, as it would be a large step forward in ecology and ecosystem modelling, but achieving this objective is likely to be very difficult.

It was also clarified that the departure from the expected krill survey design recommended by CCAMLR was due to the data being collected in conjunction with a survey for whales. In particular, there is simulation work underway to compare the bias and precision of the krill biomass estimates that might be achieved from the NEWREP-A survey design versus that which will be achieved following the standard survey design advocated by CCAMLR. In addition, data collection has been increased in an attempt to obtain the required number of samples. A concern was raised that data collected from EK60 and EK80 echosounders may not be comparable.

6.2 Ecosystem functioning

Resolution 2016-3 tasked the Working Group with investigating the contribution of cetaceans to ecosystem functions. The interessional correspondence group (ICG-28) reported progress in this area, developing terms of reference that included: (1) determining how best to integrate this task into the Ecosystem Modelling Working Group; (2) reviewing and developing pathways between cetaceans and ecosystem services, as well as integrating these into ecosystem models; and (3) develop a gap analysis regarding research in the contribution of cetaceans to ecosystem models and identify needed research. The importance of identifying an area, or areas, where such research could take place was also highlighted. There is broad interest in understanding the role of cetaceans in ecosystem functions, as evidenced by the recent Convention on Migratory Species (CMS) and the formation of a Standing Working Group on Cetaceans and Ecosystem Functioning in the Conservation Committee, in which it is acknowledged that migrating cetaceans provide valuable contributions to ecosystem function. Specifically, the Working Group will be looking at the scientific aspects of ecosystem functions, while the Conservation Committee will focus on the conservation and social science aspects of the issue. Further, CMS has expressed interest in collaborating with the IWC to advance development on this issue.

In discussion, the need to develop a framework to approach this complicated issue was raised. It was **agreed** that in order to understand the contribution of cetaceans to ecosystem services it was first necessary to identify broad gaps in our knowledge, the broad ecosystem function categories of interest, data needs and availability, and geographical locations as well as species that may be suitable for exploration of this issue. Only after this was achieved could detailed modelling approaches be considered, but first feasibility studies would need to be undertaken (see subsequent discussion at end of this section). It was determined that the Southern Ocean was the mostly likely place where the role of cetaceans in ecosystem function could be studied, because smaller regions would suffer from complications when accounting for immigration and emigration. Another advantage of the Southern Ocean was the possibility of cooperation with CCAMLR, and other organisations such as CSIRO, to share relevant data. Additional organisations, such as the Scientific Committee on Ocean Research (SCOR) and the Scientific Committee on Antarctic Research (SCAR), are already doing research in this area that is relevant, particularly with regards to ocean ecosystem variables.

Lastly, it was noted that even where data available and study systems were well defined, it may not be possible to determine the contribution of cetaceans to ecosystem services. Many researchers have studied multi-species interactions and ecosystem models over the years, but general conclusions have been difficult to draw. The Working Group agreed that is was worthwhile to pursue research into the contribution of cetaceans to ecosystem functioning, but that it must be done with the acknowledgment that the work may not be as successful as anticipated and that it is unlikely that the ultimate goal of fully determining the contribution of cetaceans to ecosystem functioning could be achieved in under a decade. A more immediate and achievable goal is the carrying out of a gap analysis to address knowledge gaps. Therefore, the Working Group agreed that it would be beneficial to hold a workshop to define clear objectives and determine what further research is required in order to begin modelling the contribution of cetaceans to ecosystem function, and that CMS should be approached to determine their interest in participating in such a workshop.

Table 5

Summary of the two-year work plan for the EM Working Group.

Item	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting (SC/68b)
(1) Ecosystem modelling in the Antarctic Ocean	Continue further analyses.	Review results of further analyses	Continue further analyses.	Review results of further analyses
(2) Application of species distribution models (SDMs)	Intersessional Working Group activity (see Annex Y)	Review progress Working Group.		
(3) Effect of long-term environmental variability on whale populations	Continue further analyses. Intersessional Working Group activity (see Annex Y)	Review results of further analyses. Review progress Working Group.	Continue further analyses	Review results of further analyses
(4) Further investigation of individual-based energetic models	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(5) Modelling of competition among whales	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(6) Update of any exercises on krill distribution and abundance	Conduct NEWREP-A krill survey and an international cooperative krill survey. Conduct simulation analyses to resolve issues on survey design.	Review results of survey and analyses.	Conduct NEWREP-A krill survey. Conduct analysis of data taken by the international survey.	Review results of survey and analyses.
(7) Cetaceans and Ecosystem Functioning: a gap analysis workshop	Review relevant scientific studies before workshop (or pre-meeting) in addition to preparation of workshop.	Review outcomes of workshop and develop clear work plans with priorities.	Continue analyses	Review results of analyses.

Table 6

E-mail Intersessional Correspondence Groups, Steering Groups, Working Groups and Terms of Reference (see Annex Y for final list).

Group	Sub-committee	Terms of Reference	Membership
(1) Applications of species distribution models (SDMs)	EM	Develop guidelines and recommendations for best practice in species distribution modelling	Murase (convenor), Friedlaender McKinlay, Miller, Kelly, Kitakado, Palacios, Palka
(2) Effects of long-term environmental variability on whale populations	EM	Compile a literature review on the subject of how environmental variability may affect whale populations	Cooke (convenor), Butterworth, de la Mare, Kitakado
(3) Cetaceans & Ecosystem Functioning: a gap analysis workshop (Steering group)	EM	Prepare a Workshop under a Steering Group	Ritter (convenor), Butterworth, Donovan, Galletti, Kitakado, Suydam

Table 7

Summary of the 2-year budget request for Ecosystem Modelling.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
EM-1	Cetaceans and Ecosystem Functioning: a gap analysis workshop	£20,300	
Total request		**£20,300**	

7. WORK PLAN AND BUDGET REQUEST

7.1 Work plan for 2019-2020

The Working Group discussed the proposed details of the workshop agreed upon in Item 6.2, which would be integrated with the work being done by the Sub-Committee CMP. It was noted that there were many researchers already working on understanding the contribution of species to ecosystem function, including ecosystem modellers. As a result, it was suggested that the list of workshop participants try to represent the different research groups with experience working in this area. The workshop would then provide an opportunity to bring people together and combine resources to avoid the problem of different groups attempting to solve the same problem. The Working Group **endorsed** the workshop proposal.

In response to the proposed workshop, Japan made the following statement.

As Japan expressed at the occasion of the adoption of Agenda of this Scientific Committee, it does not support the Scientific Committee to deal with issues outside the competence of IWC. It found that a number of activities envisaged to be dealt with at the proposed workshop are outside the competence of IWC. For this reason, Japan cannot support the proposed workshop, and especially it cannot support the allocation of a budget of Scientific Committee for this purpose.

7.2 Budget requests for 2019-2020

Table 7 summarises budget requests for the Ecosystem Modelling Working Group.

8. ADOPTION OF REPORT

The report was adopted on 2 May 2018 at 12:22. The Chair expressed his sincere appreciation to the rapporteur, New, for her excellent work and thanked the participants for their valuable contributions. The Working Group thanked Kitakado for his leadership and gratefully accepted his offer to convene the Group next year.

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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 Review progress of analysis for 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 Modelling the relationship between whales and prey
   3.3 Modelling of competition among baleen whales
   3.4 Effects of long-term variability on whale populations
   3.5 Stable isotope analyses
4. Ecosystem modelling in the Antarctic Ocean
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   6.1 Review information on krill distribution and abundance by NEWREP-A
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7. Work plan
   7.1 Work plan for 2019-2020
   7.2 Budget requests for 2019-2020
8. Adoption of report

Appendix 2

BODY CONDITION ANALYSES IN ANTARCTIC MINKE WHALES

Céline Cunen, Lars Walløe and Nils Lid Hjort

Introduction

In Cunen *et al.* (2017) and in later contributions (for instance SC/67b/EM02 of this year), we have investigated the question of decreasing body condition in Antarctic minke whales during the JARPA years. We have devoted considerable energy into developing and motivating a biologically plausible model for the measurements of body condition (we call this 'the wide model'). We have looked at a total of five, correlated response variables. In this appendix, we summarise our analysis of blubber thickness (BT11), because McKinlay *et al.* have analysed this dependent variable in their analyses (SC/67b/EM01 and SC/67b/EM03), but we have similar results for the four other responses. Guided by previous comments in the Scientific Committee, we have used the class of linear mixed models, since these models make it possible to account for dependencies between the observations. Specifically, we let several terms in our model be affected by random effects, which let observations from the same season (year) be correlated. The main question is whether there has been a considerable and statistically significant decrease in body condition, which in our regression framework translates into whether we can claim that the parameters describing the effect of year are negative and significant on any usual level of significance (when we have a linear year effect, there is only one parameter describing the year effect).

In large biological models like the one we have used here, there is often a need for some model selection criterion. The main reason for this is that the models that are biologically plausible and well-motivated, usually are very big (i.e. have many parameters) since we have many different predictor variables that may influence the response. Such a big model will often lead to large uncertainty around the parameter estimates and thus make it difficult to draw clear conclusions from data. Model selection aimed at simplifying a large model can be conducted in various ways, some ad hoc and others more principled. A common example of such a procedure is the usual backward selection of predictors; another example is in a way penalised regression methods. Here, we have used the focused information criterion (Claeskens and Hjort, 2008), which offers a principled way of reducing the number of parameters in a large model **when one has a specific focus in mind**. The focus parameter is the parameter of main interest and needs to have a clear statistical interpretation across candidate models. Here it is natural to focus on some measure of the year effect (we will come back to how we define this), since this informs the main question of the analysis.

Since the existing FIC framework did not cover the class of linear mixed effect models, we have developed a new FIC for the occasion (see Cunen *et al.,* 2018). We have used FIC to find a simpler model which describes the year effect as precisely as possible. This sentence must not be understood as FIC always finding a model with a significant focus parameter: if the estimated focus parameter is small compared to the variance, FIC can select a model where the focus parameter is zero. We have also analysed the wide model in itself. Both in the model selected by FIC (the winning model) and in the wide model we obtain negative and significant year effects. As expected (given the aim of FIC), the model selected by FIC estimates the year effect with better precision. Our finding is also strengthened by the fact that FIC gives a very bad score to any linear mixed effect model not containing the year effect: if the signal in the wide model had been weak, a model without year effect would have been preferred (since that model has zero variance), but that was not the case. In our view, there is therefore sufficient evidence that there has been a decline in body condition during the JARPA period.

Note that here we use the same wide model as in SC/67b/EM02 but we have investigated several small alterations to this model. Specifically, we currently favour a model similar to the model in SC/67b/EM02, but with an extra second order interaction term *Sex* ∗ *Year* ∗ *Region*, which allows us to investigate differences in year effect between regions and males/females. Results from using this model have been reported on in SC/67b/EM08 and importantly, **they do not change the main conclusions we present here**.

Wide model and candidate models

We have used a similar wide model to the one in Cunen *et al*. (2017).

The few alterations compared to the wide model in Cunen *et al*. (2017) are described in SC/67b/EM02. The wide model contains a second order effect of year. This allows the wide model to handle more complicated trends than simply linear ones. A natural definition of the focus parameter in the wide model is then $\mu = \beta_{year} + 2\beta_{year2}\bar{x}_{year}$, where the term is the mean year in the dataset and β_{year2} is the coefficient corresponding to the second order year term. The focus parameter corresponds to the derivative of the response with respect to year, and then evaluated in the mid-point year; it may also be interpreted as the mean of the derivative values of the response, across the years of study. Crucially, since the candidate models are supposed to be as simple as possible, and since the second order term appears to be quite small, we

Table 1

```
cc1 <- lmer(BT11~YearNum + I(YearNum^2) + BLm + Sex + DiatomF +DateNumS
      + I(DateNumS^2) + LatNum + Sex:Fetus.length + Sex*DiatomF
      + DiatomF*DateNumS + DiatomF*I(DateNumS^2) + LatNum*DateNumS
      + LatNum*I(DateNumS^2) + Region + YearNum*Region
      + I(YearNum^2)*Region + LatNum*Region + Sex*Region
      + DiatomF*Region + (1 +DateNumS + I(DateNumS^2)|YearNum),
      data=df1,contrasts = list(Region="contr.sum"))
```

have only included candidate models with linear year effect. For these the focus parameter is simply as $\mu = \beta_{year}$ before.

The model defined above has p = 27 fixed effect coefficients. The notation (1 + *Date* + *Date*^{2}|*Year*) specifies the random effect structure; the groups are defined by a categorical version of the year variable. We have 3 random effects giving a total of 34 parameters to estimate. For now, we have limited ourselves to investigating 22 candidate models (check SC/67b/EM02 for model specifications). The models differ in their random effect structure, their inclusion of , the inclusion of some interaction terms, and a few fixed effects. The last model, , is a baseline model without any year effect, so $\mu_{M_{22}} = 0$.

Interpreting FIC results

The focused information criterion ranks the different candidate models according to how precisely they estimate the parameter of main interest (the focus). Precision is measured as mean squared error (MSE) under the wide model. The model with the lowest FIC score is the winning model according to FIC. In some cases, this could be the wide model itself, but usually it will be a smaller model. If the signal in the focus parameter is weak in the wide model, FIC will select a model not containing the focus parameter (M_{22} in our case): FIC thereby conducts an implicit test of the focus.

The FIC approach we have used in Cunen *et al*. (2017) and Cunen *et al*. (2018) hinges on a biologically plausible wide model (which the user must believe is wide enough to accurately represent the real data generating mechanisms) and consists of a principled way of reducing this wide model in order to obtain more precise estimates of a certain parameter of interest. Unlike the wide model, the candidate models need not necessarily be biologically plausible: the candidate models are primarily meant to produce good estimators and are not necessarily meant to be interpreted as being close to the true data-generating mechanism. Thus the candidate models need only contain covariates that influence the estimation of the focus parameter. The candidate models may therefore lack some covariates that are important in themselves, but do not influence the focus. When a candidate model is selected by the FIC score it must be interpreted in the following way: this candidate model accurately represents the focus parameter in the wide model, but the user still believes in the wide, not the candidate.

Results from model selection with FIC

We have 4,718 observations. The results of model selection are displayed in the FIC plot below. There, one can read of the root-FIC scores and estimates of the models. The scale in use for both estimates and root-FIC scores is in

Table 2

```
cc6 <- lmer(BT11~YearNum + Sex +DateNumS + I(DateNumS^2) + LatNum
      + Region + (1 +DateNumS + I(DateNumS^2)|YearNum),
      data=df1,contrasts = list(Region="contr.sum"))
```

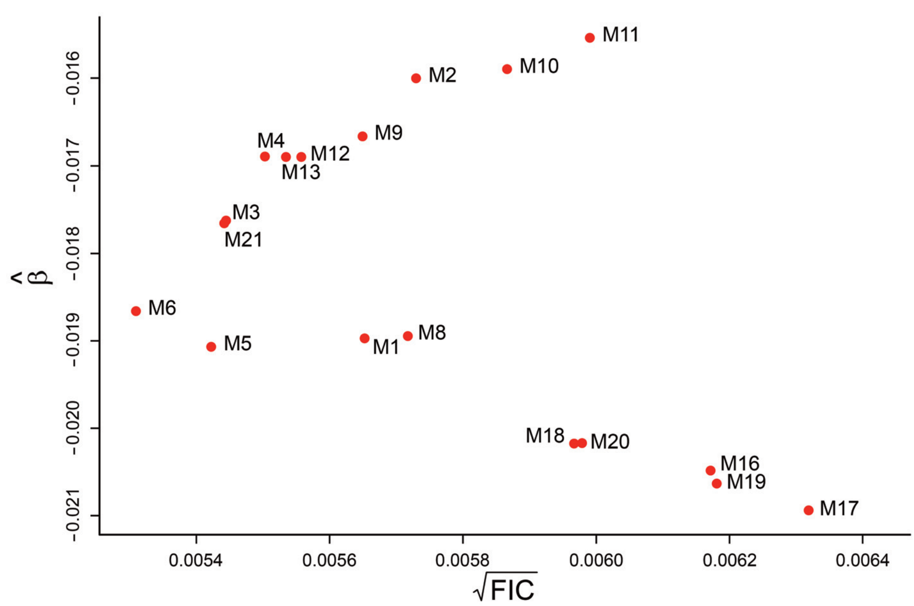

Fig. 1. FIC plot for BT11, showing only the best models. The baseline model has root-FIC score of 0.016 and the wide model has root-FIC score of 0.0071 and gives a focus parameter estimate of -0.018.

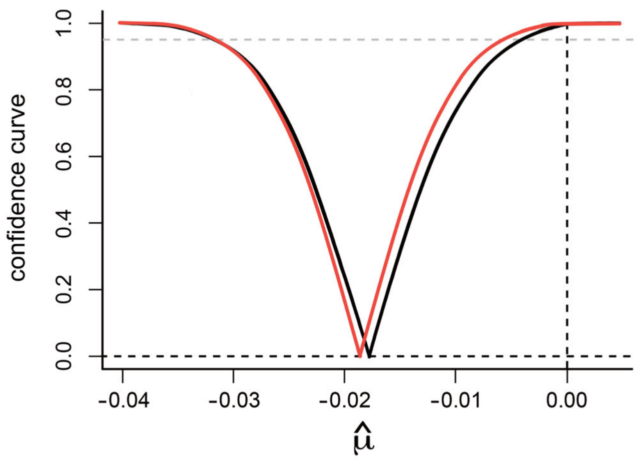

Fig. 2. Confidence curves for the effect of year, for the wide model (black) and the winning model (red).

centimeters. For ease of presentation, the figure is zoomed in on the best models. The winning model is M_6.

Presenting the wide model and winning model

In the wide model we had an estimated year effect of **-0.0178** with standard error of **0.0071**; in the winning model we had an estimated year effect of **-0.0186** with standard error of **0.0066**. Note that this standard error is calculated **under** the wide model, i.e. we still believe in the wide model, but we use the winning model as a lower dimensional representation of the wide model. We can look at the full confidence curve for the focus parameter in the wide model. We see that it is significant at most common levels of significance. We can also compute the confidence curve for the winning model . Again, the confidence curve is computed **under** the winning model. We see that it is narrower and has a slight bias compared to the wide model.

Problems with MDW

In 'No substantial change in Antarctic minke whale condition during the JARPA years' (SC/67b/EM03), the authors, hereafter referred to as MDW, model two responses, body weight (BWt) and blubber thickness (BT11), using the framework of generalized additive models (GAMs). They split the available data into four parts according to sex and region (West/East) and provide some arguments for this choice. In their presentation of the results, they introduce a new focus parameter (a variable of primary interest), namely the *accumulated blubber thickness in each year*. We will focus our attention on the BT11 analyses in SC/67b/EM/03. The choice of response variable was discussed in great lengths in the 2017 Scientific Committee meeting and in our opinion, several delegates agreed that total body weight constitutes a less relevant measure of body condition compared to the available measurements of blubber thickness, fat weight and girth. The following is a summary on our assessment of MDWs contribution (full text in SC/67b/EM08).

(1) We consider MDW's choice of focus (the accumulated blubber thickness in each year) to be less informative than the more natural choice of looking at the effect of year directly. The accumulated blubber thickness does not fully reflect the potential year trend. For instance, if one season has been 'bad' the whales will probably start the next season at a lower level, while the accumulation stays the same or even increases. Also, we do not believe that MDW have chosen a suitable model for assessing the accumulated blubber thickness: the model should have included the year covariate only through its interaction terms and not as a main effect. In addition, we are skeptical to the way MDW define their early and late season whales – we are concerned that some individuals in poor condition may have been inadvertently excluded from the predictions, it seems like they might condition on a late season whale being healthy, which will likely obscure any patterns of decreasing body condition. Especially for the size of fetuses late in the feeding season, it is possible that females with small fetuses have experienced bad feeding conditions resulting in a delayed estrus and/or a slow growth of the fetus. The result could well have been that McKinlay *et al.* select away from their analyses whales that have experienced bad feeding conditions even if they have been in the Antarctica the whole austral summer.

(2) It is our opinion, when looking at the partial effects plots of year effect in MDW's models, that their results are broadly consistent with ours, and with our opinion that there has been an overall decrease in body condition. Their models show that for most groups of whales there has been a decrease in body condition over the JARPA years. For some groups the decrease has been more pronounced than the overall decrease, while for other groups it has been less pronounced. The reason MDW reach opposite conclusions compared to ours in SC/67b/EM03, lies not in our mostly linear approach, nor in 'our failure to' include body weight and length as the size controlling variables The differences in conclusion are primarily due to MDW's non-standard and unusual choice of focus, namely the accumulated blubber thickness in each season. Although MDW have provided some arguments for this choice of focus parameter, we note that their analyses are heavily influenced by the predictor values they choose to condition on.

(3) Splitting up the data into four parts is unnecessary. On the contrary, we believe that one should allow the possibility of borrowing strength between regions, while also including interaction terms so that potential differences are taken care of. MDW claim that space and time are 'exactly confounded', but in our opinion this would only be correct if one believed in absolutely no smoothness in space and time. Splitting the data can make issues with uneven sampling worse, as it hinders the model to benefit from existing similarities between effects in the different groups defined by MDW.

(4) We also find that the decline in blubber thickness is somewhat larger in the West than in the East, but we do not find any difference in decline between males and females, neither in the West nor in the East. MDW argue that the small increase in whale lengths during the JARPA years could explain the decrease in blubber thickness. Because of this possibility we consider the total fat weight, which is the sum of the weight of subcutaneous fat ('blubber') and the weight of the intestinal fat dissected out during the flensing of the whale as a more reliable measure of storage of fat. This variable also shows a substantial and significant decline over the JARPA years. In the wide model we had an estimated year effect on fat weight of **-0.0073** with standard error of **0.0029**; in the winning model it had an estimated year effect of **-0.0073** with standard error of **0.0023**. Again, only small differences between the two sexes.

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Appendix 3

BODY CONDITION ANALYSES IN ANTARCTIC MINKE WHALES

John McKinlay and William de la Mare

1. Regressions of yearly estimates from model outputs for GAM models of minke accumulated blubber thickness

The Working Group suggested it may prove useful to examine linear regressions of the yearly estimates of accumulated blubber thickness that were presented in SC/67b/EM/03. The intent of this request was to put the two techniques, linear mixed effects (LME) models by Cunen, Walloe and Hjort (CWH) and generalised additive models (GAMs) by McKinlay, de la Mare and Welsh (MDW), onto an 'even footing' for comparative purposes. We do not think the model outputs of CWH are entirely comparable with our own, but these regressions do facilitate an easy comparison of our own results, and they additionally reveal why CWH, fitting a global trend, might report a linear decline in condition.

The regression response is predicted accumulated blubber thickness between the 20th percentile of sampling data for low diatom animals and the 80th percentile of sampling data for high diatom animals. Full details of conditioning for predictions are in SC/67b/EM/03. Body weight (in addition to body length) is included as a covariate in GAM models to account for several features of these data, described shortly.

Fig. 1 shows a linear fit imposed upon the non-linearly derived yearly mean estimates from our preferred GAMs. Importantly, the GAMs included a main effect of body weight and a year*body length interaction. These results show that males and females in the East region have slightly increasing body condition over the period, while males and females in the West have declining condition. We note two important features: (i) of these trends, only the female decline in the West is significant at 5% (Table 1); and (ii) the fit for males in the West, even though non-significant, is heavily influenced by two high leverage points in 2002 and 2004.

We next examine a linear fit to all the predicted means, ignoring the group structure (i.e. both regions and both sexes combined). This shows that the linear fit to the predicted means from the GAM that includes weight as a covariate has

Table 1

Summary of slope estimates from linear regressions of yearly predicted accumulated blubber from GAM models that included body weight.

Model	Year trend	SE	t	$P(>t)$
West, females	-0.0378	0.0004	-9.174	<0.001
East, females	+0.0029	0.0099	+0.290	0.780
West, males	-0.0100	0.0142	-0.703	0.509
East, males	+0.0036	0.0101	+0.359	0.730

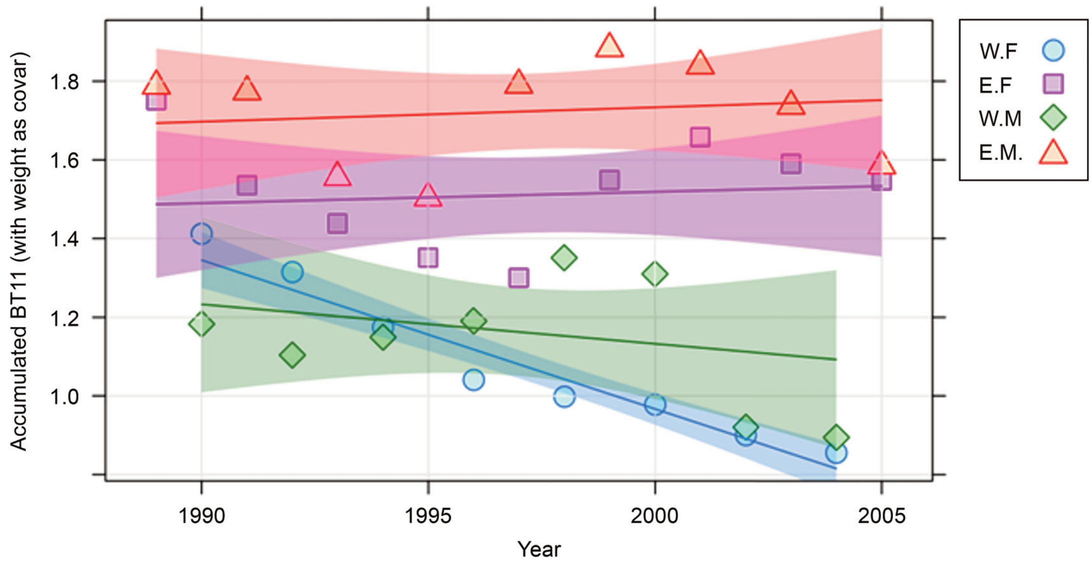

Fig 1. Regressions of year estimates of accumulated BT11 from GAMS, groups separate (males and females, West and East), including weight as an additional covariate in GAM models. Points weighted by $1/SE^2$ from GAM fits.

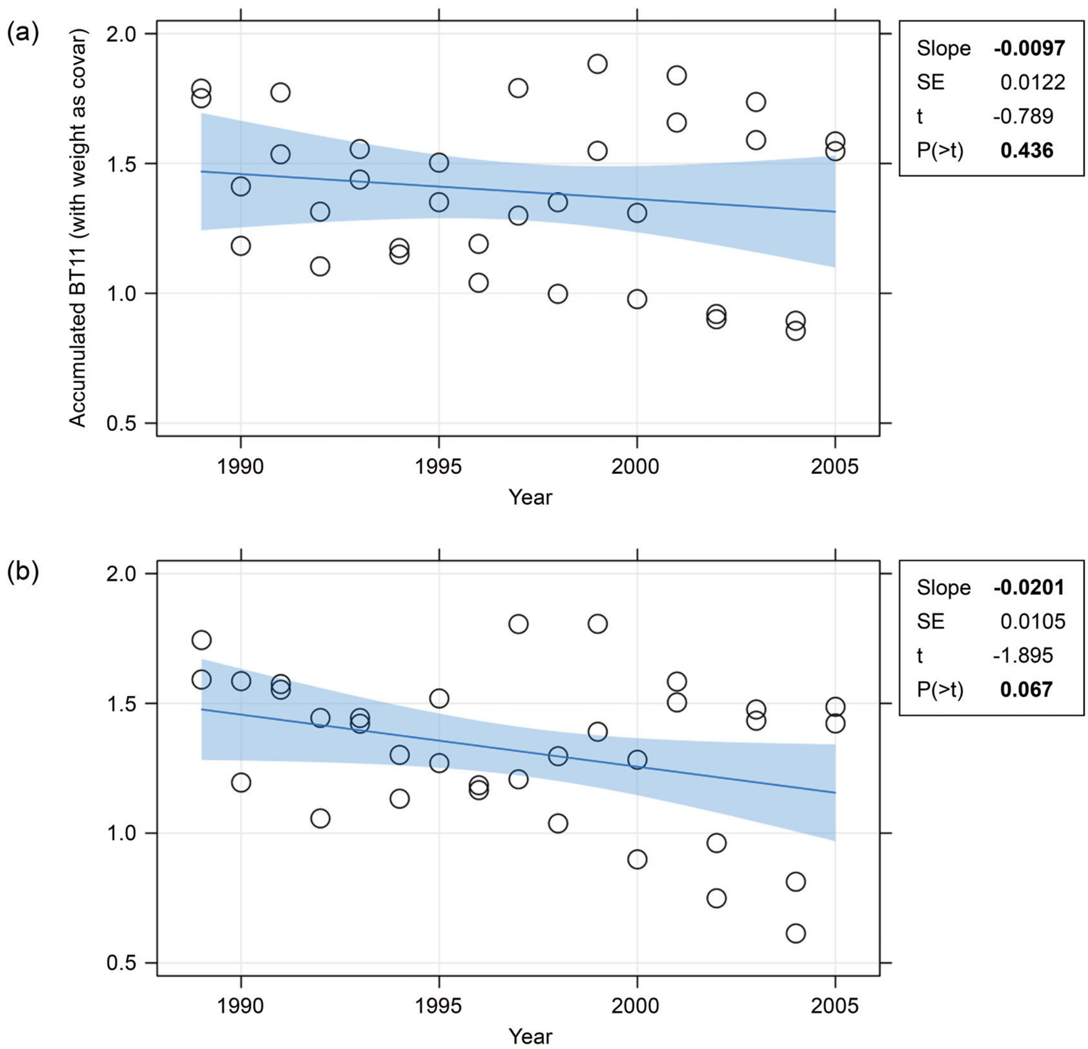

Fig. 2. Regressions of all groups combined (males and females from West and East) for year estimates of accumulated BT11 from GAMS: (a) including weight as an additional covariate in GAM models; and (b) excluding weight as a covariate. Points weighted by $1/SE^2$ from GAM fits.

a slope very close to zero -0.0097 (SE 0.0122) and is non-significant at conventional levels (p=0.436) (Fig. 2a). In contrast, the linear fit to the GAM results based on a fit ignoring weight as a covariate shows a much stronger linear decline of -0.0201 (SE 0.0105), and this is approaching significance at 5% (p=0.067).

We take two main points from these analyses: (i) you can get a misleading result if you take a single, strong trend (e.g. females in the West) and average it over several other weak or non-existent trends; and (ii) including body weight in our GAM models has the effect of removing some apparent signal for declining condition (i.e. the slope in Fig 2a is smaller than in Fig 2b). We now show why this latter effect is occurring.

First, consider some simple linear models fitted to the raw JARPA data, showing blubber thickness (BT11) as a proportion of body length (cm/m) against body length (m) (Fig. 3). We show 95% CI for the fit, and exclude the data (because there is a lot of it). This clearly shows that *blubber thickness proportionately decreases with increasing body length*.

Next, consider the average catch lengths in the JARPA data, plotted against year (Fig. 4). This clearly shows that, except for males in the East sampling region, *catch lengths have been increasing over time*. We do not know why this might have occurred in the Japanese Special Permit programme, but it has.

We note that these two results will interact with one-another. If catch lengths go up, and blubber decreases with increasing body length, then this will provide a signal for decreasing blubber thickness unless these relationships are correctly captured in models. Including body weight in models achieves this goal, a point we demonstrate in SC/67b/EM/03 (Section 3.3, Figs 8-10).

2. Responding to a request from Norwegian scientists on how we think their models should be modified

During the discussions of the Working Group our Norwegian colleagues asked how they could accommodate into their models some of the issues we have discussed in our primary paper, SC/67b/EM/03. It is beyond the scope of this Appendix to do that topic justice and we refer the interested reader to our primary paper where we discuss the issues in detail. Further, as we do not subscribe to the philosophy of the Focused Information Criteria as a suitable model selection process, at least not in the case under consideration here, we are reluctant to try and suggest specific models. However, what we can point to are some important effects that we think should be captured in their models:

(a) Diatom score is an important indicator of time spent feeding, so in our models we have tried to capture the contrast between low score animals captured at the

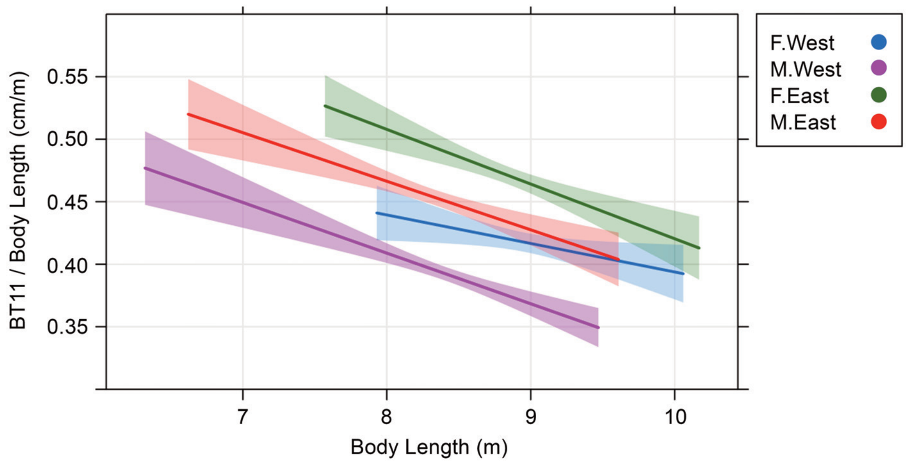

Fig. 3. Blubber thickness (BT11) as a proportion of body length regressed against body length, showing proportionate decrease in blubber thickness with increasing length.

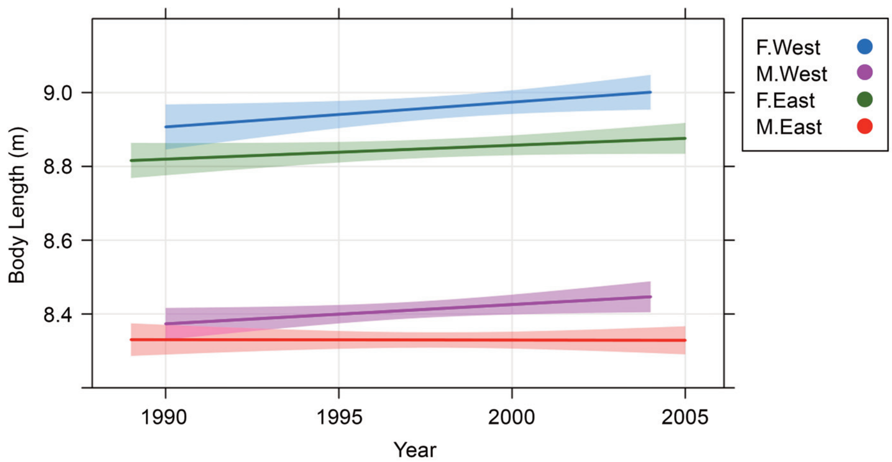

Fig. 4. JARPA catch lengths regressed against year for each group (sex and region).

beginning of the sampling season and high score animals captured at the end of a season.

(b) Average catch lengths in JARPA data have increased through time, a point easily demonstrated from the data (Fig. 4 above). Models should therefore capture this feature; we would suggest a year*length interaction.

(c) Blubber thickness proportionately decreases with increasing body length; again, a feature that is easily confirmed from the data (Fig. 3 above). Given that catch length have been increasing over time, and that blubber decreases with length, failing to account for these features will induce a false signal for decreasing condition, or will exaggerate any real decrease that may be occurring. We have found that including both body length and body weight as covariates in models of BT11 has been the most effective way of capturing these aspects of the blubber-length-weight relationship. Assessing trends in blubber thickness when weight is included as a covariate in models requires careful conditioning.

(d) Most importantly, in Fig. 1 we show that trends are different between the regions and sexes, and this should be modelled. We see no utility in fitting and reporting a single, overall trend. We do not think such an approach is consistent with the stated requirements of the Scientific Committee, as reflected in the Ecosystem Modelling report from SC/67a.

3. Including total body weight as an independent variable is justified

Analyses of JARPA condition data need to correct for the effects of variations in the sizes of animals because, for example, the weight of fat an animal has depends on how large it is. At last year's Ecosystem Modelling meeting and again at this meeting there have been reservations expressed about using total weight as an independent variable as a measure of size in statistical analyses of body condition from JARPA data. The concern is that changes in total weight include the consequences of variations in other measures of body condition, such as fat weight. For example, because total weight includes fat weight, including the former as an explanatory variable leads to the claim that total weight cannot be considered as a valid independent variable. To examine this concern further we set up a simple model to determine whether this concern is consequential in the circumstances roughly applicable to the analyses of minke whale fat weight.

Whale blubber consists of several tissue types, some of which are primarily lipid stores and others have structural functions. Assume for simplicity that blubber weight is composed of a fixed structural component related to body size and a variable component reflecting energy storage. The total weight W of an animal is given by:

$$W = W_l + F_s + F_e \tag{0.1}$$

W_l is the lean weight
F_s is the weight of structural blubber,
F_e is the weight of stored lipid (includes visceral fat as well)

Assume that the weight of structural blubber is directly proportional to lean weight, that is:

$$F_s = \alpha W_l \tag{0.2}$$

Now suppose that there is a trend in energy storage (the central question) given by:

$$F_{e,t} = f_{e,1} + \beta t + \varepsilon_e \tag{0.3}$$

where t is the year of sampling and is a normal random variable with mean = 0.0 and standard deviation. However, due to the difficulty of collecting random samples further suppose that the sizes of animals, reflected in their lean weight, has a trend over time as well so that:

$$W_{l,t} = W_{l,1} + \gamma t + \varepsilon_l \tag{0.4}$$

where ε_l is a normal random variable with mean = 0.0 and standard deviation σ_l. The only quantities that are directly observed are the total weight W_t and the total fat weight ($F_t = F_{s,t} + F_{e,t}$). Although lean weight can be calculated by subtracting the fat weight from the total weight, that does not eliminate the issue that the dependent variable (fat weight) is a component of an independent variable.

To anchor the model in the roughly the same numeric values as minke whales put:

$$\begin{aligned} W_{l,1} &= 8 \\ \sigma_l &= 0.1 \\ \alpha &= 0.125 \\ F_{e,1} &= 0.5 \\ \sigma_e &= 0.001 \\ t &= 1 \cdots 18 \end{aligned} \tag{0.5}$$

Fitting a linear model to a single realisations of the model (with negligible random errors) gives:

Model	Trend in W_l	True trend in F_e	Estimated trend in F	Bias
$F \sim t$	0.05	-0.015	-0.0087	-0.0063
$F \sim t + W$			-0.0128	-0.0022
$F \sim t$	-0.05	0.0	-0.0062	-0.0062
$F \sim t + W$			-0.0010	-0.0010

Including total weight (W) in the model has led to a considerable reduction in bias compared with using year (t) alone.

Including total weight (W) in the model has led to a considerable reduction in bias compared with using year (t) alone.

Appendix 4A

STATEMENT OF JAPAN REGARDING DATA AVAILABILITY AGREEMENT FOR BODY CONDITION ANALYSES

The Data Availability Agreement related to the body condition analysis for the use of JARPA data allowed the relevant parties to use them until the 2017 SC. In this regard all concerned issues were needed to be raised in 2017 SC, and the Norwegian scientists followed this condition and submitted comprehensive results to the 2017 SC and submitted a revised document to the 2018 SC in response to last year's comments, while the Australian scientists did not follow the agreed timeline.

Nevertheless, Japan allowed them to submit a document (SC/67b/EM03) to the 2018 SC, which included new analyses that were not based on last year's comments, in order to maintain collaboration in the SC. However SC/67b/EM01 rev submitted by Australian scientists only expands criticising other parties with new arguments which are not presented or even discussed at the 2017 SC. The collaborative work between the Australian delegation and the other two delegations failed due to such improper use of data by the Australian delegate.

The aforementioned DAA should be totally terminated at this SC, and the use of JARPA data treated under the ICR protocol.

Appendix 4B

RESPONSE FROM DE LA MARE AND MC KINLAY

De la Mare and McKinlay responded that their research plan and data request specified:

Although it is possible that work may be complete by the 2017 SC meeting, analyses are computer intensive and may need to be presented to the SC in a staged process. Final results, or at minimum a progress report, will be presented at the SC meeting in 2017.

We appreciate the pragmatic approach by the ICR, which has enabled us to bring this long standing issue to a conclusion at this meeting. However, we reject any implication that we have behaved improperly. Correspondence between us and the ICR demonstrates that we behaved ethically and, in particular, would not submit new analyses without ICR prior approval, which was provided to us. Criticism of research is a normal part of the scientific process.

Annex M

Report of the Sub-Committee on Small Cetaceans

Members: Scheidat, Porter (Convenors), Alfaro-Shigueto, Almeida, Amorocho, Andriolo, Archer, Avila, Baker, Barreto, Bell, Bjørge, Brownell, Caballero, Cañadas, Castro, Charlton, Cipriano, Collins, Cooke, Coscarella, Cosentino, Crespo, Currey, Dalla Rosa, Di Tullio, Diallo, Domit, Elwen, Forestell, Fortuna, Freitas, Frey, Fruet, Gallego, Galletti Vernazzani, Genov, Gushcherov, Hielscher, Hoelzel, Holm, Hubbell, Iñíguez, Jacob, Jaramillo-Legorreta, Jimenez, Kim, Hyun Woo, Lang, Langerock, Lauriano, Leslie, Luna, Lundquist, Mangel, Marcondes, Marmontel, Martin, Minton, Mosquera Guerra, Natoli, Nda, Northridge, Parsons, Phillips, Pierce, Reeves, R., Reeves, S., Reyes Reyes, Ridoux, Ritter, Rodriguez-Fonseca, Rojas-Bracho, Rose, Sampaio, Santos, Secchi, Sequeira, Siciliano, Simmonds, Slooten, Stachowitsch, Stimmelmayr, Strasser, Suydam, Tarzia, Thomas, Trejos Lasso, Trujillo, Urbán, Van Waerebeek, Vermeulen, Wade, Wambiji, Wang, Williams, Zagrebelnyi, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Scheidat and Porter welcomed the participants to the meeting and provided an introduction to the work methods of the IWC Scientific Committee and the focus of the Small Cetacean (SM) sub-committee for this meeting.

1.2 Election of Chair and appointment of Rapporteurs

Scheidat and Porter were elected as chairs and R. Reeves, Cipriano, Genov, Jiminez and Thomas appointed as rapporteurs.

1.3 Adoption of Agenda

The adopted Agenda is given as Appendix 1.

1.4 Review of documents

The following available documents contained information relevant to the work of the sub-committee: SC/67b/SM01rev1; SC/67b/SM02-10; SC/67b/SM18rev1; SC/67b/SM19; NAMMCO (2017); Martin and da Silva (2018); Moore *et al.* (2018); Avila *et al.* (2018); and da Silva *et al.* (2018).

2. A REVIEW OF SMALL CETACEANS IN RIVERS AND ESTUARIES IN SOUTH AMERICA

2.1 Overview of taxonomy, distribution and abundance for *Inia* and *Sotalia*

2.1.1 Taxonomy

Family Iniidae:

Inia geoffrensis (Blainville, 1817). Amazon river dolphin.

– *I. g. boliviensis* (d'Orbigny, 1834). Bolivian bufeo.
– *I. g. geoffrensis* (Blainville, 1817). Common boto.

Family Delphinidae:

– *Sotalia fluviatilis* (Gervais and Deville in Gervais, 1853). Tucuxi.
– *Sotalia guianensis* (Van Bénedén, 1864). Guiana dolphin. Costero.

Two genera of dolphins occur within the Amazon, Orinoco, Tocantins and Araguaia River basins. Only one species of the boto, *Inia geoffrensis* and two sub-species, *I. g. geoffrensis* found within the Amazon basin and *I. g. boliviensis* in the Bolivian Amazon, are recognised by the Taxonomy Committee of the Society for Marine Mammalogy. A third putative subspecies (*I. g. humboldtiana)* in the Orinoco basin of Venezuela and Colombia is not recognised.

Species-level divergence of at least some of these forms has also been suggested in several publications (Banguera-Hinestroza *et al.*, 2002; Gravena *et al.*, 2015; Ruiz-Garcia *et al.*, 2008). Gravena *et al.* (2015) reported that *Inia* in the Madeira River possess the unique mtDNA of the putative species *I. boliviensis* (one line of evidence for recognising species-level difference) and argued that even if there is hybridisation in the contact zone just downstream of the Teotônio waterfall, the *Inia* below Teotônio remain distinct and follow an independent evolutionary path. Elevation of *I. g. boliviensis* to species and recognition of *I. g. humboldtiana* await further work and formal taxonomic revision.

Similarly, another new species, *I. araguaiensis*, has been proposed to apply to the dolphins that inhabit the Tocantins and Araguaia basins of central Brazil (Hrbek *et al.*, 2014; Siciliano *et al.*, 2016). The Tocantins basin is considered geologically and hydrologically separate from the Amazon basin, although it discharges into the southern part of the greater Amazon delta. The description of this putative new taxon was based on samples from the extremes of the distribution of *Inia*, and cranial characters from only two specimens of '*I. araguaensis*' were included in the morphological analysis. It has therefore been difficult to reach firm conclusions because of the limited number of specimens (e.g. Araguaian *Inia* are rare in scientific collections with only 14 specimens available for examination in Brazil and abroad) and lack of a comprehensive analysis including morphometrics of sufficient numbers of specimens and use of the same genetic characters across the range and consistently for all putative taxa. A summary of the complicated taxonomic history is given by Siciliano *et al.* (2016).

In the case of *Sotalia*, two species are recognised at present: *Sotalia guianensis* (marine) and *Sotalia fluviatilis,* a freshwater form in the Amazon basin. *S. guianensis* in the Orinoco basin probably represents an independent population unit, isolated from other coastal populations (Caballero *et al.*, 2017).

Attention: CG-R, G

Given the incomplete resolution of Inia *taxonomy, the importance of clarifying and solidifying recognition (or elevation to species) of the Inia subspecies found in different river basins, the possibility that in such complex habitats localised specialisation is likely, and the need to focus attention on the conservation of demographically independent populations, the sub-committee:*

Encourages *support for efforts to resolve Inia spp. taxonomy in light of the significant and diverse threats affecting the populations inhabiting the Amazon-Orinoco-Tocantins/Araguaia drainages.*

2.1.2 Distribution

SC/67b/SM16 presented a spatial analysis of river dolphins in the Amazon, Orinoco and Tocantins basins, using niche and spatial modelling tools. Representativeness of both protected areas and habitat that have been transformed by hydroelectric dams within the range of the two river dolphin genera (*Inia* and *Sotalia*) was evaluated. The model used the MaxEnt algorithm to integrate 35,594 georeferenced records (satellite tag positions) and 19 environmental variables derived from the Bioclim and Hydroshed databases. This analysis indicated that the distribution of river dolphins is reasonably well represented within the protected area network, although the limited management of the aquatic ecosystems inside the 'protected' areas means that the desired conservation outcomes are not guaranteed. A major threat to river dolphins in South America is the population fragmentation and loss and degradation of habitat as a result of dam construction. SC/67b/SM16 also examined the degree of overlap between the distribution of *Inia* and *Sotalia* and hydroelectric projects in construction, operation and planning phases and provided an initial quantification of this tensor (threat factor). Cumulative impacts (fragmentation, regulation of the flood pulse, upstream retention of nutrients, altered productivity) from this type of infrastructure at the macrobasin scale will exacerbate the threats to river dolphins and their habitat in the Amazon and Orinoco basins.

The sub-committee expressed appreciation for receiving the summary of this study. In discussion, Trujillo clarified what the authors intended by use of the term 'transformed' in contrast to 'protected', i.e. that hydroelectric dams have a major impact on habitat quality both upstream of the dam (more than 50% of nutrients and sediments retained) and downstream (nutrients and sediments depleted), while protected areas with no dams allow natural transport of nutrients and sediments and fish stocks are maintained. Trujillo estimated that more than 50% of the range of Araguaian *Inia* is affected by damming.

2.1.3 Abundance

Some information on abundance of *Inia* and *Sotalia* has been produced by a number of research groups in the region over the last decade. One example is a regional initiative that has surveyed 28 rivers in Brazil, Colombia, Peru, Ecuador, Bolivia and Venezuela (28,600 linear km), producing density and abundance values (Gomez-Salazar *et al.*, 2012; Pavanato *et al.*, 2016; Williams *et al.*, 2016). While there are a few abundance estimates for several rivers, there is very limited information on population trends. In the Upper Amazon River, at the border between Colombia and Peru, Williams *et al.* (2016) estimated a 3.4% reduction of the *Inia* population between 1993 and 2007 in an area of 245km^2. Such results, however limited, provide useful information given the difficulty of implementing systematic surveys in such a complex and logistically challenging environment.

SC/67b/SM09 described an experiment to test the effectiveness of using unmanned aerial vehicles (UAVs) for detecting both *Inia* and *Sotalia* compared to more traditional survey methods. Simultaneous observation from large boats and UAVs showed that in some cases drones were able to detect dolphins missed by observers, but in other cases the observers saw dolphins that the UAV missed. UAV observations more accurately quantified the total number of dolphins in a group, but short battery life, the time required to view and score video records, and legal restrictions on the use of UAVs were disadvantages. In response to questions, Marmontel noted that no negative reactions by the dolphins had been observed, even when UAVs were hovering only 10m above them; wind effects could be significant and limited the utility of the technique; detection in different water types had not been assessed thus far; and use of thermal imaging sensors may also be tested as a way to improve detection. Zerbini suggested that use of the UAVs might also allow a more direct estimation of the actual survey area rather than the approximation parameters typically used in line-transect surveys, and that might provide more accurate abundance estimates.

2.2 *Inia*

Trujillo presented a summary of information on the taxonomy of *Inia geoffrensis* (known as boto in Brazil and bufeo in the other range countries) and key aspects of distribution in the Amazon, Orinoco and Tocantins/Araguaia basins. *Inia* occur throughout the Amazon and Orinoco river basins in Brazil, Colombia, Ecuador, Peru and Venezuela, from the river deltas upstream to where impassable rapids, waterfalls, lack of water, and possibly low temperatures block their movement (Best and da Silva, 1989a; Best and da Silva, 1989b). *Inia* in the Tocantins basin may represent a different species (Hrbek *et al.*, 2014). A range expansion of Araguaian *Inia* into the waters of the Marajó Bay estuarine system may indicate a distribution shift (Siciliano *et al.*, 2016), or may be an extralimital extension by a group of vagrants. Abundance surveys have been conducted in multiple rivers of these basins, but only two studies have had sufficient temporal and geographic coverage to allow inference of population trends: one in the Mamirauá Sustainable Reserve (Brazil) for 22yrs and another in the Amazon River (Colombia/Peru) for 19yrs. The main threats to *Inia* include: interactions with fishing (bycatch); directed capture for piracatinga fishing; deforestation; mercury contamination; and loss of connectivity of rivers due to the construction of dams.

SC/67b/SM14 presented information on satellite telemetry tracking of 15 river dolphins (*Inia geoffrensis*) in the rivers Tapajós (Brazil), Amazon and Orinoco (Colombia) and San Martín (Bolivia) using Spot 299A transmitters linked to the Argos satellite system (Wildlife Computers, Redmond, WA, USA). This study was the first to identify patterns of movement and habitat use of *I. g. geoffrensis, I. g. humboldtiana* and *I. g. boliviensis* using this type of technology in the Amazon and Orinoco. The largest displacements were observed for *I. g. boliviensis*, where a male individual moved 333.7km between the rivers San Martín and Iténez in Bolivia. These results show variable patterns of movement that may be related to water type, system productivity and prey biomass. Finally, the importance of the confluences, small tributaries and wetland complexes within the protected areas such as the national and departmental natural parks and Ramsar sites was highlighted.

In discussion, Trujillo noted that it was not yet possible to estimate the maximum longevity of the tags used because some are still transmitting. The longest time interval for tracks obtained so far is around two months. The study was designed to include tagging of around 50 individuals but few animals close to dams have been tagged so far; the MaxEnt model was chosen for analysis as it is considered useful for movement trend analysis; and the research team is considering a similar exercise in the Tocantins basin and the Tapajos River. The sub-committee commended Trujillo and his team for initiating this study as it begins to address some of the most important scientific questions concerning *Inia* ecology, habitat use and behaviour (particularly movements).

Martin summarised the results of a study of *Inia* reproduction in the area centred on the Mamirauá Reserve, Brazil, based on 1,360 captures and over 66,000 subsequent sightings of 670 individually marked (freeze-branded) dolphins (Martin and da Silva, 2018). This study found that the reproductive characteristics of *Inia* are remarkably similar to those of delphinid dolphins of similar size, despite millions of years of evolutionary separation which have resulted in profound morphological and behavioural adaptation to a freshwater environment. Two results are of particular relevance to the deliberations of this sub-committee. The first is that fewer than half of all established pregnancies result in a calf's reaching one year of age. The second, perhaps linked, is that calving is seasonal and centred on the period of low water in the Brazilian Amazon. As a consequence, most calves are born when their mothers are on the margins of large rivers and at a time of year when the density of monofilament gillnets is at its highest. Very young botos have neither the experience to avoid gillnets, nor the strength to escape from them after being entangled, so drowning in gillnets is plausibly a major contributor to the low recruitment rate discovered in this study.

Da Silva *et al.* (2018) provided the first long-term population trend of a boto population, using 363 standardised surveys over 22yrs. The analysis demonstrated a substantial decline over the entire period, but closer examination revealed that numbers were not significantly diminished until the year 2000, after which they fell at an average annual rate of 6.7%, equivalent to a halving every 10yrs. Coincidentally or not, 2000 was the year in which the study team first saw evidence of the harpooning of botos for use as fish bait.

Using data from Martin and da Silva (2018), Moore *et al.* (2018) calculated a generation time for *Inia* of 24.8yrs – a measure that is central to IUCN Red List assessments. The rate of population decline shown by da Silva *et al.* (2018) equates to a loss of 82% per generation and in excess of 99% over three generations. Such values are well above the threshold for a Red List assessment of a species, subspecies or subpopulation as Critically Endangered.

In discussion of these studies Martin noted that previous estimates of calf survival had been based on analysis of a small number of carcasses. He recalled that estimates of calf survival in Sarasota bottlenose dolphins were much different – 70-80% of calves survive through their first year. Although it is difficult to determine with certainty the cause(s) of the high rate of mortality of <1yr-old calves in Mamirauá, most of the carcasses examined by Martin and da Silva have shown evidence of harpooning or net entanglement; moreover, the peak of calving is during the period with lowest water levels so calves are born on the margins of the main river channels when gillnet density is the highest – up to one gillnet every 200m according to Martin. PCBs and other contaminants were not thought to be contributing to prenatal mortality as ultrasound examinations showed that most pregnancies persist to term.

In further response to questions, Martin stated that survival rates of >1yr-old juveniles and adults appeared much higher, and some juveniles and adults seemed able to extricate themselves from nets when entangled. Individuals with net marks but otherwise healthy have been encountered in the tagging studies of Martin and da Silva. A very small number of cases of infanticide by adult males has been observed, but this was considered an unlikely explanation of the low overall survival rate. Martin stressed that the 20-year study described in da Silva *et al.* (2018) was intended to address relative rates of decline, not overall abundance; such trends are difficult to detect and must be very dramatic to be detected over shorter observation periods. It was emphasised that the results did not suggest that there had been no decline before 2000, or that the decline prior to 2000 was in any sense 'sustainable'. Dolphins in the Mamirauá Reserve are part of an open system and satellite tracking has shown some very large-scale movements. The Mamirauá dolphins thus represent the dolphin population using a much larger area. Martin also noted that although this study was conducted in the Mamirauá Reserve, where it is illegal to block off channels with gillnets at night, such blocking is routinely observed.

Even though the Martin and da Silva findings were based on direct observations in a very small geographic area of the Amazon and therefore a very small proportion of the total range of *I. geoffrensis*, and, as such, extrapolation to the whole region would be unwarranted, the sub-committee found these results and their implications for population decline alarming.

Attention: CG-A, G

Given the population declines documented in two study areas and the lack of abundance surveys in most parts of the range of genus Inia*, the sub-committee:*

***Encourages** the collection of data, calculation of abundance estimates and analyses to estimate population trends for Inia throughout its range, for use in assessments of the status of the species, subspecies, and regionally isolated populations.*

2.3 *Sotalia*

Distribution of *Sotalia fluviatilis* (known in Brazil as tucuxi, in Colombia as delphín gris, in Peru and Ecuador as bufeo negro) is restricted to the Amazon basin in Ecuador, Peru, Colombia and Brazil. This species has a more limited distribution than *Inia*. One of the main limitations to distribution is isolation by rapids and geographical barriers.

The Guiana dolphin (*Sotalia guianensis)* occurs mainly in nearshore and estuarine waters along the Atlantic seaboard of South America from southern Brazil northwards into the Caribbean Sea and along the coast of Central America to northeastern Nicaragua and possibly Honduras. There is a small population in Lake Maracaibo and the lower reaches of the Orinoco River.

Martin summarised the portions of da Silva *et al.* (2018) relating to *Sotalia fluviatilis* distribution and abundance, drawn from a 22-year time series of standardised dolphin surveys in the Mamirauá Reserve, Brazil. This paper showed a precipitous decline in abundance throughout the study period, averaging 7.4% per year. Using the generation time estimate of 15.6yrs from Taylor *et al.* (2007), the Mamirauá population trend equates to a 97% reduction over three generations, which is substantially in excess of the threshold for Critically Endangered under IUCN Red List criteria.

In discussion, Martin suggested that gillnet entanglement was the most likely primary cause of the loss of *Sotalia* in this region, based on carcass examination by the research team and by Iriarte and Marmontel (2013) in the same region. *Sotalia* have not been subject to directed hunting for fish bait, as have *Inia* since around the year 2000, so it was not surprising that the discontinuity in the rate of *Inia* population decline reported by da Silva *et al.* (2018) was not apparent in the *Sotalia* data. The slightly greater rate of decline of *Sotalia* may be due to the fact that they are smaller and weaker than *Inia*, and far more prone to catatonic stress, so more likely to drown when enmeshed.

2.4 Threats shared by dolphins in the Amazon and Orinoco River systems and Lake Maracaibo

Trujillo gave an overview of threats to dolphins in the Amazon and Orinoco systems. Both basins are experiencing significant habitat degradation. The human population of the Amazon basin is expanding rapidly, with currently more than 34 million people, of whom only 3.5 million are indigenous. Immigration has been motivated by opportunities for large-scale soybean farming, hydroelectric development, oil development, road construction and the consolidation of large population centres. With regard to contaminants, there is evidence of high levels of mercury in fish, dolphins and even humans in the region. The South American Action Plan for the Conservation of Dolphins, and national action plans endorsed by the governments of Brazil, Colombia, Ecuador, Bolivia, Venezuela and Peru, provide guidelines and priorities for mitigating against threats to dolphins.

Trujillo also presented an update on the situation of the Guiana dolphin (*Sotalia guianensis*) in Venezuela, both along the Caribbean coast and in the Orinoco River. The main anthropogenic threats are habitat degradation, chemical contamination, bycatch, and direct hunting for bait and human consumption. Illegal hunting is a transnational problem (between Colombia and Venezuela), making it even more difficult to create and enforce effective conservation measures. These problems are particularly severe for the dolphin populations in Lake Maracaibo (a large tidal estuary in Venezuela) and the Orinoco River. In the southern part of Lake Maracaibo, takes of four to five individuals per week for human consumption have been estimated. For the Orinoco River, there is a report of more than 800 *Inia* deliberately killed for the piracatinga fishery. Lake Maracaibo and the Orinoco are also severely affected by oil spills and heavy metal contamination. The oil industry in the lake has resulted in repeated spills over almost a century. In the Orinoco, an ambitious mining project called ‘Mining Arch’ has established a concession area covering >100,000km^2 for mining gold, diamonds, iron, copper, bauxite and coltan, among other resources. Its main purpose is to bring cash into the country.

Discussion of the many issues in Lake Maracaibo highlighted the dangerous situation facing researchers trying to identify and quantify the threats to river dolphins, including directed takes, because of the activities of criminal bands. It was noted that community involvement and community-based measures have been and remain the only effective approach. Resources to support these communities are badly needed and even modest investments are likely to make a large difference in terms of threat mitigation.

Attention: G

The sub-committee noted with alarm the situation reported for Lake Maracaibo in Venezuela, where both directed takes and oil pollution are thought to be having serious impacts on populations of S. guianensis*, and the sub-committee:*

***Recommends** that NGOs and researchers focus on documenting the threats to Sotalia and work with local communities to mitigate the impacts on these dolphin populations.*

2.4.1 Deforestation

The rate of deforestation appeared to be levelling off at the beginning of the century but has increased markedly in recent years. This has an indirect effect on dolphins, especially in the ‘blackwater’ (tannic) rivers where productivity is low and the fish dolphins prey upon depend on the seeds and fruits of the flooded forest. It is estimated that one hectare of this ecosystem can produce 20 tons of seeds per year. When the forest is lost, there is no way to sustain fish stocks and this affects the availability of food for the dolphins.

2.4.2 Hydropower development

Existing dams and future dam development are currently among the greatest threats in the Amazon since they affect the flows regime, the connectivity of rivers, the migrations of fish and in some cases fragment populations of dolphins as has already occurred in the Tocantins River basin. Approximately 142 large dams are currently operating, and there are proposals for at least 160 more (Anderson *et al.*, 2018).

2.4.3 Mercury

SC/67b/E16 reported on total mercury concentrations in river dolphins (*Inia* and *Sotalia*) in the Amazon and Orinoco river basins. Mercury was analysed in the tissue of animals found floating dead (*n*=19, 50%), stranded (*n*=4, 10,5%) and captured for instrumentation with satellite transmitters (*n*=15, 39,5%) in the Arauca and Orinoco rivers (Colombia and Venezuela border), Amazonas river (Colombia and Peru border) and Itenez or Guapore river in Bolivia. Recorded concentration ranges were: *I. g. humboldtiana* 0,003-3,99mg/kg^{-1} (*n*=21, sd=1,34), *I. g. geoffrensis* 0,1-0,35mg/kg^{-1} (*n*=7, sd=0,09), *I. g. boliviensis* 0,03-0,37mg/kg^{-1} (*n*=8, sd=0,78) and *Sotalia fluviatilis* 0,1-0,87mg/kg^{-1} (*n*=2, sd=0,55). It is highly probable that mercury biomagnifies in the dolphins, which are top predators, and this might explain the high tissue concentrations observed.

2.4.4 Negative interactions with fisheries

Negative interaction with fisheries is also a major threat to dolphins. In the sixties, with the introduction of electric generators, large fishing nets were first used and, according to the reports of many fishermen and traders in the region (Trujillo *et al.*, 2010), resulted in large bycatch mortality of dolphins. In the eighties, when more regular observations and some systematic studies of dolphins occurred, significant mortality was still being reported. In the nineties, in the Colombian Amazon, dolphins were reported to approach nets without always being caught, and at the beginning of the 2000’s the first interactions were observed in which the dolphins removed fish from the nets (Trujillo *et al.*, 2010). This created a conflict with some fisheries, especially those of large catfish, and retaliation against dolphins was reported. Cases of retaliatory dolphin poisoning and other deliberate ‘control’ killing were reported in several locations in Peru as early as the 1990s (Reeves *et al.*, 1999). Bycatch is still a major threat in much of the range of *Inia* but there are no robust assessments of levels or trends.

2.4.5 Directed takes

This item was discussed at the Workshop on the Poorly Documented Takes of Small Cetaceans in South America: Including In-Depth Review of the Hunting of Boto (*Inia geoffrensis*) for the Piracatinga (*Calophysus macropterus*) Fishery held in Santos (Brazil) from 19 to 21 March 2018.

2.4.6 Channel dredging

SC/67b/SM04 described the planned construction of a commercial waterway (or ‘hydrovia’) about 2,700km in length, where dredging and other river modifications will take place in the Maranon, Huallaga, Ucayali and Amazon rivers in the Peruvian Amazon. This is part of a larger project to develop hydrovias in several countries in South America (Hidrovias Sudamericanas) and highlights the need for regional work and cooperation to prevent further degradation of river dolphin habitat. Hydrovias Amazonica, a subset of Hidrovias Sudamericanas, will overlap key habitats for both species of South American river dolphins, potentially causing multiple changes to the habitats and populations that may require extensive and prolonged monitoring and mitigation. Contingent upon completion of the project's Environmental Impact Assessment (EIA), the Chinese company SYNOHIDRO plans to start construction of the hydrovia in Peru in 2019. The authors of SC/67b/SM04 recommended an inclusive and transparent EIA and project development process that includes: (a) input from aquatic mammal experts regarding potential impacts on river dolphins; and (b) the planning and implementation of mitigation plans prior to, during, and after construction for the duration of the project lifetime.

During discussion, it was clarified that dredging had not yet begun, so it was still possible to comment on and possibly influence the scope of the planned hydrovia project in Peru; hydrovia projects are also being considered by other countries in the Amazon region. It was suggested that an evaluation to distinguish which rivers are more or less important to each of the two species may help to prioritise the collection of baseline information and impact assessment.

2.4.7 Multiple threats in the Tocantins Basin

Siciliano provided information on threats to *Inia* in the Tocantins basin (described as the putative species *Inia araguaiaensis* (Hrbek *et al.*, 2014). Current threats include river damming, water pumping for agriculture, fisheries interactions, intentional killing, high boat traffic, and water contamination by sewage, heavy metals and other chemicals. The limited range of the Araguaian boto, restricted to the Araguaia-Tocantins river basin and adjacent Marajó bay, has implications for its conservation. Its major habitat is surrounded by the Cerrado vegetation of central Brazil, which is heavily modified by human activities. Large-scale agriculture and cattle farming have transformed the landscape in most of the river sections. Side effects of these large-scale activities include massive use of agrotoxins that enter the land and find their way into the river. Large growing cities and agricultural activity require huge amounts of energy. Seven hydroelectric power plants are already operating in the Tocantins River and a large one is projected in the upper part of the river in Marabá. Given its isolation in a separate river basin and a region with high anthropogenic impact, the conservation status of the Araguaian boto is of increasing concern.

2.4.8 Threats overall

A general discussion on the status of *Inia* and *Sotalia* revolved around: (a) the dire situation created by the multiplicity of threats; (b) the need for direct actions to stop or slow the deterioration of the Amazon and Orinoco (particularly Lake Maracaibo); (c) the potential for IWC Scientific Committee recommendations to improve awareness of the issues; and (d) the importance of continued (and in fact, greatly expanded) monitoring and research that focuses on issues of most significance to the river dolphin populations across the region. It was noted that the typical habitat of *Sotalia fluviatilis* – main river channels and lakes – is more limited both geographically and perhaps ecologically than that used by *Inia.* The relative vulnerability to bycatch of the two species is little understood although the smaller size of *Sotalia* suggests that it is less able to escape from entanglement. *Sotalia* dolphins are also much more sensitive to disturbance and to deliberate live-capture, and therefore they are more likely to die even if released from nets, although coastal *S. guianensis* in some areas are reportedly less sensitive and have been successfully tagged and tracked over several months. Entangled *Inia* are more likely to be killed by fishermen and used, especially in those areas where dolphin flesh is in demand as bait. Gillnets of many types, and deployed in many ways, are common throughout the region. They are most dangerous to dolphins when set close to shore as the animals can become trapped between the net and riverbank, although entangling gear is a significant threat to dolphins wherever encountered.

Attention: CG-A, G

Given the multiple threats associated with development, habitat degradation and fragmentation, and pollutants facing river dolphins in the Amazon, Orinoco and Tocantins basins, the sub-committee:

***Encourages** the Brazilian, Bolivian and Peruvian Governments, as they carry out their reviews of proposed construction of new dams for hydroelectric energy production, to explicitly consider the potential impacts on river dolphins (e.g. isolation, loss of genetic diversity, habitat degradation);*

***Discourages** water pumping in the Araguaia-Tocantins river basin for agricultural use as such a practice causes dramatic decreases in water levels in rivers, thereby increasing the probability that dolphin populations will be extirpated;*

***Encourages** range states of the Amazon basin and its tributaries to: (a) support and carry out baseline research into the impacts of the development of commercial waterways in the Amazon (hydrovias) and their potential impacts on dolphin populations and habitats, including but not limited to the ecological impacts of dredging, noise pollution, channelisation by embankments, altered sediment suspension and transfer, and changes in turbidity, light, oxygen availability and primary productivity; and (b) work to minimise or at least mitigate these impacts;*

***Encourages:** (a) review of the status of dolphins trapped within dammed stretches of the Tocantins and Madeira rivers; and (b) evaluation of possible relocation (translocation) of animals when environmental conditions create a high likelihood that they cannot continue to survive in this severely compromised habitat; and*

***Encourages** the review of the effects and the scale of contaminant and heavy metal (e.g. mercury) pollution on river dolphins in key areas of the Amazon (Japura/Caquetá, Içá/Putumayo, in Brazil and Colombia) and Orinoco (Venezuela) basins.*

2.3 *Tursiops* species (populations occurring in estuarine areas in southern Brazil)

SC/67b/SM19 summarised information on the life history of two populations of Lahille's bottlenose dolphins (*Tursiops truncatus gephyreus*) in southern Brazil – Patos Lagoon Estuary (PLE) and Laguna (LGN) – and on threats faced by these populations. Both have been the focus of long-term ecological studies that provide a good source of information on the conservation status of the subspecies. Monitoring in both areas started more than 30yrs ago and has been carried out systematically since the mid-2000s. This monitoring consists of year-round mark-recapture and biopsy sampling, and regular beach surveys along the core area of the populations to collect dolphin carcasses. Mark-recapture studies indicate that a large proportion of the animals in these areas are year-round residents and permanent emigration is unlikely. Population sizes are very small in both areas: only around 85 dolphins in PLE and 60 in Laguna. Genetic studies found moderate mtDNA diversity for PLE (three closely related haplotypes) and very low diversity for Laguna (only one haplotype), while nuclear DNA variation was very low for both populations, with signs of inbreeding for the Laguna population. For Patos Lagoon, adult female survival was estimated at 0.97, higher than that of adult males (0.88). Juvenile and first-year calf survival was 0.83 and 0.84, respectively. A similar pattern was found for the Laguna population, with overall adult survival rates of 0.95 and survival rates to age one of around 0.80. Mark-recapture studies supported the notion of birth seasonality, with most births in late spring and summer (Dec-Feb), and mean inter-birth intervals of three years for PLE and 2.4yrs for Laguna. Pollutant analyses indicated moderate levels of persistent organic pollutants (POPs) and that agricultural and industrial activities are the sources of POPs in LGN and PLE, respectively. Bycatch in coastal artisanal gillnet fisheries is the main threat to both populations, and there is evidence of increasing rates of bycatch-related mortality in LGN in recent years. However, bycatch rates are higher in Patos Lagoon Estuary and surrounding areas, where it is responsible for at least 43% of the overall documented mortality. Of additional concern is a chronic dermal infection in LGN, with evidence of an increasing number of affected animals in recent years (prevalence of 14% recently). Despite evidence of increased anthropogenic mortality, there is no clear evidence of a negative trend in abundance. Nevertheless, there is a high probability of population decline in the near future, given the small population, the high degree of residency and the continuing mortality as a consequence of IUU (illegal, unreported, unregulated) fishing and other human activities in these areas.

In discussion, the sub-committee noted that the occurrence of lobomycosis-like skin disease is highly variable among different areas and may be related to pollution. Although the two small populations in southern Brazil are likely the highest priority, better abundance estimates and assessment of threats are needed throughout the range of this endemic coastal subspecies. Fruet noted that the POP concentrations analysed thus far are not particularly high, so it is unclear whether and how pollutants are influencing the occurrence of the disease.

Preliminary evidence suggests that a bottlenose dolphin protection area in southern Brazil is failing in regard to the management objective to reduce bycatch (SC/67b/HIM10). Increased mortality of bottlenose dolphins along the beaches of southern Brazil has raised concern about the trends in abundance and conservation status of the population in Patos Lagoon Estuary (PLE) and adjacent coastal areas. Article 8 of a normative that regulates gillnet fisheries in southern and south-eastern Brazil, established by the Brazilian Government in August 2012, bans boat-gillnet fisheries in the core area of the population. Under a scenario of full compliance and effectiveness of the normative, a significant decreasing trend in the stranding rates of bottlenose dolphins around PLE since the normative's implementation in 2013 would be expected, as would a lack of a significant seasonal pattern in mortality. However, as shown by the analysis in SC/67b/HIM10, despite inter-annual variation over the 25yrs of data analysed, mortality remained high and seasonal (following the seasonal pattern of fishery effort in the area) after implementation of the normative. In addition, five cases of entanglements of bottlenose dolphins by three different types of fisheries operating within the boundaries of the protected area were reported. These findings suggest that the protected area for bottlenose dolphins in southern Brazil has not been effective. The reasons may include: lack of compliance; failure of the normative to apply to beach seine and stake and cable set nets, which can incidentally catch bottlenose dolphins; and insufficiency of the coverage of the no-take area.

Barreto presented results from beach monitoring in Santa Catarina, Paraná, and São Paulo provinces, north of the area described in SC/67b/HIM10. A total of 119 strandings of bottlenose dolphins and 442 Guiana dolphins were recorded over two years. Evidence of entanglement was found in 45% of the bottlenose dolphin carcasses that were fresh enough to show such evidence. There is as yet no evidence on which subspecies of bottlenose dolphin is or are represented in these strandings. Skulls and genetic samples are being analysed, and it is hoped that this work will be completed by the end of 2018.

Luna provided additional information on the Brazilian normative (ordinance) (IN) number 12, which regulates the gillnet fisheries over a wide area in southern and south-eastern Brazil, using a mosaic of measures to monitor its effectiveness. In some places (e.g. the Patos lagoon and adjacent coast) the normative has not reduced the impact of fishing on species that it is intended to protect. The Brazilian government is looking into this subject and seeking ways to improve the normative's effectiveness in protecting dolphins and other threatened species in these locations.

The sub-committee expressed concern that given their relatively small population sizes and constricted ranges, these bottlenose dolphin populations are highly vulnerable to threats. The coastal populations of bottlenose dolphins in the southwest Atlantic were recently recognised as a distinct subspecies (*T. t. gephyreus* Lahille, 1908) by the Society for Marine Mammalogy's Taxonomy Committee. That conclusion was also described as '*well supported by morphological and molecular genetic data, as well as ecological and distributional data'* at this sub-committee's Tursiops Taxonomy Workshop in 2018. At SC/66b, the Scientific Committee had recommended an updated assessment of population status of the Argentine population of this subspecies and the two reports provided to this meeting (SC/67b/HIM10 and SC/67b/SM19) indicated that the two small populations in southern Brazil are subject to high levels of bycatch and have a high incidence of individuals with chronic dermatitis.

Attention: SC, CG-R

*Given the small sizes of the two known populations of Lahille's bottlenose dolphins (*T. t. gephyreus*) in southern Brazil and the conservation concerns surrounding these populations (especially related to bycatch), the sub-committee:*

***Draws attention to** range states (Argentina, Brazil, Uruguay) the conservation concerns for this entire subspecies;*

***Recommends** immediate action to reduce the level of bycatch in the southern Brazil populations;*

***Recommends** continued monitoring and photo-identification work on the populations throughout the subspecies' range to refine survival estimates and to assess trends in abundance and the prevalence and etiology of the chronic skin infections; and*

***Recommends** that the conservation status of the subspecies be prioritised for assessment in the future.*

3. FRANCISCANA CMP

3.1 Preparation for an in-depth review for 2019

The sub-committee noted that the Scientific Committee first reviewed the status of the franciscana (*Pontoporia blainvillei*) in 2004 and the species has been on the agenda of the Committee for a number of years. A task team for FMA I was established in 2015 and resulted in two documents being presented at this meeting (SC/67b/CMP03 and SC/67b/CMP05). In 2016, the IWC created a Conservation Management Plan (CMP) for the franciscana.

A review of the status of the franciscana is timely as substantial new information is available and such a review would be key to refine the research, monitoring, conservation recommendations and management actions specified in the recently established franciscana CMP. A proposed process to conduct the review is presented in Appendix 2.

4. REPORT OF THE 2018 *TURSIOPS* TAXONOMY WORKSHOP

The sub-committee received the report of the 14-16 January 2018 intersessional *Tursiops* Taxonomy Workshop on evaluating taxonomy and population structure of bottlenose dolphins (*Tursiops* spp.) worldwide. This workshop, funded by the small cetaceans (SM) and stock definition/DNA testing (SD) sub-committees followed the three-year review conducted by SM (2015-17). In the Scientific Committee context, the issue of 'taxonomy' mainly concerns the potential for unrecognised diversity – distinct species, sub-species and demographically independent populations are fundamental management units, and if they have not been recognised there is the potential for conservation issues, especially in areas with known threats.

Bottlenose dolphins have a cosmopolitan distribution, show morphological and genetic divergence throughout their range, and in some regions show strong population structure, often over a very fine geographic scale. This raises issues about the recognition of discrete units needed for effective conservation and management. These characteristics have historically led to the naming of more than 20 nominal species of *Tursiops*, but only two – *T. truncatus* (Montagu, 1821) and *T. aduncus* (Ehrenberg, 1832) – are currently recognised. Key objectives of the workshop were to determine whether the currently accepted *Tursiops* species and subspecies accurately represent valid taxa, and whether there are more *Tursiops* subspecies and/or species than currently recognised.

The three-year review and workshop brought together researchers and experts from around the world to discuss this topic, motivated focused research, and promoted new collaborations. Results from studies presented at the SM sub-committee meeting reviews and at the workshop were compiled and formed the basis for evaluation of taxonomic and population distinction issues in each geographic region during the workshop. The SM sub-committee's priority topic review and workshop, in combination, provided a unique opportunity to form a global view of issues related to small cetaceans.

The sub-committee expressed appreciation for the efforts of the workshop participants and their development and testing of a framework for addressing 'taxonomic' issues of interest to the IWC. Discussion of the conclusions and recommendations of the *Tursiops* Taxonomy Workshop focused first on data deficient areas and the sub-committee expressed interest in continuing compilation of information on specimens, data, and researchers from those areas to facilitate collaborations and future work, and nominated additional areas for inclusion to the list identified by the workshop. There was also interest in the use of high resolution genetic analyses such as ddRAD (double-digest restriction associated DNA) sequencing, as some new results reviewed by the workshop were able to resolve differences not possible previously, even using whole-mitogenome sequencing. Use of such methods can be very effective for addressing some of the remaining questions, such as whether *Tursiops truncatus gephyreus* should be elevated to species status, and for developing a better understanding of island-associated bottlenose dolphins with use of a consistent set of genetic markers to allow addition of new study sites over time, without the calibration issues associated with microsatellite analysis.

Attention: SC, G

Having reviewed the extensive information included in the 2015-17 review and 2018 Workshop for evaluation of Tursiops *species, subspecies and population distinctions, the sub-committee:*

***Draws attention to** the need for* Tursiops *research in the data deficient areas identified in the* Tursiops *Taxonomy Workshop report (the African coast of the eastern Atlantic, southern and eastern Mediterranean Sea, eastern South Pacific, Pacific coast north of California and off the Mexican mainland, Central American coast of the eastern North Pacific, Central American Atlantic and Caribbean Sea and Atlantic coast of northern and north-eastern Brazil, eastern Australia and in the western Pacific the islands of Micronesia, Melanesia, Polynesia, the Philippines and Vietnam);*

***Encourages** collection of additional data, including morphometrics, and high-resolution genetic analyses (e.g. ddRAD which may also be useful in other areas where there are similar questions requiring high-resolution analysis), to better characterise divergence between coastal and offshore forms in the western South Atlantic Ocean, to help confirm whether subspecies or species classification is more appropriate for* T. t. gephyreus*;*

***Encourages** the further investigation of* T. aduncus *lineages in the Indian Ocean and western South Pacific to assess potential subspecies recognition, extending the geographic coverage to include eastern Africa, the region between Pakistan and Indonesia, and the region between Australia and China;*

***Encourages** the continued study of the genetics and morphology of southern Australia bottlenose dolphins with the '*T. australis*' mtDNA lineage, in the context of both* T. truncatus *and* T. aduncus*;*

Encourages *examination of the level of male-mediated gene flow between the coastal and offshore forms in the western North Atlantic to determine whether the coastal form should be elevated to species or subspecies status;*

Encourages *more comprehensive morphometric analyses comparing* T. truncatus *in the Mediterranean, Black Sea and eastern Atlantic to integrate with genetic data and evaluate whether any regions in addition to the Black Sea (*T. t. ponticus*) harbour a taxonomic unit above the level of population;*

Encourages *comprehensive morphometric analyses of coastal and offshore* T. truncatus *in the eastern North Atlantic and comparison to those from the western North Atlantic to better evaluate potential regional differences;*

Encourages *morphometric analyses of Gulf of California coastal and offshore dolphins relative to those from California and the eastern tropical Pacific, with a particular focus on the level of divergence of coastal dolphins in the upper Gulf of California to other areas; and*

Encourages *the collection of additional genetic and morphological data throughout the eastern South Pacific and further studies to investigate coastal versus offshore forms throughout the region, including coastal and offshore waters from Central America to Mexico, and if possible around the southern tip of South America to Argentina.*

Attention: SC, G

After reviewing the development and use of a strategy for objective evaluation of species, subspecies and population-level distinctions by the 2018 Tursiops *Taxonomy Workshop, the sub-committee:*

Agrees *with the strategy implemented in the workshop for evaluation of species, subspecies and population level distinctions;*

Encourages *use of the criteria and guidelines in Reeves* et al. *(2004) for the assessment of species-level taxonomy, in Taylor* et al. *(2017) for subspecies-level taxonomy, and in Martien* et al. *(2015) for Demographically Independent Populations; and*

Agrees *to continue compilation of specimen, study, and researcher details, and concentrated effort to improve our understanding of* Tursiops *in data-deficient areas.*

After reviewing the 2018 Tursiops *Taxonomy Workshop's evaluation of the support provided for taxonomic (subspecies, species) and population-level distinctions proposed in the publications reviewed, the sub-committee:*

Concludes *that the current taxonomy provided by the Society for Marine Mammalogy's Committee on Taxonomy is well supported by morphological and molecular genetic data, as well as ecological and distributional data. This taxonomy includes the common bottlenose dolphin* T. truncatus *and the Indo-Pacific bottlenose dolphin* T. aduncus*. Three subspecies are recognised within* T. truncatus*: the nominate subspecies,* T. t. truncatus*, the Black Sea bottlenose dolphin,* T. t. ponticus *and Lahille's bottlenose dolphin,* T. t. gephyreus*;*

Concludes *that discordance in currently available results from morphometric analyses and across different genetic markers of the recently described '*T. australis*' from southern Australia calls into question its validity at this time; and*

Concludes *that future taxonomic questions should be examined within an appropriately wide and inclusive geographic context and that multiple lines of evidence are necessary when positing taxonomic changes.*

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5. POORLY DOCUMENTED TAKES FOR FOOD, BAIT OR CASH AND CHANGING PATTERNS OF USE

The poorly documented take of small cetaceans for use as wildmeat is a priority topic of the Scientific Committee. An Intersessional Correspondence Group (ICG) was established to ensure progress on this topic between Scientific Committee meetings. The ICG was tasked with the development of a toolbox of techniques that could guide and co-ordinate research into this topic with the aim of better understanding the issue on regional and global levels. A series of workshops were proposed to fulfil this task, the first of which covered South East Asia and was reported in SC/67a. A second workshop focused on this issue in South America and incorporated a detailed review of the use of Amazon river dolphins as bait in the piracatinga fishery, which is also a wildmeat[1] issue (SC/67b/Rep01).

5.1 Progress on the work plan

Porter summarised the report from the workshop held in the Santos, Brazil, in March 2018. The workshop was divided into two separate sessions, one which discussed the issue of wildmeat in South America and one which reviewed the take of Amazon dolphins for bait in the piracatinga fishery. This workshop fulfilled several goals of the Scientific Committee; the ongoing work of ICG 30 on the poorly documented take of small cetaceans and the completion of the work of the Amazon Dolphin/Piracatinga Steering Group (SG 21). The workshop aimed to:

(1) identify threats, past and present, in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Suriname, Peru, Uruguay and Venezuela with respect to 'wildmeat', and discuss which techniques can be utilised to better understand this issue; and
(2) review current knowledge of the use of Amazon river dolphins as bait in the piracatinga fishery and provide recommendations for future work and action.

Information was summarised for all countries, except Guyana and Suriname. Products from small cetaceans are used throughout South American countries, and Costa Rica, for both food and non-food purposes. This type of use is referred to as 'aquatic wildmeat'. The usefulness of various tools and techniques was discussed, including data gathering techniques and forensic investigation. A database, comprising more than 3,000 references, was used to map existing knowledge and understand data gaps. A framework was established with the intention that future data collection should be collated in such a way as to be standardised and systematic, with a view to gathering sufficient information to better understand regional and global patterns of small cetacean wildmeat use. The workshop participants populated a database from which regional patterns were mapped. Areas that were highlighted as a cause of conservation concern

[1] Following the formal definition of terminology with other IGO's working in this topic, and as reported in SC/67a, the term 'wildmeat' will be used for both terrestrial and aquatic wildlife species that are used for food and non-food purposes. As such, the term 'wildmeat' is now commonly used in reporting.

were; Bolivia, Brazil. Colombia, Costa Rica, Ecuador, Peru and Venezuela.

The take of Amazon river dolphins as bait in the piracatinga fishery was reviewed. All range countries of *Inia* and *Sotalia* have laws in place to protect dolphins and prohibit intentional killing. Fishing for piracatinga is banned in Brazil and its trade is prohibited in Colombia due to its impact on river dolphins and other wildlife. Colombia does not have a piracatinga fishery using dolphins as bait, however, the high demand for this fish in Colombia drives fisheries elsewhere. The practice of using dolphins as bait has recently expanded to Peru, Bolivia and Venezuela, following the imposition of restrictions in Brazil, however, no other range country has developed specific legislative or regulatory action, beyond the general protection of river dolphins, in response to the emergence of this practice.

The workshop concluded that small cetaceans are used throughout South American countries for a variety of wildmeat purposes and that some species and populations require urgent attention. The sub-committee **endorses** and **adopts** the recommendations made in the workshop report. The sub-committee noted that some workshop recommendations pertain to management actions and these are highlighted for the attention of the Conservation Committee.

The sub-committee **commends** the Government of Brazil on its swift action in declaring a moratorium on the piracatinga fishery and **urges** the government to maintain this moratorium to allow sufficient time to evaluate the effectiveness of protective measures and continue the necessary protection of river dolphins. The Government of Brazil is respectfully requested to continue to provide progress reports to the Scientific Committee on its efforts to combat the use of Amazon river dolphins (botos *I. geoffrensis* and tucuxis *S. fluviatilis*) as bait for the piracatinga fishery in the Amazon Basin.

The sub-committee **agrees** that the science-based recommendations of the workshop should be highlighted as there are several issues that require further action.

Attention: CG-R, S

Given continued concern over the use of dolphins as bait in the piracatinga fishery, the sub-committee:

***Recommends** that the Government of Brazil maintain the moratorium on the piracatinga fishery to allow sufficient time to evaluate the effectiveness of protective measures and continue the necessary protection of river dolphins;*

***Reiterates** previous recommendation of the Scientific Committee of the IWC that range states (Bolivia, Brazil, Colombia, Peru and Venezuela) engage in a co-ordinated effort to strengthen legislative, enforcement, management and scientific efforts to ensure protection of the Amazon River dolphins; and*

***Encourages** range state authorities to work together and exchange information on the movement of piracatinga products across international borders.*

In addition, the sub-committee:

***Recommends** that a letter be sent, by the secretariat of the IWC to the Buenos Aires Group highlighting the issue of dolphins being used as bait in the piracatinga fishery and requesting joint efforts to enhance enforcement on wildlife and trade laws.*

Attention: SC

To improve regional knowledge and aid conservation research, the sub-committee:

***Recommends** that potential divisions within the genus Inia are evaluated, and genetic conservation units are established;*

***Strongly encourages** an evaluation of historical data on river dolphins to better understand other threats, e.g. from bycatch, to provide further insights into current trends;*

***Encourages** the use of new technologies, such as drones and satellite telemetry, to establish trends, habitat use and dispersion patterns of Inia within Amazon River Basin; and*

***Encourages** new efforts to improve regional research capacity.*

As evidence shows that several small cetacean species and/or populations are being negatively impacted by their use as wildmeat in South America, the sub-committee;

***Recommends** that abundance and distribution surveys, in tandem with investigation into the magnitude of aquatic wildmeat use, be conducted on these species. Appropriate survey designs should be implemented that consider the statistical power required to detect trends and the resultant data should then be used to estimate the impact of deliberate take for wildmeat on the following populations:*

*Boto (*Inia geoffrensis*) in Purus and Japurá rivers, Brazil, and Içá/Putumayo river in both Brazil and Colombia, utilising previously established standardised methods. Also, studies should be expanded into other areas where take for bait may be a cause for concern.*

- *Chilean dolphin (*Cephalorhynchus eutropia*) in Chile;*
- *Burmeister's porpoise (*Phocoena spinipinnis*) in both Chile and Peru;*
- *Burmeister's porpoise (*Phocoena spinipinnis*) in Peru, noting that current evidence suggests that the Peruvian population is distinct;*
- *Dusky dolphin (*Lagenorhynchus obscurus*) in Peru, noting that evidence shows that landings of this species has decreased and populations may have been heavily impacted;*
- *Guiana dolphin (*Sotalia guianensis*) and other small cetaceans in Amapá, Pará, Maranhão, Piauí, Ceará, Espírito Santo, São Paulo and Paraná, in Brazil, as there is a documented use of bycatch for wildmeat purposes;*
- *Bottlenose dolphins (*Tursiops truncatus*) and pantropical spotted dolphins (*Stenella attenuata*) in Bahia Solano, Colombia, noting that deliberate take for a long line fishery is ongoing;*
- *Tucuxi (*Sotalia fluviatilis*) throughout its range, in Brazil, Colombia, Ecuador, as it shares most of the same threats as Inia geoffrensis, and may also be used as bait in the piracatinga fishery; and*
- *Guiana dolphin (*Sotalia guianensis*) in Lake Maracaibo in Venezuela, noting that deliberate take for food is ongoing.*

*The sub-committee also **draws attention to** the Boto dolphins that have been isolated within the dam system of the Tocantins and Maderia Rivers in Brazil and, given the confined condition of the dolphins' habitat:*

***Recommends** that the status of these dolphins be evaluated, to include abundance, genetic, habitat and prey availability* *assessments, with a view to developing a translocation protocol, including under what circumstances such a protocol should be enacted.*

Given the concerns over the extensive habitat modification that will result from the Mega Project 'Arco Minero del Orinoco', a large-scale mining operation proposed along the river and watershed of Venezuela, the sub-committee:

***Recommends** that population sizes and trends of both Inia geoffrensis and Sotalia guianensis, in the Orinoco River basin, be monitored before and during this project.*

Attention: CC

The workshop report on the use of Small Cetaceans for Food and Non-Food Purposes contains several management-based recommendations, as such the sub-committee:

***Draws attention to** the recommendations within this report, in particular, the need to have a regionally coordinated fisheries management plan for the Amazon River basin and a regional strategy for the conservation of river dolphins.*

The sub-committee **concludes** that as the magnitude of use of small cetaceans as aquatic wildmeat is a regional cause of concern, all parties, including researchers and management authorities, are **strongly encouraged** to standardise data collection efforts to better understand this issue, and to actively encourage a collaborative and coordinated approach to understand regional patterns and trends. A framework for such an approach was developed during the workshop.

5.2 Wildmeat databases

At the previous meeting of the Scientific Committee in 2017, it was agreed that the intersessional group would work, with the input of the IWC Global Database Repositories Convenor, to develop an overarching aim for any future cetacean wildmeat database, and to provide specific questions that such a database might address, and present these at the Scientific Committee meeting in 2018. SC/67b/SM12 provided an update on this intersessional work. In response to growing concerns over aquatic wildmeat, a research agenda was developed to better understand the issue and formulate the key questions that could be addressed through the development and analysis of an aquatic wildmeat database. These include the information on which species are taken, where and when the takes occur, by whom they are acquired and what the drivers of the process are. The following list of characteristics should be considered when designing an aquatic wildmeat database: (1) ease of use; and (2) space to record relevant information for data providers. It is hoped that an aquatic wildmeat database would support conservation planning and act as a repository for past, present and future information on aquatic wildmeat.

SC/67b/SM02 provided an update on 'The Aquatic Wildmeat Database', an online application/interface intended to centralise data on global aquatic mammal use. This database is expected to facilitate identification of understudied areas and those of greatest concern, as well as to provide a basis for detecting and tracking trends in use since 1945. The inclusion of different types of data will make it possible to carry out studies at different geographic and spatial scales. The database was built using the R package *shiny.* The data are displayed as a global interactive map and as trends plotted by country. Data were obtained from researchers as well as from literature and online newspaper articles. The application is also used opportunistically to document events that are rarely published, by allowing users to contribute using a form. The database currently contains 93 data points from 27 countries, pertaining to 24 species. Anticipated future work includes promoting the database among international and regional bodies, such as the IWC and CMS, and continuing to populate it and expand coverage to other taxa. The Aquatic Wildmeat Database is expected to be a useful tool for the scientific community and the public at large, as well as for managers and policy makers, and to inform research and conservation programmes.

In discussion, potential issues of concern were discussed, including mechanisms for data validation and quality control, as well as the historical timeline cut-off point.

The sub-committee welcomed this information and agreed that the database is a useful tool, noting that it is not being built for the specific use of this sub-committee's work. An interessional correspondence group was established to discuss refinements, especially methods for data quality evaluation, with a view to making this database useful for the work of the Scientific Committee. The sub-committees welcomes Cosentino to report on progress at a future meeting.

6. SMALL CETACEAN TASK TEAM

6.1 Progress on South Asian river dolphins task team

Simmonds (as Task Team Coordinator) 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 and was deemed a success by the Scientific Committee.

At SC/66b it was agreed that the situation facing South Asian river dolphins is a matter of grave concern and requires immediate attention, and that a Task Team should be assembled. This has been progressed intersessionally with discussions on membership, geographic coverage, convenors and first actions. At the time of writing, the South Asian River Dolphin Task Team has some 14 members with representation from Bangladesh, India, Nepal and Cambodia. University-associated researchers, WWF and the Wildlife Institute of India are also represented in the team. The nominated co-conveners for the Task Team are Dipani Sutaria and Nachiket Kelkar. Simmonds noted that the Task Team would need some funding to be able to meet, which would certainly help its progress. It was suggested that the IWC website could be used to increase the profile of the Task Team.

The sub-committee thanked Simmonds for his intersessional work. The sub-committee **strongly supports** the Task Team initiative, including the proposed workshop for the South Asian River Dolphin Task Team. The sub-committee encourages the Task Team to work expeditiously and **agreed** that an improved website profile was appropriate.

7. PROGRESS ON PREVIOUS RECOMMENDATIONS

7.1 Vaquita (update on CIRVA progress)

7.1.1 Dolphin bycatch in totoaba nets

SC/67b/SM15 described the first cetacean bycatch (*Delphinus delphis*) in an illegal totoaba gillnet to be documented in January 2018 in San Felipe, Mexico. While focusing on vaquitas in recent years, researchers and managers have generally neglected the bycatch of other small cetaceans, especially *Tursiops*. During the recent IWC Workshop on Tursiops Taxonomy in La Jolla, CA in March, the participants noted that there is significant genetic differentiation between coastal populations in the Gulf of California and California, raising concern about the conservation status and bycatch of Tursiops in the region. The authors of SC/67b/SM15 encouraged further evaluation of *Tursiops* genetics in the Gulf of California, and specifically also assessment of bycatch to better understand the conservation status of these dolphins. They also recommended systematic beach surveys for stranded specimens and subsequent evaluation of human interaction to quantify bycatch rates during the peak totoaba season, January through May.

7.1.2 Vaquita

7.1.2.1 ACOUSTIC MONITORING

Rojas-Bracho and Jaramillo-Legorreta introduced SC/67b/SM01, the report of the Tenth Meeting of the International Recovery Team for Vaquita (CIRVA-10). Jaramillo-Legorreta presented the results of the acoustic monitoring program for vaquitas which has been conducted annually using identical methods since 2011. The 2011-17 data series gathered from the regular 46 C-pod sampling grid, shows a continued decline in vaquita detections with no change in the trend since the last report in 2016.

In 2017 a near-real-time sampling scheme was developed to provide data on vaquita distribution over short timeframes to support the Vaquita Conservation, Protection and Recovery project (VaquitaCPR). This consisted of an enhanced sampling grid of 87 sites, covering the entire Vaquita Refuge and areas around the margins.

The sampling plan for 2018 includes the regular annual sampling period between June and September (46 sites) and other efforts outside this period. A grid of six sites has been in place since February 2018 and will remain in place into May. These six sites account, on average, for 58% of the total clicks detected during the regular annual sampling period and provide an interim window into vaquita presence.

The sampling grid used for the near real-time acoustic monitoring scheme, implemented during the VaquitaCPR field season, included 36 sites covering the areas with most of the acoustic activity during the regular sampling period. C-pods were interchanged, and data were analysed and reported on a daily basis with the goal of reporting on the presence of vaquitas a few hours prior to daily visual searching operations. Reports of the location of acoustic encounters, were usually delivered about three hours prior to visual operations, between 2-3am. This near real-time monitoring proved to be reliable in guiding the visual search teams to locations where vaquitas were encountered. The VaquitaCPR team recognised that, without this tool, locating vaquitas on a daily basis would have been considerably harder.

7.1.2.2 VAQUITACPR

Rojas-Bracho provided a brief review of the VaquitaCPR project to capture vaquitas and bring them into human care as described at SC/67a. VaquitaCPR was designed to be undertaken in a phased approach, with each step dependent on the success of the previous one. The field program conducted in October and November 2017 included 90 experts from nine countries and was organised into several teams devoted to finding, catching, handling and care. The first component was dedicated to finding vaquitas, using acoustic (as described above) and visual methods. The visual team employed three vessels. A mother ship (*Maria Cleofas*) supported an observer team equipped with two deck-mounted 'big-eye' (25-power) binoculars and a full-time data recorder to document the positions of vessels and vaquitas. Two smaller sport-fishing boats with flying-bridge viewing platforms completed the visual detection fleet. A special computer program was created and used on the *Maria Cleofas* to track vaquita sightings and the other sighting and catch vessels using Automatic Identification System (AIS) technology. All sighting vessels were crewed by observers experienced in previous vaquita sighting surveys. When vaquitas were sighted, the sighting vessels formed a triangle, with the goal of keeping the vaquitas between them until catch boats could be guided into proximity.

Capture efforts involved an international team of experts, including researchers experienced in the capture and handling of harbor porpoises, animal care professionals and veterinarians. This team was distributed across three small (~8m) vessels. Once vaquitas were located by the visual survey team, the catch boats were directed towards the animals by those aboard the sighting vessel with the vaquitas in sight. Once in close proximity ahead of or near the vaquitas, lightweight floating gillnets (256-512m long and 9-18m deep) were rapidly deployed by the catch boats. The catch boats were then used to herd the vaquitas toward the nets. The nets were deployed three times and animals were caught twice. The nets allowed vaquitas to surface easily to breathe and facilitated efforts to remove them. Two vaquitas were successfully captured (a third animal escaped at the time the second animal was caught). The first vaquita, caught on 18 October, was an immature female (V01F). The second, captured on 4 November, was an adult female (V02F).

In both cases, medical and behavioural evaluations were conducted to determine the suitability of the animals for transport to the floating pen or shore-based facility. Through the whole process the animals' health was continuously monitored by a team of experienced marine mammal veterinarians.

The first vaquita caught (V01F) was determined to be in good condition after veterinary assessment. However, after transport to shore, the veterinary and animal care teams determined that the animal was not acclimating to the vaquita care centre pool or to the sea-pen facility and the decision was made to release it. Prior to release blood and skin samples were collected for cell culture and genetic sequencing.

V02F was monitored carefully after capture and before transport and considered to be in good condition for transport to the sea-pen. However, after initially showing signs of adapting to the facility, the animal stopped swimming and an emergency release was initiated. The release was unsuccessful and the vaquita was quickly recaptured for administration of emergency care. Following three hours of emergency response, the animal went into cardiac arrest and did not respond to resuscitation attempts. After necropsy, tissues were collected for histopathology, cell culture, gamete rescue and genetic sequencing. Gamete rescue has been successful at SeaWorld (T. Robeck). Ongoing genetic analyses using mitochondrial DNA sequencing underway at the Southwest Fisheries Science Center do not indicate a loss of genetic diversity in this small population. Tissue culture has also been successful; dozens of cell cultures from both specimens have been frozen under the supervision of Dr. O. Ryder at the San Diego Zoo Institute for Conservation Research of the San Diego Zoo.

CIRVA commended SEMARNAT and the numerous partners who made this unprecedented effort possible. It further stressed that the strong on-the-water presence during the VaquitaCPR capture effort appeared to discourage illegal fishing. Moreover, the local, national and international collaborations forged during VaquitaCPR raised awareness at the local to global levels of the urgent need for forceful action to conserve vaquitas. The effort as a whole also reinforced the strong commitment within Mexico and internationally to do everything possible to prevent the extinction of the vaquita. Efforts are underway to review the overall VaquitaCPR programme and compile lessons learned.

7.1.2.3 ENFORCEMENT

Rojas-Bracho reported on advances by the Government of Mexico in enforcement and regulations. The Mexican Navy (SEMAR) reported to CIRVA on the enforcement measures put in place in 2015 and how they have been continued and enhanced to the present. A permanent naval station was established in San Felipe in 2017, both for maritime emergency response and to enhance the Government's capability to take immediate and effective action against illegal activities. On average, two large ships, numerous small boats, as well as airplanes, helicopters, drones, and over 700 individuals, are engaged in the enforcement effort.

With regard to removal of entangling gillnets from the range of the vaquita, SEMARNAT is leading an effort involving the Sea Shepherd Conservation Society (SSCS), Museo de la Ballena (MB), the Mexican Navy and the Ministry of Environment's watchdog agency PROFEPA. SSCS is participating with three large vessels and MB with two. They are receiving small-vessel support from the Navy and enforcement capability has been enhanced with the presence of Navy and Environmental Gendarmeria and enforcement personnel on the net retrieval vessels.

The programme to remove both active and derelict fishing gear from the range of the vaquita has removed 518 nets over 166 effective days of effort from 10 October 2016 to 8 December 2017. In 2018, from 2 January to 25 April, a total of 486 nets had been retrieved, 81 of them active: 95% of those were totoaba gillnets. Since the beginning of the programme 19 months ago, approximately 1,029 nets or pieces of fishing gear had been removed. The removed nets are destroyed and the remains recycled by 'Parley for the Oceans' which will produce specially labelled products from them.

The survival of the vaquita depends on gillnet-free habitat. Both the CIRVA report and reports since then[2] on the 'success' of the net removal programme demonstrate that illegal totoaba gillnets are still routinely set in great numbers in vaquita habitat. Despite enhanced enforcement efforts there is a continued failure to prevent illegal fishing.

Prior to the current seasonal surge of illegal totoaba fishing, CIRVA stated that immediate action was needed to improve the situation through implementation of a series of recommendations. In particular, CIRVA recommended that the Government of Mexico establish an enhanced enforcement area (Fig.1) during the totoaba spawning season (December 2017 through May 2018) when illegal fishermen concentrate in the Upper Gulf. This area has the highest co-occurrence of vaquitas and illegal totoaba nets and is now designated as the 'enhanced enforcement area'.

CIRVA recommended that within the exclusion zone the Government of Mexico:

(1) prohibit all fishing and navigation;
(2) increase enforcement presence to a level that makes it possible to respond to any report of illegal activities within 30 minutes;
(3) increase and focus net removal efforts within the exclusion zone; and
(4) negotiate the appropriate transit corridors to allow legal fishing to continue outside the exclusion zone.

In addition, CIRVA recommended that drones be used to monitor the areas of historical totoaba fishing and vaquita entanglement near El Golfo de Santa Clara to ensure that illegal totoaba fishing effort does not shift to those areas.

Mexico established the enhanced enforcement area through a 24 April 2018 notice in Mexico's Federal Register.

While the illegal totoaba fishery is the major enforcement challenge, work continues through the Expert Committee on Fisheries Technologies (ECOFT) to develop and disseminate alternative gear techniques that could support legal commercial fishing opportunities year-round. CIRVA endorsed ECOFT's recommendations on suitable gear and recommended prohibition of the use of any monofilament or multi-monofilament nylon line in construction of alternative fishing gear.

7.1.2.4 CONCLUSIONS AND RECOMMENDATIONS

As this sub-committee has stressed for years, the vaquita population is at a critically low level and recent evidence demonstrates that the cause of the decline – use of illegal large-mesh gillnets – continues, making extinction in the wild increasingly likely. It is important to consider the carefully planned, staged attempt by an international team of experts to bring animals into captivity in order to protect them in light of these dire circumstances. Despite a huge investment of resources, time and effort, the attempt sadly failed, but through no fault of the team. The sub-committee commends the SEMARNAT, VaquitaCPR team and its supporters for their valiant efforts.

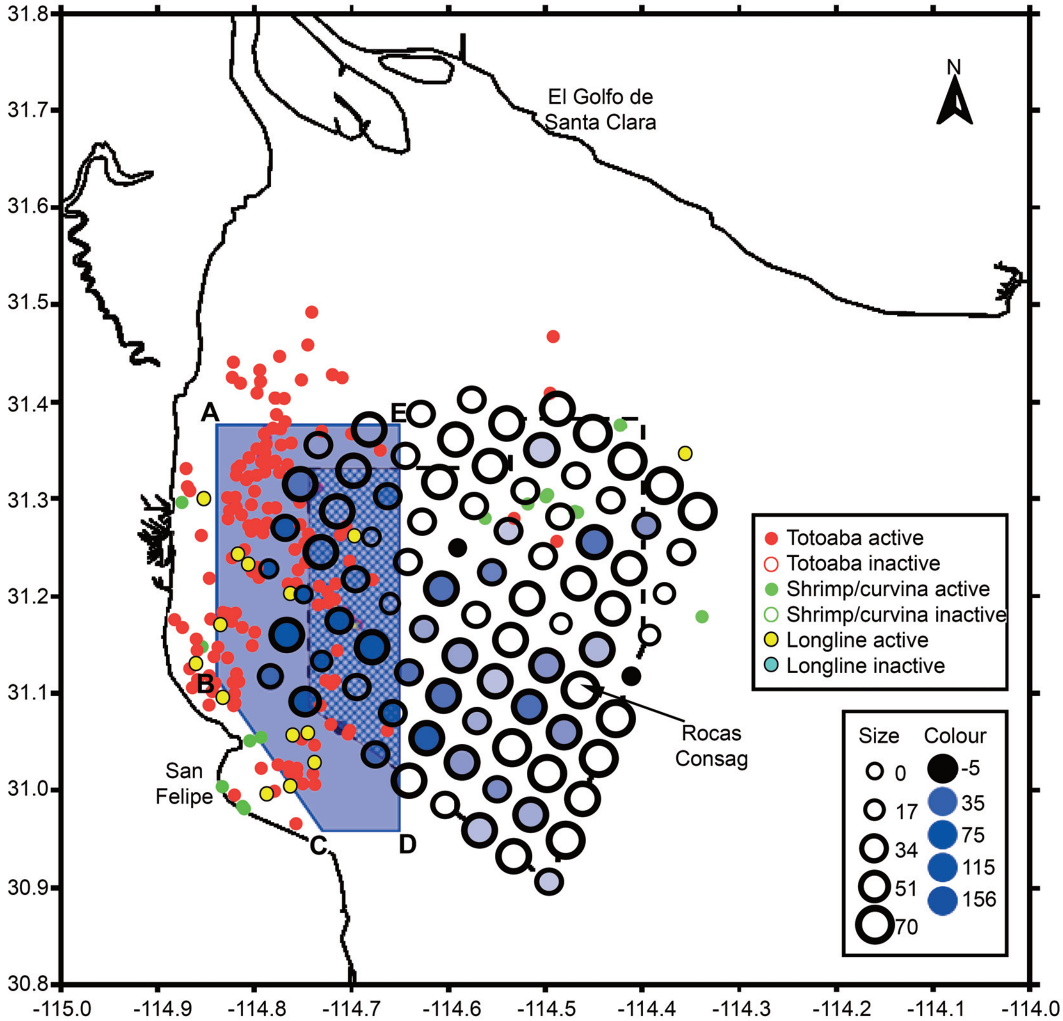
The sub-committee again expressed its disappointment and frustration that, despite almost two decades of repeated warnings, the vaquita continues to be on a rapid path towards extinction as a result of ineffective conservation measures. As such, the sub-committee **re-emphasised** the concerns it has raised on the status of the vaquita over many years, in particular its recommendations of the past two Scientific Committee meetings, and **endorsed and adopted the recommendations** in the CIRVA-10 report (SC/67b/SM01).

The sub-committee again **commended** the Government of Mexico for its attention and response to the CIRVA findings and recommendations and respectfully **requested** that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards saving the vaquita.

Attention: SC, CC, CG-R

The long-term decline in the vaquita reported previously has continued in 2017. As acoustic monitoring is critical for evaluating the effectiveness of conservation actions, the Committee:

[2] (*http://www.iucn-csg.org/index.php/2018/04/06/first-vaquita-found-dead-in-2018-march-2018-update/*).



Vertex	Longitude	Latitude
A	-114.83908	31.37629
B	-114.83908	31.11555
C	-114.72977	30.95786
D	-114.65015	30.95786
E	-114.65015	31.37629

Fig.1. Enhanced enforcement zone (also called exclusion zone).

Strongly recommends *that the CIRVA-10 acoustic monitoring programme be continued as in previous years to provide an annual empirical estimate of population trend.*

And further ***re-iterating*** *the recommendations made in CIRVA-10, the sub-committee* ***recommends*** *that:*

(a) all Mexican enforcement agencies increase their efforts on land and in water immediately and continue this enhanced enforcement program for the duration of the period of illegal totoaba fishing (at least until June 2018) to eliminate all setting of gillnets in the range of the vaquita; and (b) emergency regulations be promulgated immediately to strengthen the current gillnet ban and enhance enforcement and prosecution by:

- *eliminating all fishing permits for transient fishermen and limiting fishing access to only those fishermen who can demonstrate residency in the fishing villages;*
- *confiscating any vessel that does not have the appropriate vessel identification, permits and the required vessel monitoring system;*
- *requiring vessel inspection for each fishing trip at the point of departure and landing;*
- *prohibiting the sale or possession of gillnets on land and at sea within the area of the current gillnet ban and on adjacent lands within a specified distance of the coastline;*
- *requiring that all gillnets be surrendered or confiscated and destroyed; and*
- *eliminating the exemptions for all gillnet fisheries, including the curvina and sierra fisheries.*

The sub-committee further:

Recommends *that the Mexican enforcement agencies: (a) efforts to remove gillnets from vaquita habitat be continued and enhanced and the numbers and locations of new nets recovered be published monthly; (b) also publish monthly the number of inspections, interdictions, arrests, sentences and other enforcement actions, together with information on observed levels of illegal activities obtained from intelligence operations, for example from drones; (c) ensure that successful prosecution and subsequent penalties be sufficient to deter illegal fishing; and (d) development of gillnet-free fisheries be enhanced and linkages to incentivise the conversion of the fleet to gillnet-free operations be strengthened.*

7.2 Yangtze finless porpoise

A rangewide survey of Yangtze finless porpoises (*Neophocaena asiaeorientalis asiaeorientalis*, YFP) was conducted between 10 November and 31 December 2017 following the same methodology as surveys in 2006 and 2012 (SC/67b/SM07). The 2017 abundance estimate of total population size was approximately 1,012 individuals, with 445 in the mainstem of the Yangtze River (1,200 in 2006, 505 in 2012), 457 in Poyang Lake (450 in 2006 and 2012) and 110 in Dongting Lake (150 in 2006, 90 in 2012). The overall estimate in 2017 was lower than that in 2006 (~1,800) but very similar to that in 2012 (~1,045). Note that it was not possible from the information and data provided in the paper to evaluate the quality of these estimates; the 2006 and 2012 estimates, however, are published as Zhao *et al.* (2008) and Mei *et al.* (2014). The author of SC/67b/SM07 interpreted the results of the 2017 survey as indicating that the rapid decline observed between 2006 and 2012 has now slowed, and that numbers may even be increasing in some areas, e.g. Dongting Lake from 90 in 2012 to 110 in 2017. Nevertheless, the Critically Endangered status of this species remains unchanged (Wang *et al.*, 2013).

YFP distribution within the mainstem of the river remains fragmented, as observed previously in the 2006 and 2012 surveys. The porpoises tend to concentrate in better-quality habitat, therefore leading to more fragmentation. Overall, habitat quality and habitat connectivity are very poor. Most habitat areas are degraded and continue to deteriorate, although some small parts of the mainstem and some lake areas show improvement. Overall, water quality appears acceptable for YFP survival.

The Government of China has been highlighting environmental issues in recent years, which includes improved law enforcement, stricter fisheries management (e.g. a seasonal fishing ban), better management of sand mining, and habitat restoration (e.g. removal of derelict jetties). In the view of the author of SC/67b/SM07, those measures are responsible at least in part for the observed increase in porpoise abundance in some sections of the river and in Dongting Lake. The sub-committee considered this news encouraging and regarded it as a possible indication that *in situ* conservation of YFP is feasible.

The sub-committee welcomed the information on measures taken by the Government of China to improve conditions in the Yangtze for porpoises and other aquatic wildlife. The sub-committee **concluded**, however, that for the porpoise population to make a sustained recovery in both numbers and range, it would be necessary for the trend of introducing measures to improve habitat in the Yangtze River and Dongting and Poyang Lakes to continue and expand.

Needed further measures include but are not limited to: (1) protection and restoration of aquatic habitat in the Yangtze River and the lakes, maintaining a network of *in situ* reserves; (2) strengthening the capacity of bodies responsible for managing the reserves to enforce the fishing ban; (3) maintaining and where necessary restoring the natural connectivity between the lakes and the mainstem of the river; (4) strengthening the *ex situ* conservation management programmes and moving towards releasing animals from the semi-natural reserves into the Yangtze River and adjoining lakes as part of a step-wise restocking plan; (5) ensuring that the volume, speed, and routing of ship traffic in the Yangtze River are managed in a way that incorporates protection of the porpoises; and (6) implementing a year-round fishery ban throughout the entire Yangtze River basin, although concerns on the feasibility of such a plan remain.

In discussion, the sub-committee noted progress and **commended** the efforts undertaken by the Chinese government, Wang Ding and colleagues and local NGOs. Nevertheless, the sub-committee also expressed concern over several threats to YFP, which include vessel strikes, bycatch and underwater noise. In particular, vessel traffic is most intense alongshore due to favourable currents, which is where much prime porpoise habitat occurs. There is substantial concern over the planned construction of new bridges in YFP habitat, as there is evidence that these bridges inhibit the animals' movements. More research is needed to corroborate this. Planned construction of a dam across the channel connecting Poyang Lake to the river is an additional concern. Based on the construction plans, the widest possible gate for porpoise movement would be 60m across, which could be too narrow to allow porpoises to move freely into and out of the lake.

The sub-committee highlighted the need for post-release monitoring in order to document the fate of animals that are released back into natural habitat in the Yangtze system and more generally to assess the effectiveness of a restocking programme. It was acknowledged that following YFP post-release is extremely challenging. Nevertheless, Wang Ding noted that one animal was released into a semi-natural reserve following seven years in captivity. The animal was retrained to forage in the wild before being released. Subsequently, this individual has produced several offspring, some of which produced offspring of their own, with documented records up to four generations.

The sub-committee **re-iterated its previous recommendation** that primary conservation actions should focus on restoring and maintaining suitable habitat for porpoises 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.

Attention: SC, CG-R

Given the extensive and pervasive nature of the threats that the Yangtze finless porpoise population faces, primary conservation actions should focus on restoring and maintaining suitable habitat throughout the Yangtze River and associated lakes, the sub-committee:

***Re-iterates its previous recommendation** that a network of in situ reserves is maintained and efforts are made to ensure that genetic diversity is preserved and that harmful human activities are limited.*

7.3 Māui dolphin

New Zealand's annual update on its research and management approach for Māui dolphin provided data on sightings, necropsies and fisheries observer coverage as well as information on current research projects to inform a review of management measures scheduled for later this year (SC/67b/SM08). Observer coverage of the set net fishery in Taranaki was 95.5% and coverage of the trawl fisheries adjacent to existing closure areas was 88.3%. Outside of this target coverage area, an additional 114 trawl fishing days were observed. No captures of Māui dolphins were reported by observers or fishermen in commercial fisheries in the 12-month reporting period to 31 March 2018. A necropsy on the only beachcast dead dolphin reported in this period determined that the animal had suffered multiple shark bites prior to death. Preliminary analysis of acoustic data collected in Māui dolphin habitat showed that dolphins were detected at 8, 10, and 12km offshore, but not 14, 16, or 18km offshore.

A species-specific, spatially explicit, multi-threat risk assessment is being developed for Māui and Hector's dolphins. A workshop is scheduled for July 2018, where the risk associated with fishing and non-fishing threats, including threats to health, will be evaluated for various management scenarios. The results of this assessment will inform consultation on an updated Threat Management Plan later in 2018. Full details and results of the Hector's and Māui dolphin-specific risk assessment will be submitted to the Scientific Committee in 2019.

The Committee **welcomes** the update on Maui dolphins provided and looks forward to receiving the species-specific, spatially explicit, multi-threat risk assessment in 2019.

Attention: SC, CG-R, CC

*The sub-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 sub-committee:*

***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;*

***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);*

***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;*

***Respectfully encourages** the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation; and*

***Respectfully requests** that reports be provided on progress towards the conservation and recovery goals as updates become available.*

7.4 Cruise report from northwestern Africa

SC/67b/ASI01 reported on the 3rd cetacean sighting survey in the coastal waters of Guinea, Sierra Leone and Liberia from 6-12 March 2018. The purpose was to obtain information on distribution and abundance of cetaceans in the EEZ's of member countries of the Ministerial Conference on Fisheries Cooperation Among African States Bordering the Atlantic (COMHAFAT/ATLAFCO). The survey was carried out by the Centre National des Sciences Halieutiques de Boussoura of Guinea (CNSHB) under the auspices of COMHAFAT, with the collaboration of African fisheries institutions and fisheries research centres such as the University of Abidjan in Côte d'Ivoire, the IMROP of Nouadhibou in Mauritania, the Direction des Pêches Maritimes in Congo Brazzaville, the National Fisheries and Aquaculture Authority in Monrovia, Liberia, and the Ministry of Fisheries and Marine Resources in Freetown, Sierra Leone.

The survey used line transect methods authorised by the Scientific Committee. Searching was carried out from the N/O *General Lansana Conte* (29.93m Guinean research vessel) according to the procedure and protocol used in the IWC/SOWER cruise (Diallo and Bamy, 2013; Matsuoka *et al.*, 2003), covering 558.1 n.miles of transects. Fourteen schools of five species for a total of 433 individual cetaceans were sighted as follows: eight schools and 204 individuals of bottlenose dolphins, one school of five pantropical spotted dolphins, three schools of 34 individuals of Atlantic spotted dolphins, one school of 40 of unidentified dolphins and one school of 150 spinner dolphins.

The sub-committee thanked Diallo for this report on this poorly surveyed area. The absence of sightings of common dolphins, which are present just North of the survey area, was noted. A more substantive analysis and mapping of species presence might be achieved by combining the results of this survey with those of two previous surveys reported to the Committee. It was also noted that if the Scientific Committee were given ample notice of future cruises, this would allow members to provide methodological, equipment, training and even personnel support.

In discussion, attention was also drawn to a recent publication that reported on cetacean surveys in 2013-14 and on issues affecting cetaceans somewhat further North off the coasts of Ghana and Côte d'Ivoire (de Boer *et al.*, 2016).

7.5 Monodontids (report on workshop)

Suydam presented the Global Review of Monodontids Report from a workshop held from 13-16 March 2017 in Hellerød, Denmark (NAMMCO, 2018). He noted that the Scientific Committee last reviewed the monodontids (with emphasis on white whales and little attention given to narwhals) in 1999 (IWC, 2000). That review suffered from a lack of full participation by scientists from Canada, Greenland and Russia. Also, because of limited time the review was relatively cursory. Since 1999, the sub-committee has recommended an updated monodontid review several times and a steering committee was formed to investigate how best to proceed.

The steering committee concluded that involving researchers from all range states including Canada (not an IWC member) was necessary for a quality and thorough review. In discussions with the North Atlantic Marine Mammal Commission (NAMMCO) and other potential sponsors, it was concluded that a four-day workshop would be needed to conduct a thorough global review of the status of both monodontid species. NAMMCO assumed primary responsibility for organising and hosting the workshop and for preparing and publishing the report. Researchers and subsistence hunters from across the Arctic and subarctic participated. Several IWC scientists also participated, including Litovka, Reeves and Suydam. Researchers were asked to provide status reviews prior to the workshop for each of the stocks and those detailed reviews were made available as supplements to the main report. All materials are available on NAMMCO's website (*https://nammco.no*).

The main report from the workshop summarises what is known about the status of narwhal and white whale populations/stocks. It provides information, including maps, for 12 stocks of narwhals and 22 stocks of white whales. There may be more stocks than this as information on stock structure is incomplete for some areas. Table 2 on page 66 of the report summarises information about each stock. Since the 1999 IWC review, a great deal of new information has become available regarding population abundance, movements, removals and threats. Some of the abundance estimates are outdated and trend data are lacking for many of the stocks. The summary information and identification of threats and concerns will be helpful in prioritising future research. Some stocks are doing well but conservation actions are desperately needed for some others.

Reeves noted that the IUCN Red List status and documentation for both species was updated (to Least Concern) in December 2017 and that the information summarised in the NAMMCO review was very useful for those assessments (*http://www.iucnredlist.org/*).

Wade expressed appreciation for the review and acknowledged the value of summarising relevant information for each stock, but pointed out that some terminology used in the report was incorrect. Specifically, for many of the stocks a threshold for evaluating hunting catches was calculated and referred to as the 'Potential Biological Removal' (PBR). Although calculations were made that were similar to the PBR formula (Taylor *et al.*, 2000), a point estimate of abundance (N_{best}) was used instead of a minimum population estimate (N_{min}). The thresholds calculated are therefore more closely related to Maximum Sustainable Yield (MSY) (it actually represents the MSY rate multiplied by the current abundance, therefore, under the assumption of a logistic population dynamics model, it will equal MSY when the population is at the MSY level). The sub-committee agreed and recommended that the terminology and method be used correctly in future assessments.

Suydam commented that the main objectives of the review were to identify stocks, and then to summarise the available information on status and trends, removals, threats and levels of conservation concern for each stock. The report will be useful for recommendations regarding future research and monitoring and management actions. Wade noted that the assessment appeared to consider 'sustainability' to be the main conservation objective, though this was not explicitly stated, nor was the term specifically defined. The sub-committee concluded that the assessment could have benefited from a more clearly defined objective but the summary information was nevertheless of considerable value. In particular, the highlighting of specific stocks of the highest conservation concern was one of the most important outputs. Those stocks are listed in Table 1.

The sub-committee thanked NAMMCO for completing this valuable review of monodontids.

Also, the sub-committee **drew attention** to the recommendations contained in the NAMMCO report and **encouraged** their implementation, particularly those pertaining to the stocks of greatest concern.

8. REVIEW TAKES OF SMALL CETACEANS

8.1 New information on directed catches

Information presented at SC/67a on the takes of small cetaceans was updated based on data compiled from online sources[3] and data presented in the progress report on small cetacean research (see Appendix 3). It summarises data on small cetacean fisheries in calendar year 2016, as well as research conducted during April 2016 to March 2017 by the National Research Institute of Far Seas Fisheries. The data and information on small cetaceans from online sources are not included in the 'National Progress Report' submitted by Japan to the SC/67a meeting. Direct catches of small cetaceans are given in the table by prefecture and type of fisheries. These data have been collected by the International Affairs Division of the Fisheries Agency of the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan (FAJ), based on reports from prefectural governments. It was noted that catch statistics in the Japan Progress Report on small cetacean cover catches in the calender year, that is, from 1 January to 31 December, following the guidelines for IWC National Progress Report, while the catch quota of small cetacean fisheries are set seasonally. Thus, in some cases, the calendar yearly catch may exceed the seasonal (yearly) catch in appearance, but in such cases, the actual seasonal catch is aligned with the allocated catch quota.

In discussion, it was noted that the catch of 1,057 Dall's porpoises in the hand harpoon hunt was significantly lower than previously recorded reported and below the quota. It was opined that this is a result of the destruction of the community that conduct this hunt, rather than a change in the cetacean population, following the earthquake and tsunami of 2011.

The sub-committee thanked Jimenez in compiling these data and noted the absence of Funahashi at this year's meeting. Funahashi has assisted with the compilation and interpretation of Japan catch statistics for many years and her contribution to this sub-committee is much appreciated.

8.2 Live captures

SC/67b/SM10 reported on new guidelines on national legislation regarding live capture of cetaceans for commercial purposes developed by the Convention on Migratory Species (CMS). At its 11th meeting in 2014, the Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) adopted Resolution 11.22 on Live Capture of Cetaceans for Commercial Purposes. Amongst other things, it called upon Parties to develop and/or implement national legislation prohibiting the live capture of cetaceans from the wild for commercial purposes, and also urged Parties to consider

[3] *http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-9.pdf.*

Table 1

Types and levels of concern for the 8 stocks identified and reviewed by NAMMCO and considered of greatest concern.

Stock	Concern
White whales	
Ungava Bay	Possibly extirpated
Cook Inlet	Very small stock, decreasing trend, multiple threats
St. Lawrence Estuary	Small stock, likely decreasing trend, multiple threats
Cumberland Sound	Small stock, likely decreasing trend, possible overharvest
Eastern Hudson Bay	Limited knowledge about abundance, stock structure, threats
Barents-Kara-Laptev Sea	Data deficient, high past removals, rapidly changing habitat
Narwhals	
Melville Bay	Small stock, overharvest
East Greenland	Low abundance, data deficient, overharvest, habitat concerns

taking stricter domestic measures in line with CITES Article XIV with regard to the import and international transit of live cetaceans. In order to assist Parties to implement this Resolution, the CMS Secretariat developed Best Practice Guidelines which were endorsed at the 12th Meeting of the Conference of the Parties (COP12) in October 2017 through Resolution 11.22 (Rev.COP12). These Guidelines include two sets of recommendations:

– Recommendations for Developing National Legislation for Prohibiting the Live Capture of Cetaceans for Commercial Purposes; and
– Recommendations for Implementing Stricter Domestic Measures Relating to Import and Transit of Live Cetaceans for Commercial Purposes.

A questionnaire survey was conducted that asked CMS Parties to review to what degree relevant legislation was already in place to implement Resolution 11.22. Thirty-eight responded that existing legislation allowed for full implementation of the resolution; 20 responded that existing legislation allows partial implementation; one Parties' response was inconsistent; and three responded that no relevant legislation was in place. Sixty Parties did not respond.

As IWC and CMS aim to work together on relevant common issues across conventions, this sub-committee agreed to continue liaising with CMS over the issue of live capture of cetaceans for commercial purposes.

Rose reported that Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO) will consider a quota of 13 killer whales for 2018 and is holding a public hearing in Vladivostok on 3 May 2018 to take comments on this plan. This proposed new quota still considers killer whales in the Sea of Okhotsk as one population.

Zharikov informed the sub-committee that the proposal for killer whale catch quotas in the Sea of Okhotsk is based on the latest abundance assessment of over 3,000 individuals. This number is considered minimal since only 50% of the sea had been surveyed in 2010. According to Zharikov, there are too many uncertainties in the information on Okhotsk Sea killer whales to recognise the existence of separate stocks within the basin and therefore to describe their distribution and estimate their abundance individually. Colour and fin patterns, observed feeding behaviour and what is known about movements of killer whales in the region do not allow clear identification of different ecotypes, while all genetic samples analysed to date, according to Zharikov, belong to a single population. Consequently, the Okhotsk Sea killer whales are managed by Russia as a single stock. Based on a 'PBR' approach, the total take recommended by the Russian authorities is 13 killer whales in various parts of the basin. This proposed take limit will be subject to a public hearing and consultations with government and independent experts, after which a quota may be issued.

In discussion, it was noted that most published information on Okhotsk Sea killer whale abundance and stock structure is in the Russian-language literature, or as part of internal documents. It was also noted that with regard to killer whales in Russia, the sub-committee has previously recommended that the two ecotypes of killer whales should be recognised and managed as distinct units.

Attention: C-A, CG-A

The sub-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 sub-committee:

Reiterates *its concern that removals of killer whales are occurring from the Okhotsk Sea population.*

In light of the verbal report received at this meeting that Russian authorities intend to proceed to consider limits of allowable live-capture removals of killer whales in the Sea of Okhotsk on the basis that there is no stock structure and there are no ecotype differences between the populations in this region, the sub-committee:

Encourages *more extensive effort to examine these issues and* ***requests*** *that relevant analyses be provided for the Scientific Committee's consideration at its next meeting.*

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9. STATUS OF THE VOLUNTARY FUND FOR SMALL CETACEAN CONSERVATION RESEARCH

9.2 Status of funds and review progress of funded projects

In 2017, donations for the Voluntary Fund for Small Cetacean Conservation Research totalling £13,122 were received from the Government of Italy. At the end of the financial year 2017, this brought the total of the fund to £81,077.

The sub-committee expressed its sincere gratitude for Italy's contributions and noted that these funds support critical conservation research projects of direct relevance to the work of this sub-committee. It was noted in discussion that a previously funded project, the study of Irrawaddy dolphins in Sarawak, Malaysia, had recently contributed to the Important Marine Mammal Areas (IMMAs) process of the IUCN.

Five projects were offered funding following the 2016 call for proposals (Table 2). The Chair informed the committee that the project proposed by Weir was no longer being funded as the application had been withdrawn. It was noted that the Indus river dolphin abundance survey had been completed in 2017 and was reported at SC/67a. Short summaries of the active projects were provided by the Principal Investigators Sanjurjo, Heinrich and Lai.

The main objective of Sanjurjo's project is to develop a business model for fishermen in the Upper Gulf of California, Mexico, using vaquita friendly fishing gear. Sanjurjo reported good progress on this project, with positive

Table 2

Projects proposed for funding after the 2016 Call for Proposals.

PI	Project title
Heinrich	First region-wide estimates of population size and status of endemic Chilean dolphins (*Cephalorhynchus eutropia*) in southern Chile.
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.
Weir	Assessing the conservation status of the Atlantic humpback dolphin (*Sousa teuszii*) in the Saloum Delta, Senegal.
Sanjurjo	Business model to save vaquita from extinction while improving fishermen livelihoods in the Upper Gulf of California.
Khan	Abundance survey for Indus River dolphin.

feedback from participating fishermen with constructive suggestions on fishing gear modification and the fine tuning of the season that the new gear was suitable for. Sanjurjo has requested an extension of this project for a new completion date in June 2018.

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 December 2017 and April 2018, several areas were successfully surveyed, including a new area far to the South of the initially proposed study boundaries. The additional survey was funded from the small cetacean fund, following review of a modified proposal submitted by Heinrich. A total of 1,198km was surveyed and 98 groups of Chilean dolphins, 70 groups of Peale's dolphins, five groups of Burmeister's porpoise, four groups of bottlenose dolphins, one sei whale and one blue whale were encountered (including sightings in transit areas). Surprisingly, some 1,000km outside its normal range, a Commerson's dolphin was encountered, in addition to multiple purported hybrids. Three biopsy samples were obtained from these possible hybrids for detailed genetic analyses.

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. A total of 75hrs of online searching resulted in 250 reports, of which 146 were unique incidents. Of these 122 reports contained sufficient information to establish a date and location to provincial or specific locations. Eight species were identified, of which six were small cetaceans. By far the majority of unique reports recorded were of finless porpoise (88% of identified species). The individuals reported were obtained from strandings, bycatch and deliberately from encounters at seas/in the river. Some individuals were obtained from intermediary buyers, so the circumstances of their capture/death are not known.

Full reports shall be posted on the IWC website (*https://iwc.int/sm_fund*) when projects are completed.

The Chair noted that at this time the fund was insufficient to make a call for new proposals, however, it was anticipated that new funds may be obtained following the 2018 Commission meeting. Material on the fund projects and a presentation on the fund will be given at the 2018 Commission meeting to encourage parties to donate to the fund so that a new call for projects may be possible in 2019.

Depending on available funds, it is planned to spend the remaining balance of the Fund on IP support for SC/68a, 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.

10. WORK PLAN AND BUDGET REQUESTS

10.1 Priority topics for 2019 to 2024

The sub-committee discussed ongoing priorities and agreed to continue the development of these intersessionally.

10.2 Work plan for 2019-20

Table 3

Work plan for Small Cetacean (SM) Sub-Committee.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Franciscana CMP	ICG to co-ordinate outcomes of CMP across sub-committees	Report to Scientific Committee	ICG to synthesis actions from 2019 SC Report and develop a work plan	Report to sub-committee
Wildmeat	ICG to plan and conduct African Workshop	Report to sub-committee	Email group to summarise workshop series and develop future work plan	Report to sub-committee
Small Cetacean Task Team	Intersessional Workshop on South Asian river dolphins	Report to sub-committee	Act on recommendations from 2018/19 river dolphin Workshop	Report to sub-committee
Sotalia	ICG to plan and conduct workshop no. 1 (at SOLOMAC)	Report to sub-committee	ICG to plan and conduct final	Report to sub-committee

Table 4

Overview of intersessional working groups (for final list see Annex Y).

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 17.3 SM	ICG-30	Poorly documented takes of small cetaceans	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.	Porter (Convenor), Baker, Brownell, Collins, Cosentino, Donovan, Fortuna, Frey, Jiminez, Parsons, R. Reeves, Scheidat, Simmonds. *wildmeatSG@dist.iwc.int*
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, Fortuna, Genov, Parsons, Porter, R. Reeves, Scheidat. *taskteamSG@dist.iwc.int*
Item 17.1.3 SM/CMP	ICG-23	Franciscana	Co-ordinate presentation of CMP projects across sub-committees at SC/68a.	Iñiguez (Convenor), Cunha, Zerbini, Ia Marcondes, Siciliano, Domit, Secchi, Crespo, Cremer, Brito-Junior, Santos, Ott, Di Tullio
Item 17.6.2	ICG-43	Aquatic Wildmeat Database	Discuss: (1) which research questions the 'Aquatic Wildmeat Database' could help answer and to assess the best approach for data validation and quality control for data obtained other than from the SM sub-committee; and (2) an overarching aim for any future IWC cetacean wildmeat database, and to identify specific questions that such a database might address.	Cosentino (Convenor), Avila, Collins, Double, Gallego, Ingram, Reeves, R., Simmonds, Slooten, Suydam, Trujillo

10.3 Budget requests for 2019-20

Table 5

Summary of the 2-year budget request for SM Sub-Committee.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshops			
Task Team - Workshop	Intersessional Workshop of the task team on South Asian River dolphins	8,958	
Small Cetacean Workshop	Guiana dolphin pre-assessement (*Sotalia guianensis*) by the IWC Scientific Committee	9,990	
Modelling/computing			
Research			
Database/catalogues			
Total request		**18,948**	

11. ADOPTION OF THE REPORT

The report was adopted at 15:21 on 2 May 2018.

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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. A review of small cetaceans in rivers and estuaries in South America
   2.1 *Inia* species
   2.2 *Sotalia* species (all riverine populations plus lake Maracaibo)
   2.3 *Tursiops* species (populations occurring in estuarine areas in southern Brazil)
3. Franciscana CMP
   3.1 Preparation for an in-depth review for 2019
4. Reporting on progress of *Tursiops* taxonomy
5. Poorly documented takes for food, bait or cash and changing patterns of use
   5.1 Results of workshops
   5.2 Update on wildmeat database
6. Small cetacean task team
   6.1 Progress on South Asian river dolphins task team
7. Progress on previous recommendations
   7.1 Vaquita (update on CIRVA progress)
      7.1.1 Dolphin bycatch in totoaba nets
      7.1.2 Vaquita
   7.2 Yangtze finless porpoise
   7.3 Māui dolphin
   7.4 Cruise report from northwestern Africa
   7.5 Monodontids (report on workshop)
8. Review takes of small cetaceans
   8.1 Directed catches
   8.2 Live captures
9. Status of the voluntary fund for small cetacean conservation research
   9.1 Status of funds and review progress of funded projects
   9.2 Work plan and budget requests
   9.3 Priority topics for 2019 to 2024
   9.4 Work plan for 2019-20
   9.5 Budget requests for 2019-20
10. Adoption of the Report

Appendix 2

PROPOSED PROCESS FOR THE REVIEW OF THE STATUS OF THE FRANCISCANA (*PONTOPORIA BLAINVILLEI*) BY THE IWC SCIENTIFIC COMMITTEE

Group members: Almeida, Andriolo, Barreto, Crespo, Dalla-Rosa, Di Tullio, Domit, Fruet, Iñíguez, Luna, Marcondes, Secchi, Siciliano, Suarez, Zerbini

The franciscana (*Pontoporia blainvillei*) is a small cetacean endemic to southwestern Atlantic coastal waters between central Brazil and central Argentina (Fig. 1, Crespo *et al.* (1998), Siciliano *et al.* (2002). It is considered the most threatened marine cetacean species in South America (Secchi *et al.*, 2003a) and is listed as Vulnerable by the IUCN (Zerbini *et al.*, 2017). Incidental mortality in gillnet fisheries has been a major conservation concern for franciscanas but the species is also exposed to other threats of potential concern throughout its range, such as coastal development, marine debris, diseases and vessel

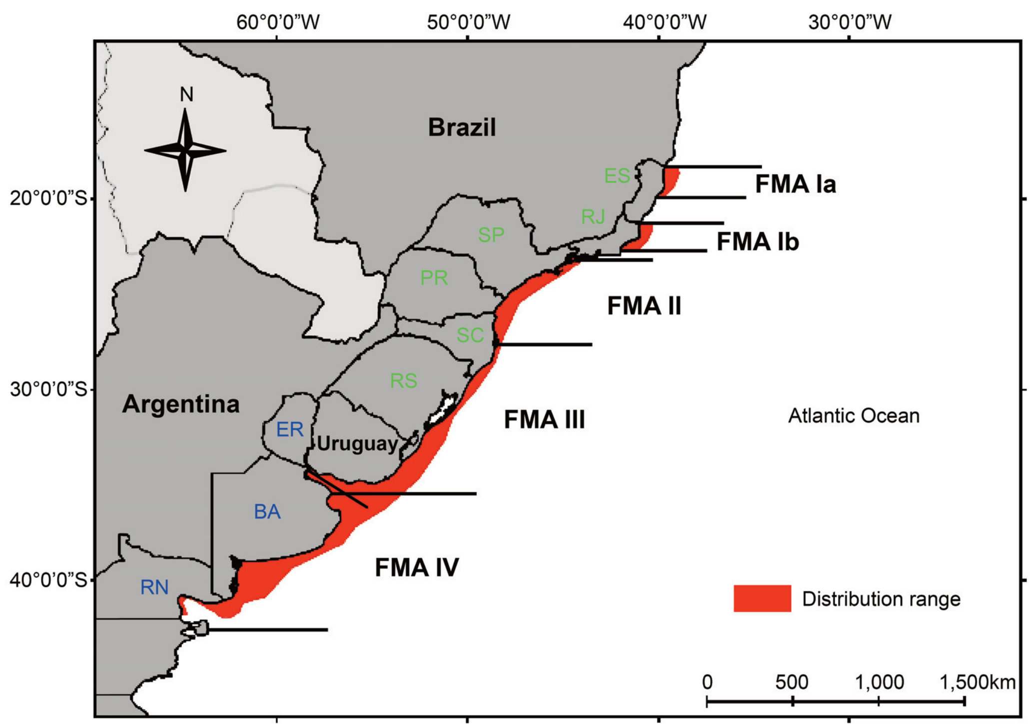

Fig. 1. Map indicative of the franciscana distribution and the boundaries of the Franciscana Management Areas along the coast of Brazil (BR), Uruguay (UY) and Argentina (ARG). Acronyms for states in Brazil and provinces in Argentina are indicated in green and blue, respectively (ES=Espírito Santo, RJ=Rio de Janeiro, SP=São Paulo, PR=Paraná, SC=Santa Catarina, RS=Rio Grande do Sul, ER=Entre Ríos, BA=Buenos Aires and RN=Río Negro).

traffic; e.g. Di Beneditto and Ramos (2014), Denuncio *et al.* (2011).

In 2003 the range of the franciscana was divided into four 'Franciscana Management Areas', or FMAs, numbered I to IV (Secchi *et al.*, 2003b). Subsequently, FMA I was divided into two separate management units: FMA Ia and FMA Ib (Anon., 2015; Cunha *et al.*, 2014). These areas are illustrated in Fig. 1.

The Scientific Committee first reviewed the status of the franciscana in 2004 and the species has been on the agenda of the Committee for a number of years now. A task team for FMA I was established in 2015 and resulted in two documents being presented at this meeting (SC/67b/CMP03 and SC/67b/CMP05). In 2016, the IWC created a Conservation Management Plan (CMP) for the franciscana. A review of the status of the franciscana by the Scientific Committee is timely because substantial new information has been produced since the last review. In addition, and perhaps most important, a review of the status of the species will be key to refine research, monitoring and conservation/management recommendations and actions specified in the recently established Franciscana CMP. This document proposes a review process to be initiated at SC/67b, continuing intersessionally and ending with the completion of the review in 2019 (SC/68a).

The review process suggested here includes the intersessional preparation of review papers on stock structure, abundance and trends, threats, biological parameters and conservation/management actions. These papers would be prepared by collaborating scientists working on the various FMAs as specified in Table 1 (note that additional collaborators can be added during the development of the review if applicable). The review papers listed in this table are linked to actions identified in the Franciscana CMP. The review papers (and potentially supporting documentation) shall be submitted to next year's meeting for review by the relevant sub-committees/working groups as illustrated in Fig. 2.

An intersessional e-mail group will be established to coordinate the review. The e-mail group would be composed of at least the Franciscana CMP coordinator and the point of contact (POC) for each review topic identified in Table 1.

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Table 1

Review topics (by Franciscana Management Area [FMA] when applicable) and initially suggested potential collaborators to perform the reviews.

Topic for review	Area	Possible collaborators	CMP actions
Stock structure	All FMAs	Cunha (POC), Gariboldi, Mendez, Oliveira, Ott, Secchi	RES1
Abundance estimates	All FMAs	Zerbini (POC), Andriolo, Crespo, Danilewicz, Sucunza,	MON1
Threats	FMA Ia	Marcondes (POC), Azevedo, Brito-Junior, Cremer	MON1
	FMA Ib	Siciliano (POC), Brito-Junior, Hauser Davis,	
	FMA II	Domit (POC), Barreto, Bertozzi, Cremer, Santos, Trevisani, Zerbini	
	FMA III	Secchi (POC), Castilho, Danilewicz, Ott, Prado	
	FMA IV	Crespo (POC), Bordino	
Biological parameters	FMA Ia	Cremer (POC), Marcondes, Bisi, Brito-Junior	MTI1, MTI2, MTI3
	FMA Ib	Brito-Junior (POC), Bisi, Siciliano	
	FMA II	Santos (POC), Barreto, Bertozzi, Cremer, Domit, Zerbini	
	FMA III	Ott (POC), Botta, Castilho, Danilewicz, Secchi	
	FMA IV	Crespo (POC), Bordino	
Management and conservation actions	Brazil	Di Tullio (POC), Domit, Fruet, Monteiro, Ott, Prado, Siciliano, Secchi, Zerbini	
	Argentina	Iñíguez (POC), Bordino, Crespo	
	Uruguay	To be determined	

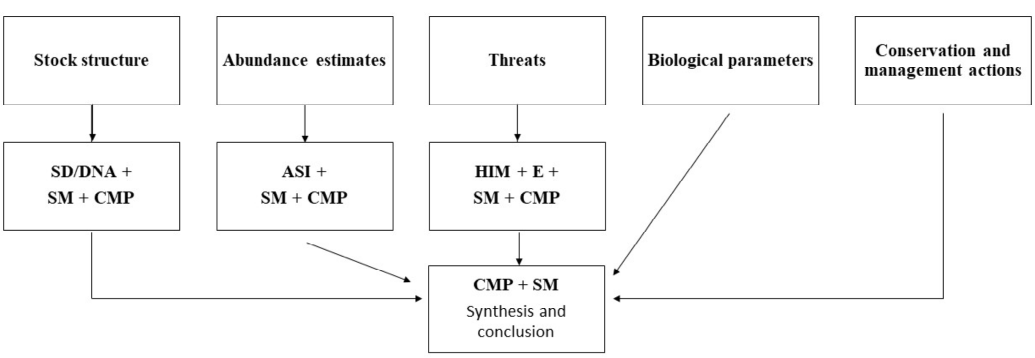

Fig. 2. Diagram showing how the different topics reviewed will be presented to the sub-committees of the Scientific Committee.

Appendix 3

DIRECT TAKES OF SMALL CETACEAN IN JAPAN BY TYPE OF FISHERY AND PREFECTURE OF DEPARTURE PORT, 2002 TO 2016

		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	2016
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	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	May-26	31/26	26/22	26/30	21/24	25/24
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	Jan-35	27	29	24	-/10	-/16	-/20	-/22	-/10	-/-	Jan-15	-/10	01-Feb	May-15	3 / 2
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	41
H	Okinawa	92/85	77/69	61/53				38	36	72	90	56	79	62	54	34	46	25	47	18	9	21
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	232
H	Wakayama	246/242	238/234	230/226	-	-	-	154	168	60	46	105	185	122	94	126	104	52	38	103	13	1
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	625
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	10
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	147
H	Wakayama	95/89	84/79	73/68	-	-	-	38	52	43	66	75	97	93	77	38	40	73	68	35	43	11
H	Okinawa	9	8	7	-	-	-	3	7	10	10	12	4	1	4	1	3	3	3	-	-	5
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	20
H	Wakayama	70	70	70				18	30	2	13	5	16	-	3	7	2	12	4	18	-	2
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	6
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	1.24	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	1.14	89	29	77	14	11	1
H	Miyagi	269/260	250/241	231/221				229	226	171	246	181	254	180	103	-	-	-	18	2	4	-
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	1057
H	Miyagi	16	15	214				3	3	-	-	-	-	-	-	129	8	-	-	32	28	1

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. *[1]For Baird's beaked whale, carryover is permitted. *[2]The 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; http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-9.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 4

FISHERY BYCATCH AND VESSEL STRIKES OF SMALL CETACEANS REPORTED IN THE 2018 PROGRESS REPORT DATABASE

Compiled by Marion Hughes

Table 1

Fishery bycatch of small cetaceans.

Large area	Local area	Species	Year	Indivi-duals*	Targeted species	Gear type
Argentina						
Atlantic Ocean - South	Coastal Buenos Aires province	Franciscana (*Pontoporia blainvillei*)	2018	9	-	-
Atlantic Ocean - North	Coastal Buenos Aires province	Burmeister's porpoise (*Phocoena spinipinnis*)	2018	1	-	-
Australia						
Southern Ocean	Spencer Gulf	Common dolphin (*Delphinus delphis*)	2017	12	Sardine	[PS1] SURROUNDING NETS - One-boat operated purse seines, [PS2] SURROUNDING NETS - Two-boat operated purse seines
Southern Ocean	Investigator Strait/Backstairs Passage	Common dolphin (*Delphinus delphis*)	2017	7	Unknown	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Pacific Ocean - Tasman Sea	Terrigal, NSW	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Atlantic Ocean - North	The Entrance	Andrews' beaked whale (*Mesoplodon bowdoini*)	2017	1	-	[NSC] SHARK CONTROL NETS
Atlantic Ocean - North	Caves Beach, NSW	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2017	1	-	[NSC] SHARK CONTROL NETS
Atlantic Ocean - North	Manly, NSW	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Atlantic Ocean - North	North Avoca, NSW	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	-	[PTB] TRAWLS - Otter trawls (side or stern)
Pacific Ocean - South	Queensland	Common dolphin (*Delphinus delphis*)	2017	8	White, tiger, bull sharks	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Queensland East Coast	Australian snubfin dolphin (*Orcaella heinsohni*)	2017	2	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - South	Queensland	Common bottlenose dolphin (*Tursiops truncatus*)	2017	3	White, tiger, bull sharks	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Queensland	Indo-Pacific humpback dolphin (*Sousa chinensis*)	2017	1	White, tiger, bull sharks	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Gulf of Carpentaria	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2017	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Indian Ocean	Western Australia	Common bottlenose dolphin (*Tursiops truncatus*)	2017	2	-	[MIS] MISCELLANEOUS GEAR
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	-	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	4	-	[OT] MIDWATER TRAWLS - Otter trawls (not specified)
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	4	-	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Common dolphin (*Delphinus delphis*)	2017	19	-	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - South	-	Common dolphin (*Delphinus delphis*)	2017	3	-	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - South	-	Unidentified dolphin	2017	9	-	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - South	-	Unidentified dolphin	2017	3	-	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - South	-	Unidentified dolphin	2017	41	-	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - South	-	Unidentified dolphin	2017	1	-	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - South	Terrigal, Central Coast NSW	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	4	-	[OT] MIDWATER TRAWLS - Otter trawls (not specified)
Pacific Ocean - South	The Entrance NSW AUS	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	-	Common dolphin (*Delphinus delphis*)	2017	4	-	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - South	Lighthouse beach, Ballina, NSW	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Caves Beach, NSW, AUS	Common bottlenose dolphin (*Tursiops truncates*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Shelly Beach, Ballina, NSW	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Manly	Common dolphin (*Delphinus delphis*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Soldiers Beach, Central Coast North	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	-	[NSC] SHARK CONTROL NETS
Pacific Ocean - South	Jervis Bay	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Croatia						
Atlantic Ocean - Adriatic Sea	Eastern Adriatic Sea	Common bottlenose dolphin (*Tursiops truncatus*)	2016	4	-	-
Atlantic Ocean - North	Eastern Adriatic Sea	Common bottlenose dolphin (*Tursiops truncatus*)	2017	6	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED

Large area	Local area	Species	Year	Individuals*	Targeted species	Gear type
France						
Atlantic Ocean - Bay of Biscay	-	Common dolphin (*Delphinus delphis*)	2015	4	RAJ/MNZ/SOX	[GTR] GILLNETS AND ENTANGLING GEAR - Trammel nets
Atlantic Ocean - Bay of Biscay	-	Common dolphin (*Delphinus delphis*)	2015	3	HKE/MNZ/POL	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Atlantic Ocean - Bay of Biscay	-	Common dolphin (*Delphinus delphis*)	2015	2	SBX	[PTM] MIDWATER TRAWLS - Pair trawls
Atlantic Ocean - Bay of Biscay	-	Harbour porpoise (*Phocoena phocoena*)	2015	2	MNZ/JOD	[GTR] GILLNETS AND ENTANGLING GEAR - Trammel nets
Korea						
Pacific Ocean - Yellow Sea	-	Finless porpoise (*Neophocaena phocaenoides*)	2017	436	-	[FPO] TRAPS - Pots, [FSN] TRAPS - Stow nets, [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - Yellow Sea	-	Common dolphin (*Delphinus delphis*)	2017	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	2017	140	-	[FIX] TRAPS - Traps (not specified), [FPO] TRAPS - Pots, [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Finless porpoise (*Neophocaena phocaenoides*)	2017	28	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified), [FIX] TRAPS - Traps (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Common dolphin (*Delphinus delphis*)	2017	651	-	[LL] HOOKS AND LINES - Longlines (not specified), [FIX] TRAPS - Traps (not specified), [FPO] TRAPS - Pots, [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Common bottlenose dolphin (*Tursiops truncatus*)	2017	13	-	[TM] MIDWATER TRAWLS - Midwater trawls (not specified), [FIX] TRAPS - Traps (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	Risso's dolphin (*Grampus griseus*)	2017	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - Sea of Japan/ East Sea	-	False killer whale (*Pseudorca crassidens*)	2017	8	-	[FIX] TRAPS - Traps (not specified), [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - Yellow Sea	-	Killer whale (*Orcinus orca*)	2017	1	-	[FIX] TRAPS - Traps (not specified)
Mexico						
Pacific Ocean - North	Zihuatanejo, Guerrero	Spinner dolphin (*Stenella longirostris*)	2017	2	-	[SX] SEINE NETS - Seine nets (not specified)
Pacific Ocean - Gulf of California (Sea of Cortés)	Upper Gulf of California	Vaquita (*Phocoena sinus*)	2018	4	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Netherlands						
Atlantic Ocean - North	North Sea	Harbour porpoise (*Phocoena phocoena*)	2016	0	-	[GEN] GILLNETS AND ENTANGLING GEAR - Gillnets and entangling gillnets (not specified)
Atlantic Ocean - North	Dutch North Sea	Harbour porpoise (*Phocoena phocoena*)	2017	11	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
New Zealand						
Pacific Ocean - New Zealand	Cannibal Bay, Catlins	Gray's beaked whale (*Mesoplodon grayi*)	2017	1	Unknown	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	West Coast	Hector's dolphin (*Cephalorhynchus hectori*)	2017	1	Unknown	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	South Timaru	Hector's dolphin (*Cephalorhynchus hectori*)	2017	1	SPO: Rig	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	Pegasus Bay, Canterbury	Hector's dolphin (*Cephalorhynchus hectori*)	2017	1	SPO: Rig	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	Northland	Common dolphin (*Delphinus delphis*)	2017	10	SKJ: Skipjack tuna	[PS] SURROUNDING NETS - With purse lines
Pacific Ocean - New Zealand	North Taranaki	Common dolphin (*Delphinus delphis*)	2017	1	TRE: Trevally	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	East Cape	Common dolphin (*Delphinus delphis*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Bay of Plenty	Common dolphin (*Delphinus delphis*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Bay of Plenty	Common dolphin (*Delphinus delphis*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	West Coast	Unidentified beaked whale (Unid. Ziphiid)	2017	1	SWO: Swordfish	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - New Zealand	Bay of Plenty	Common dolphin (*Delphinus delphis*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	East Cape	Common dolphin (*Delphinus delphis*)	2017	2	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Kaikoura	Dusky dolphin (*Lagenorhynchus obscurus*)	2017	2	HPB: Hapuku/bass	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	Taranaki	Common dolphin (*Delphinus delphis*)	2017	1	WAR: Common warehou	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	Bay of Plenty	Common dolphin (*Delphinus delphis*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Unknown	Common dolphin (*Delphinus delphis*)	2017	1	Unknown	-
Pacific Ocean - New Zealand	Bay of Plenty	Common dolphin (*Delphinus delphis*)	2017	1	EMA: Blue mackerel	[PS1] SURROUNDING NETS - One-boat operated purse seines

Large area	Local area	Species	Year	Indivi-duals*	Targeted species	Gear type
New Zealand cont.						
Pacific Ocean - New Zealand	Unknown	Dusky dolphin (*Lagenorhynchus obscurus*)	2017	1	Unknown	-
Pacific Ocean - New Zealand	Banks Peninsula	Hector's dolphin (*Cephalorhynchus hectori*)	2017	1	SPO: Rig	[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
Pacific Ocean - New Zealand	Banks Peninsula	Killer whale (*Orcinus orca*)	2017	1	SWA: Silver warehou	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - New Zealand	East Cape	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	East Cape	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	STN: Southern bluefin tuna	[LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - New Zealand		Common dolphin (*Delphinus delphis*)	2017	1	BIG: Bigeye tuna	LLD] HOOKS AND LINES - Drifting longlines
Pacific Ocean - New Zealand	Cook Strait	Common dolphin (*Delphinus delphis*)	2017	1	HOK: Hoki	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - New Zealand	Cook Strait	Common dolphin (*Delphinus delphis*)	2017	1	HOK: Hoki	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - New Zealand	Hawkes Bay	Common dolphin (*Delphinus delphis*)	2017	1	SNA: Snapper	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Hauraki Gulf	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	SNA: Snapper	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	East Cape	Long- or short-finned pilot whale (*Globicephala* sp.)	2017	1	TAR: Tarakihi	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - New Zealand	Bay of Plenty	Unidentified beaked whale (Unid. Ziphiid)	2017	1	STN: Southern bluefin tuna	[LLD] HOOKS AND LINES - Drifting longlines
Norway						
Atlantic Ocean - North	Kvænangen, Reisa	Killer whale (*Orcinus orca*)	2017	2	-	[PS1] SURROUNDING NETS - One-boat operated purse seines
Atlantic Ocean - North	Møkkalasset fyr, Tvedestrand	Harbour porpoise (*Phocoena phocoena*)	2017	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Spain						
Atlantic Ocean - North	Tenerife, Canary Islands, Adeje	Atlantic spotted dolphin (*Stenella frontalis*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Atlantic Ocean - North	Tenerife, Canary Islands, Montaña Pelada. Granadilla de Abona	Atlantic spotted dolphin (*Stenella frontalis*)	2017	1	-	[LX] HOOKS AND LINES - Hooks and lines (not specified)
Atlantic Ocean - North	Tenerife, Canary Islands, Los Gigantes, Santiago del Teide	Atlantic spotted dolphin (*Stenella frontalis*)	2017	1	-	[HAR] GRAPPLING AND WOUNDING - Harpoons
Atlantic Ocean - North	La Gomera, Canary Islands, San Sebastian	Atlantic spotted dolphin (*Stenella frontalis*)	2017	1	-	[HAR] GRAPPLING AND WOUNDING - Harpoons
Atlantic Ocean - Mediterranean Sea	Gulf of Valencia	Striped dolphin (*Stenella coeruleoalba*)	2017	3	-	[TBB] TRAWLS - Bottom trawls
Atlantic Ocean - North	Canary Islands	Atlantic spotted dolphin (*Stenella frontalis*)	2017	3	-	-
Atlantic Ocean - North	Pte. da Toxa Illa Da Toxa-O Grove PO5	Common bottlenose dolphin (*Tursiops truncatus*)	2017	2	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Atlantic Ocean - North	I. Ons (Illa de Ons-Bueu) PO5	Common bottlenose dolphin (*Tursiops truncatus*)	2017	1	-	-
Atlantic Ocean - North	Ría Aldán (Cangas) PO5	Common dolphin (*Delphinus delphis*)	2017	1	-	-
Atlantic Ocean - North	B. Mexilloeira (O Grove) PO5	Common dolphin (*Delphinus delphis*)	2017	1	-	-
Atlantic Ocean - North	P. Congorza (Cangas) PO6	Andrews' beaked whale (*Mesoplodon bowdoini*)	2017	1	-	-
Atlantic Ocean - North	P. Raeiros (O Grove) PO5	Risso's dolphin (*Grampus griseus*)	2017	1	-	-
Atlantic Ocean - North	P. Raeiros (O Grove) PO5	Risso's dolphin (*Grampus griseus*)	2017	1	-	-
Atlantic Ocean - North	-	Andrews' beaked whale (*Mesoplodon bowdoini*)	2018	0	-	-
UK						
Atlantic Ocean - North	-	Common dolphin (*Delphinus delphis*)	2017	12	Unknown	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Atlantic Ocean - North	-	Harbour porpoise (*Phocoena phocoena*)	2017	7	Unknown	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
Atlantic Ocean - North	-	Northern bottlenose whale (*Hyperoodon ampullatus*)	2017	1	Unknown	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
USA						
Atlantic Ocean - North	-	Risso's dolphin (*Grampus griseus*)	2015	2	Pelagic swordfish, tuna, billfish	[LL] HOOKS AND LINES - Longlines (not specified)
Atlantic Ocean - North	-	Long- or short-finned pilot whale (*Globicephala* sp.)	2015	32	As above	[LL] HOOKS AND LINES - Longlines (not specified)
Atlantic Ocean - North	-	Common dolphin (*Delphinus delphis*)	2015	1	As above	[LL] HOOKS AND LINES - Longlines (not specified)
Atlantic Ocean - North		Unidentified beaked whale (Unid. Ziphiid)	2015	1	As above	[LL] HOOKS AND LINES - Longlines (not specified)
Atlantic Ocean - Gulf of Mexico	-	Sperm whale (*Physeter macrocephalus*)	2015	1	As above	[LL] HOOKS AND LINES - Longlines (not specified)
Atlantic Ocean - North	-	Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	2015	3	-	[TBB] TRAWLS - Bottom trawls
Atlantic Ocean - North	-	Common dolphin (*Delphinus delphis*)	2015	6	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Atlantic Ocean - North	-	Andrews' beaked whale (*Mesoplodon bowdoini*)	2015	30	-	[TBB] TRAWLS - Bottom trawls

Large area	Local area	Species	Year	Individuals*	Targeted species	Gear type
USA cont.						
Atlantic Ocean - North	-	Harbour porpoise (*Phocoena phocoena*)	2015	25	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Atlantic Ocean - North	-	Andrews' beaked whale (*Mesoplodon bowdoini*)	2015	4	-	[TBB] TRAWLS - Bottom trawls
Atlantic Ocean - North	-	Risso's dolphin (*Grampus griseus*)	2015	1	-	[TBB] TRAWLS - Bottom trawls
Atlantic Ocean - North	-	Common bottlenose dolphin (*Tursiops truncatus*)	2015	2	-	[TBB] TRAWLS - Bottom trawls
Pacific Ocean - North	Clallam, WA	Blainville's beaked whale (*Mesoplodon densirostris*)	2016	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	CA	Long-beaked common dolphin (*Delphinus capensis*)	2016	4	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED, [LX] HOOKS AND LINES - Hooks and lines (not specified), [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	San Juan, WA	Dall's porpoise (*Phocoenoides dalli*)	2016	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	OR-WA	Harbour porpoise (*Phocoena phocoena*)	2016	7	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED, [GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	OR	Northern right whale dolphin (*Lissodelphis borealis*)	2016	2	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED, [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - North	CA and WA	Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	2016	9	-	[NK] GEAR NOT KNOWN OR NOT SPECIFIED, [TM] MIDWATER TRAWLS - Midwater trawls (not specified)
Pacific Ocean - North	San Diego, CA	Risso's dolphin (*Grampus griseus*)	2016	1	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	OR	Striped dolphin (*Stenella coeruleoalba*)	2016	3	-	[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
Pacific Ocean - North	OR	Unidentified dolphin	2016	1	-	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)

*This column has been aggregated.

Table 2

Vessel strikes of small cetaceans.

Large area	Local area	Species	Year	Individuals*	Submitted to IWC or National Ship Strike Database	Source of information
Argentina						
Atlantic Ocean - South	Bahia San Julian	Commerson's dolphin (*Cephalorhynchus commersonii*)	2017	0	Unknown	National Collator
Australia						
Southern Ocean	Spencer Gulf/ Investigator Strait	Pygmy sperm whale (*Kogia breviceps*)	2017	0	No	South Australian Museum
Indian Ocean	Western Australia	Common bottlenose dolphin (*Tursiops truncatus*)	2017	0	Unknown	Department of Parks and Wildlife WA
UK						
Atlantic Ocean - North		Common dolphin (*Delphinus delphis*)	2017	0	Unknown	UK_CSIP
USA						
Atlantic Ocean - Gulf of Mexico		Common bottlenose dolphin (*Tursiops truncatus*)	2016	0	Unknown	NMFS Southeast Fisheries Science Center
Pacific Ocean - North	Marin, CA	Baird's beaked whale (*Berardius bairdii*)	2016	0	Unknown	NMFS Southeast Fisheries Science Center

*This column has been aggregated.

Annex N

Report of the Sub-Committee on Whale Watching

Members: Suydam (Chair), New (Co-Chair), al-Jabri, Avila, Bell, Castro, Coscarella, Cosentino, Elwen, Gallego, George, Ferriss, Fortuna, Forestell, Frey, Holm, Hubbell, Iñiguez, Jacob, Kato, Kim, Lent, Lundquist, Luna, Marcondes, Minton, Noren, Parsons, Pierce, Rendell, Reyes, Ritter, Rodriguez Fonseca, Rojas-Bracho, Rose, Ryeng, Santos, Sequeira, Simmonds, Slooten, Stachowitsch, Stack, Strasser, Suarez, Trejos, Urbán, Wambiji, Weinrich, Williams, Willson.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Suydam welcomed members of the sub-committee. He noted the recent and unexpected passing of our long-time colleague Greg Kaufman and encouraged the sharing of reminiscences after the sub-committee observed a moment of silence in his memory. Greg will be greatly missed.

1.2 Election of Chair

Suydam was elected Chair and New was elected co-chair.

1.3 Appointment of Rapporteurs

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/67b/WW01-09, SC/67b/Rep03, Avila *et al*. (2018), CMS (2017a), CMS (2017b), Gleason and Parsons (2018a), Gleason and Parsons (2018b), Irvine and Kent (2017), Ritter *et al*. (2018) and Sprogis *et al*. (2017).

2. ASSESS THE IMPACTS OF WHALE WATCHING ON CETACEANS

2.1 Review progress on Modelling and Assessment of Whale Watching Impact (MAWI)

SC/67b/WW09 and SC/67b/Rep03 reported on intersessional progress on the Modelling and Assessment of Whale Watching Impacts (MAWI) initiative. SC/67b/Rep03 presented the conclusions of a workshop held in Italy, 5-6 April 2018, which was intended to identify the key research questions for understanding the potential impacts of whale watching on cetaceans. A number of issues were highlighted, including: (a) the need to better understand the impact of recreational whale watching vessels as compared to commercial vessels; (b) the importance of looking at the potential impact of whale watching at short-term (e.g. behaviour change), mid-term (e.g. shift in habitat use) and long-term (e.g. population dynamics) time scales; (c) the use of existing and new data to explore the mid- and long-term impacts, as opposed to replicating short-term studies; and (d) the importance of building scientific capacity in the locations where the research would take place. The workshop's main recommendations were: (1) the incorporation of both social and natural sciences to better understand whale watching impacts; (2) the development of a Strategic Framework, supported by a Decision Tree, to aid in the prioritisation of policy and research choices; (3) the development of toolkits and resources that can be accessed globally; and (4) the standardisation of data collection. In addition, while the workshop met the majority of its objectives, it was not able to fully discuss the links between data collection and modelling approaches, or identify specific locations best suited to answering the questions identified in the workshop. As a result, the workshop participants also recommended that (5) a third workshop be held to address these issues.

The sub-committee expressed thanks for this concise and informative update of the MAWI initiative. It **drew attention** to the reference in SC/67b/Rep03 to Papastavrou *et al*. (2017) and the use of welfare indicators as proxies for population health, noting that this reference was consistent with recent discussions in the Committee and Commission on welfare assessment tools. In response to a question about the ability to distinguish whale watching impacts from the impacts of other environmental threats in cetacean habitats, it was noted that the workshop addressed these concerns extensively. The difficulty in distinguishing whale watching from major environmental perturbations such as El Niño, for example, was the motivation for the workshop recommending that whale watching research projects be designed and funded for longer time frames (5-30yrs versus 2-3yrs).

It was also noted that the workshop appeared to focus primarily on researchers cooperating and collaborating with local stakeholders and management, but regional cooperative efforts should be equally emphasised, particularly between neighbouring countries. While the workshop did not include this excellent point in its discussions, it was noted that a manuscript based on the workshop's discussions and outputs was being prepared for publication and this point could be included there.

It was noted that the first four recommendations of the workshop were tasks that can be accomplished by the sub-committee or the MAWI intersessional steering group (Table 3). After a consideration of the pros (e.g. bringing in experts on appropriate modelling approaches and relevant socioeconomic issues) and cons (e.g. competing for limited Commission resources), the sub-committee **endorsed** the workshop's final recommendation, to hold a third MAWI workshop, and **agreed** to request associated funding (Table 5). This workshop, to be held during the next intersessional (see below), would have three goals: (1) to determine in detail which data should be collected to best answer the natural and social science research questions developed in SC/67b/Rep03; (2) to identify the best locations for conducting research projects that address these questions; and (3) to continue to develop modelling approaches for assessing the long-term impacts of whale watching on cetacean populations (using data on short- and mid-term impacts).

It was suggested that the workshop could maximise the probability of securing the needed expertise and minimise costs by being scheduled immediately before or after the upcoming 2nd World Marine Mammal Science Conference (a joint conference of the Society for Marine Mammalogy and the European Cetacean Society) in Barcelona, Spain, in autumn 2019. This would capitalise on the presence of experts already attending this conference and costs could be further reduced by seeking meeting space at a local university.

The sub-committee **agreed** that the MAWI steering group should continue, with slightly revised terms of reference to reflect that some tasks have been completed (e.g. the list of research questions), while others remain to be completed (e.g. identify specific locations to conduct research) (see Table 3).

Attention: SC, C-R

The Modelling and Assessment of Whale Watching Impacts (MAWI) initiative held a workshop in Italy in April 2018, in conjunction with the 32nd European Cetacean Society conference. The sub-committee endorsed four recommendations from this workshop: (1) the incorporation of both social and natural sciences to better understand whale watching impacts; (2) the development of a Strategic Framework, supported by a Decision Tree, to aid in the prioritisation of policy and research choices; (3) the development of toolkits and resources that can be accessed globally; and (4) the standardisation of data collection.

The sub-committee also ***recommended*** *that a third MAWI workshop be held intersessionally, ideally just before or after the 2nd World Marine Mammal Science Conference in 2019, in Barcelona. This workshop would have three goals: (1) to determine in detail which data should be collected to best answer the natural and social science research questions developed in SC/67b/Rep03; (2) to identify the best locations for conducting research projects that address these questions; and (3) to continue to develop modelling approaches for assessing the long-term impacts of whale watching on cetacean populations (using data on short- and mid-term impacts).*

2.2 Review specific papers addressing impacts

SC/67b/CMP04 reported preliminary results of a project testing the hypothesis that stress from injuries due to kelp gull attacks negatively affects the physiological homeostasis of southern right whale (*Eubalaena australis*) calves at Península Valdés, Argentina. The technique to measure stress hormones (glucocorticoids – GC) in baleen of southern right whales could be used to evaluate the effect of whale watching on the whales' stress levels. Baleen GC levels in the whales that die in and near the hub of the region's whale watching activity (Puerto Pirámides in Golfo Nuevo) could be compared to those in whales that die in Golfo San José, which has little or no boat traffic.

In discussion, it was noted that it can be difficult to distinguish impacts of whale watching from those of other anthropogenic activities and other threats in the environment (see Item 2.1). Apportioning the cause of varying stress hormone levels in baleen will be difficult, particularly for adult whales. It was clarified that only calves, of which a number strand in this location, are being tested for stress hormone levels in baleen. It can be assumed that these calves have spent most or all of their brief lives in the waters surrounding Península Valdés. This should minimise the potential for confounding stress levels acquired elsewhere from those acquired in this calving ground. The possibility of replicating this study in the gray whale (*Eschrichtius robustus*) breeding lagoons in Mexico, a location where whale watching can also be intensive, was raised, but it is uncertain how replicable this work might be in Mexico, as few calves strand. However, it was noted that studies on hormone levels measured from the blow of gray whales have been undertaken.

It was noted that caution should be exercised in how the baleen hormone data are interpreted, as there could be a number of confounding variables. Data on small-scale habitat use would be especially valuable to understand how the whales used the area before death and current studies based on satellite tracking (SC/67b/CMP17) and on behavioural observations from cliff-top vantage points are ongoing. The tagging data could elucidate mother-calf patterns of movement, which would give additional insight on the amount of time calves spend in areas with high numbers of whale watching vessels. In addition, research on habitat use, noting the movement of the whales between Golfo Nuevo and Golfo San José, is underway in the area, which will also help clarify how much time the whales spend in the presence of whale watching vessels.

In 2004, recognising the difficulties of keeping up to date on the wealth of research on whale watching activities, in particular the impacts of these activities on cetaceans, a paper summarising recent whale watching research was presented to the sub-committee (Parsons *et al.*, 2004) at SC/56. This was deemed to be a useful review of recently published articles, so similar digests were requested in following years. SC/67b/WW07 is the 15th in this series of reviews, detailing a summary of whale watching research published since SC/67a. Those studies related to impacts of whale watching on cetaceans and compliance with whale watching regulations are summarised in Table 1. The sub-committee again welcomed this paper and thanked Parsons for presenting the information in table form, which will make the information more accessible. Minton noted that the digests were extremely useful during development of the IWC Whale Watching Handbook.

SC/67b/WW06 was an updated table of known 'solitary-sociable' cetaceans. This is a work in progress but approximately 28 solitary sociable cetaceans could be identified in the years from 2008 to spring 2018 and are reported from Europe, the USA, Australia and elsewhere. Most such animals are bottlenose dolphins (*Tursiops* spp.), as was the case in earlier reviews, but other species are also recorded exhibiting this behaviour. The authors would welcome information relating to other solitary sociable cetaceans and noted that they are working on further consideration of how these animals are classified, noting for example that not all solitary cetaceans become 'sociable'.

In discussion, solitary sociable cetaceans were reported in two areas where they had never been observed before – the German Baltic (bottlenose, *T. truncatus*) and Namibia (rough-toothed, *Steno bredanensis*); the latter will be added to the database. In the former case, the dolphin attracted considerable human attention and, given the proximity to a major shipping lane, raised substantial management concern. A coalition of groups, including animal NGOs and managers, are developing guidelines in an effort to avoid negative interactions amongst nearby vessels, the dolphin and the public. It was noted that in at least one case in the UK, a whale watching operator aggressively pursuing a solitary sociable dolphin appeared to cause aversive reactions in the animal. When the operator was approached with guidelines and actually applied them, the aversive behaviour ceased, suggesting early management intervention can be beneficial to both animals and operators when solitary sociable animals appear in an area.

Table 1

Summary of studies on the impacts of whale watching on cetaceans and compliance with whale watching regulations (SC/67b/WW07). 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
Impacts of whale watching on cetaceans				
Indo-Pacific bottlenose dolphins (*Tursiops aduncus*)	Kisite-Mpunguti Marine Protected Area, Kenya	Boat-based, Markov chain analysis	30% of time, vessels within 400m of dolphins (*n*=1-10 vessels). Behavioural impacts of vessels began at a distance of 400m. Behavioural states significantly changed in response to vessel presence – travelling decreased and diving increased.	Pérez-Jorge *et al.* (2017)
Burrunan dolphin (*Tursiops australis*)	Port Phillip Bay, Australia	Boat-based, Markov chain analysis	Swim-with dolphin tourism vessels significantly affected dolphin behavioural states and budgets. Foraging significantly decreased, with feeding bout duration declining by 13.6%. Time to resume foraging increased by 47.6% in presence of vessels. Dolphins spent more time milling and socialising in the presence of vessels. However, annual behavioural budget minimally affected by vessel presence.	Filby *et al.* (2017)
Humpback whale (*Megaptera novaeangliae*)	Glacier Bay National Park and Preserve, Alaska, USA	Acoustic modelling	In a modelling exercise, fast cruise ships (20 knots) produced more sound than slower cruise ships (13 knots). Cumulative sound exposure levels were 3 times lower in slower vessels. Arrival synchronicity of vessels affected the cumulative sound exposure levels. Speed limits and coordination of vessel arrival could reduce sound production from cruise ships.	Frankel and Gabriele (2017)
Multiple species	Cambodia, India, Indonesia, Malaysia, Philippines, Thailand	Driver-Pressure-State-Impact-Response framework, Risk factor calculation	A whale watching risk indicator was calculated using 'Pressure' (fleet size), 'State' (IUCN status of the species), 'Response' (compliance to management schemes) and 'Driver' (industry capacity). All sites (except Cambodia and Malaysia) have reached or nearly reached industry capacity. Most sites project industry expansion, although India and Thailand may contract due to overcapacity. Cetaceans at sites in India and Indonesia were at high risk of suffering impacts from whale watching activities. Cambodian cetacean species were at intermediate risk. Species at sites in Thailand, the Philippines, and Malaysia likely at low risk. This method may be useful to rapidly assess the risk of whale watching activities, particularly when the impact is uncertain due to data deficiencies.	Mustika *et al.* (2017)
Code of conduct/regulation compliance and effectiveness				
Multiple species (esp. minke whales, *Balaenoptera acutorostrata*)	Western Scotland	Questionnaire survey	Only 9% of whale watching operators referred to/used a code of conduct produced by the Scottish Government. 41% stated that they did not refer to any code of conduct. Between 2000 and 2015, there was a decline in the use of codes of conduct from 89% to 54% of operators.	Ryan *et al.* (2018)
Gray whales (*Eschrichtius robustus*)	Pacific coast, USA and Canada	Anonymous observer, questionnaire survey	Observations of whale watching operations found that out of 16 separate whale watching guidelines, only 3 were fully complied with. Guidelines complied with were: 'don't get between whales travelling together'; 'don't feed whales'; and 'don't touch whales'. Non-compliance with guidelines was greatest for: turning off engines; restrict viewing times to 30mins or less; and remain more than 100 yards away from a whale. Operators stated most important guidelines were: 'do not feed whales'; 'avoid disturbing natural behaviour'; and 'do not get in between whales travelling together'. The guideline they considered to be least important was restricting encounters to a 'viewing time of 30mins or less'.	Amerson and Parsons (2018)
Southern resident killer whales (*Orcinus orca*)	San Juan Islands, Washington State, USA	Acoustic tags	The effect of a change in regulations was investigated – prohibiting vessels from approaching closer than 400 yards (366m) to killer whales' paths of travel, or closer than 200 yards (183m) in all scenarios. Received noise levels (1-40 kHz) ranged from 96 to 127 dB re 1 μPa. The number of vessels near whales ranged from 1 to 14 (median: 3). Average vessel distance from whales ranged from 21 to 914m (median: 314m). The amount of received noise was affected by the number of vessels in the area and the speed of vessels. There was no significant effect of the introduction of regulations on received noise levels. The new regulations appear to have been ineffective as a means for reducing noise exposure.	Holt *et al.* (2017)

It was noted that solitary sociable cetaceans should be seen in the context of human actions that induce changes in dolphin behaviour. The phenomenon is wide-spread and leads to difficult human management situations. A suggested way forward for the sub-committee to address the scientific aspects of this phenomenon was to focus on social science approaches, to examine how and why humans react to encountering these animals, with a goal of offering science-based recommendations for managing these situations. In addition, efforts could be made to develop approaches to identify from which populations they come and to describe the phases of sociability (see e.g. Wilke *et al.*, 2005) in an effort to better understand the phenomenon. It was also noted that, as solitary sociable cetaceans are often found close to the coast and human habitation, they can be accessible not only to the public but to researchers, who can scientifically monitor the impacts of human interactions with these cetaceans (e.g. land-based surveys, social surveys).

Table 2

Progress on previous recommendations of the Sub-Committee.

	Recommendation/Agreement	Accomplished y/n/ongoing	Supplement page
2016	The sub-committee **strongly recommended** the continuation of modelling work on the importance of population characteristics in assessing the effects of disturbance from whale watching within the context of its work plan.	Y	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.388
	The sub-committee ***encouraged*** the continuation of the research into the emerging whale watching industry in San Matías Gulf, Argentina, and ***agreed*** that this area might be considered as a possible focus of the MAWI initiative.	First Y Second ongoing: to be followed up with MAWI	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.388
	The sub-committee welcomed this assessment of masking…The sub-committee ***encouraged*** further work to articulate where this potential loss of acoustic habitat imposes itself on the life functions of…small dolphin species…The sub-committee **agreed** that the workshop on Ship Noise and Acoustic Masking held before SC/66b was relevant to its work and to consider the recommendations and conclusions of SC/66b/Rep10 in the context of whale watching impacts.	The workshop report will be submitted to *JCRM* for publication; the manuscript's discussion could include a reference to how this workshop had results relevant to whale watching	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.388-89
	After comprehensive discussion, the sub-committee ***agreed*** that a small working group would prepare a pro forma proposal for a [MAWI] workshop…In addition, it ***agreed*** that the MAWI intersessional working group…would work to identify and contact whale watching researchers to request their input on what they consider the most pressing research questions regarding impacts on large whales from whale watching.	Y	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p. 389-390
	The sub-committee ***agreed***, based on the results of the survey and direct observation, that the IWC guiding principles pertaining to [swim-with-whale operations] are generally being violated by swim-with-whale tourism. It would therefore be helpful for the guiding principles to be included in the Whale Watching Handbook and referenced by the sub-committee or the Conservation Committee's Standing Working Group on Whale Watching in all relevant forums …The sub-committee **strongly recommended** that the Standing Working Group on Whale Watching work with the Commission and the Secretariat to collect information from Member States as to the extent of swim-with-whale programmes within their jurisdictions.	Ongoing	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.390
	The sub-committee **recommended** that the Conservation Committee consider including template data collection forms for platforms of opportunity, or links to examples of forms in published papers, when finalising the guiding principles in the Whale Watching Handbook.	N – will consider including a data sheet in the guiding principles, which will be included in the Handbook and posted to the IWC website	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.390
	Concerns were expressed about the interface between the sub-committee and the Conservation Committee. The sub-committee ***agreed*** that there was a need to improve involvement, coordination and definition of roles between the sub-committee and the Commission and Conservation Committee.	Ongoing	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.390
	Many Member States of IORA are not Members of the Commission; therefore, the sub-committee **recommended** that the Secretariat remain in contact with IORA to facilitate communication and outreach with these countries…The sub-committee also ***agreed*** to make the Indian Ocean the focus of next year's regional review…The sub-committee ***agreed*** to set up an intersessional working group to help provide advice to IORA if appropriate and to facilitate communication between IORA and the sub-committee.	Ongoing	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.391
	The sub-committee ***agreed*** that, when the beta version [of the Whale Watching Handbook] is ready for review, its members should review it and offer comment and input to the Chair of the Standing Working Group on Whale Watching…The sub-committee also ***agreed*** that industry representatives should be approached to review and offer input on the beta version when it is ready for review…The sub-committee **recommended** that the Secretariat work to secure funding for a dedicated individual to shepherd the Whale Watching Handbook to completion. The sub-committee ***agreed*** that dissemination of the Handbook will require active promotion through, inter alia, social media efforts to ensure its success, an effort this dedicated individual can also undertake.	Y	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.391
	The sub-committee **reiterated** its previous recommendation about the utility of platforms of opportunity generally…the sub-committee ***agreed*** that platforms of opportunity have the potential to make valuable contributions to the understanding of cetacean populations, especially in areas where data are lacking.	Ongoing	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.392
	The sub-committee **recommended** that the Conservation Committee's Standing Working Group on Whale Watching address the issue of standardising whale watching regulatory schemes, where best practise would inform final, unified regulations, in areas where they currently differ for transboundary populations of whales.	Ongoing, through the Handbook	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.394.
	[The survey results]…clarified the sub-committee's value to the wider whale-watching community…The sub-committee ***agreed*** that future surveys of the sub-committee's effectiveness would be useful and **recommended** that future surveys on the effectiveness of the sub-committee's activities make every effort to expand their scope and reach a broader sample of sectors, particularly government representatives, and regions…It also ***agreed*** that, while clearly the sub-committee's work was known among some elements of the whale watching community, greater effort to communicate the conclusions, results and recommendations of the sub-committee to the community is needed. It was noted that the Whale Watching Handbook could play a central role in this effort.	Y	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.394
	The sub-committee **recommended** additional research be carried out to confirm any progress made in Bocas del Toro, Panama, with results brought to a future meeting.	Ongoing	*J..Cetacean.Res.. Manage..* 18 (Suppl.), 2017, p.394

Recommendation/Agreement	Accomplished y/n/ongoing	Supplement page
The sub-committee ***agreed*** it would seek to enhance its capacity to address scientific and technical aspects of whale watching and closely coordinate and cooperate with the Conservation Committee and its Standing Working Group on Whale Watching, including through the joint Conservation Committee/Scientific Committee Working Group…The sub-committee will develop its agenda accordingly and ***agreed*** to establish an intersessional working group to refine the work programme and agenda as appropriate.	Y (ongoing)	*J. Cetacean Res. Manage.* 18 (Suppl.), 2017, p.395
The sub-committee subsequently **recommended** a list compiled at SC/65b (Gleason and Parsons, 2015) of IUCN endangered and critically endangered cetaceans subjected to whale watching should be included in the Whale Watching Handbook and forwarded promptly to the Conservation Committee for that purpose.	Y	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.336
The sub-committee ***agreed*** that its SC/57 definition of 'high speed' in relation to whale watching vessels should be used when referring to high speed vessels within the framework of MAWI and subsequent sub-committee discussions.	Ongoing	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.337
Because of the impacts and the potential management implications, the sub-committee **recommended** that Vail (2016) [a comprehensive compendium of negative interactions, occurring within the past 15yrs, between people and bottlenose dolphins around the Florida panhandle region (USA) of the Gulf of Mexico] be brought to the attention of the Conservation Committee and that the Standing Working Group on Whale Watching 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.	Y	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.338
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 whale watching 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 whale watching, and report back to the sub-committee next year at SC/67b. Simmonds was appointed Convenor.	Y	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.338
The sub-committee welcomed this update on the whale watching activities in Oman targeting endangered Arabian Sea humpback whales and noted the substantial progress...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 Whale Watching. 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.	N – requires follow up with Conservation Committee Standing Working Group on Whale Watching and the planned third MAWI workshop	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.338
Some issues and studies addressing management and mitigation of impacts of whale watching will be solidly within the realm of social science because whale watching involves people. Therefore, the sub-committee **recommended** pursuing periodic joint intersessional workshops with the Conservation Committee Standing Working Group on Whale Watching, 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.	Ongoing – requires follow-up	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.340
The sub-committee **recommended** that a joint intersessional meeting [with the Conservation Committee SWG on Whale Watching] be organised and funded well in advance of SC/67b, with the participants drawn from the sub-committee and the SWG, to discuss and draft structured and specific recommendations and advice on any revisions for the 2018-2024 Five Year Strategic Plan for Whale Watching. These draft recommendations would then be presented at SC/67b and approved by the sub-committee and Scientific Committee, and submitted to the Joint Meeting of the Conservation and Scientific Committees to be held directly after SC/67b.	Y, but only partially	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.341
In memory [of the late Carole Carlson], to help enshrine her legacy and in recognition of Carole's long and important association with whale watching work at the IWC, the sub-committee **strongly recommended** the establishment of the 'Carole Carlson Memorial Whale Watching Fund'. The fund would be used to support research, education and outreach in the context of whale watching activities and aimed at ensuring that whale watching is sustainable, educational and humane.	Y	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.341
The sub-committee ***agreed*** to seek comment from the Scientific Committee and the Joint Meeting of the Conservation and Scientific Committees on its draft Terms of Reference.	Y for Scientific Committee; N for Joint Meeting - requires follow-up	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.342
The sub-committee ***agreed*** to elevate the topic of swimming with large whales to an agenda item for SC/67b. It also ***agreed*** to continue the intersessional correspondence group…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 Whale Watching Handbook, to ensure all IWC outreach efforts to whale watching operators and other parties regarding the questionnaire survey or other swim-with inquiries are coordinated.	Y – requires follow-up regarding the Voluntary Conservation Fund	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.343
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 Whale Watching. Parsons volunteered to bring such an update to SC/67b.	Y	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.345
The Compilation of Worldwide Whale Watching Guidelines and Regulations also needs regular updating. The sub-committee ***agreed*** to ask the Secretariat about the best way forward for this undertaking.	N – requires follow-up	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.345
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 whale watching.	Y, but requires follow-up	*J. Cetacean Res. Manage.* 19 (Suppl.), 2018, p.345

Table 3

E-mail Intersessional Correspondence, Advisory and Steering Groups and Terms of Reference (see Annex Y).

Group		Terms of Reference	Membership
(1)	Swim-with-whale operations	Assess the extent and potential impact of swim-with-whale operations.	Rose (Convenor), Frey, Forestell, Gero, Jimenez-Assmus, Minton, Parsons, Ritter, Rodriguez-Fonseca, Simmonds, Sironi, C. Smith, Stack, Urban, Weinrich
(2)	Modelling and Assessment of Whale Watching Impacts (MAWI) Steering Group	Identify those whale watching locations that would be most suitable and amenable for targeted studies addressing these questions; summarise and assess the current modelling tools available to analyse the data that will be collected; develop a Strategic Framework, supported by a Decision Tree, to aid in the prioritisation of policy and research choices; develop toolkits and resources for whale watching research that can be accessed globally; and consider how to standardise data collection.	New (Convenor), Baldwin, Cook, Cosentino, Forestell, Frey, Jimenez-Assmus, Leaper, Minton, Noren, Parsons, Robbins, Rose, C. Smith, Weinrich
(3)	Human-induced behavioural changes of concern	Continue to monitor the relevant literature; seek to produce a new review of information for the Committee across the whole range of interactions; review the appropriate terminology; and continue to consider the relevance of this topic to the work of the sub-committee, including how this topic might best be studied in future.	Simmonds (Convenor), Cosentino, Forestell, Minton, Parsons, Rodriguez Fonseca, Vail, Wells
(4)	Communication with the Conservation Committee	Discuss development of better methods for disseminating recommendations and advice on whale watching to the Conservation Committee (joint with Conservation Committee).	Parsons (Convenor), Rendell (Co-Convenor), Cosentino, Ferriss, Minton, Ritter, Rose, Simmonds, S. Smith, Weinrich
(5)	Communication with the Indian Ocean Rim Association (IORA) Advisory Group	Help provide advice to IORA when appropriate and facilitate communication between IORA and the sub-committee.	Ferriss (Convenor), Baldwin, Iñiguez, New, Parsons, Simmonds, C. Smith, S. Smith, Weinrich
(6)	River dolphin interactions	Monitor, assess and report on commercial interactions, including watching, provisioning and swimming with river dolphins in the Amazon and elsewhere.	Trujillo (Convenor), Luna, Marmontel, Parsons, Rojas-Bracho

The sub-committee drew attention to the fact that these animals may be exposed to a level of disturbance and human interaction in excess of many populations affected by whale watching. The potential for injury to both humans and cetaceans due to these interactions is also increased. It was also noted that these interactions are typically not via commercial whale watching vessels (which often operate under a code of conduct), but via recreational whale watching (see definition in Parsons *et al*., 2006) and members of the general public. Therefore, the application of specific regulations or management infrastructure to address and mitigate impacts of these interactions is more difficult.

Consequently, the sub-committee **agreed** to continue intersessionally to monitor the phenomenon of solitary sociable cetaceans as part of its work in the context of human-induced behavioural changes (Table 3) and **encouraged** the authors of SC/67b/WW06 to continue work on their inventory.

Attention: SC, CG-A

The term 'solitary sociable dolphin' or cetacean is usually taken to apply to cetaceans that have little or no contact with conspecifics and who regularly closely approach humans, often including touch, social, sexual and play behaviours (Wilke et al., *2005). Given that solitary sociable cetaceans often end up in circumstances where they are harmed and killed and that they may come to present a threat to human swimmers, the sub-committee **recommended** that, where these animals occur, research be conducted to determine whether the emergence of harmful behaviours either to the animal or to people can be reversed. In addition, the sub-committee **advised** local authorities and other concerned parties to keep people away from them in order not to encourage behaviour that may prove harmful to the animal or swimmers.*

Ritter *et al*. (2018) reported on the situation in La Gomera (Canary Islands), where 23 cetacean species have been documented, yet few operators offer whale watching trips to date. In 2017, the first permanent platform for the observation of cetaceans from land was established by the NGO MEER. It is designed and equipped for scientific research but also serves as an aid for whale watching operators when cetacean sightings from land are communicated to research vessels. From April to October 2017, on 40 observation days, 69 cetacean sightings were documented, comprising six species. Various behavioural states and responses to vessels were documented, as well as boat presence. Observations from the platform are available for all current operators, and hence fulfil a variety of tasks, apart from research: (a) helping increase the sighting success of vessels; (b) acting as a mediator between operators competing for the same resource; and (c) helping create a sense of community amongst operators. The platform will also help reduce potential disturbances by dispersing boats within the area covered by operators. Thus, the new platform represents an essential part of a long-term conservation strategy to collect data on impacts from vessels on cetaceans, mitigate those potential impacts and further develop whale watching as a sustainable use of cetaceans off La Gomera. It is hoped that similar platforms will be established on other Canary Islands and elsewhere.

Sub-committee members noted that the ability of platform observers to 'call over' whale watching operators to a group of whales could allow experimental designs for impact studies i.e. before/during/after treatments. Such studies were conducted in Colombia, where significant differences in behaviour were found between treatments and are also being conducted in Hawaii. Results from the Hawaiian studies have been reported to the sub-committee previously (e.g. McCordic *et al*., 2017) and additional results will be reported at future sub-committee meetings. Similar studies were also conducted in British Columbia with killer whales (*Orcinus orca*), with treatments ranging from one vessel to 17. There was a critical number of vessels after which the whales ceased to respond, suggesting a scenario of 'learned helplessness' (when an animal perceives it cannot avoid a stimulus and 'gives up' trying to evade or mitigate it). This was helpful in later meta-analyses, to distinguish between 'no effect' and 'learned helplessness'. Ritter intends to model future research on these killer whale studies.

During the Committee Plenary at the beginning of SC/67b, there was a short presentation on the development of a Whale Welfare Assessment Tool and interested parties also met subsequently with the developer of the assessment tool. The objective is to scientifically assess the health and welfare significance of non-hunting threats to wild cetaceans. Simmonds presented to the sub-committee the hypothetical whale watching case study that had been used in the first trial of the assessment tool. The information used in the trial was compiled in a case study document that was provided to a panel of (non-cetacean) welfare experts. The case study document included a definition of the issue under consideration, an introduction to reported effects, including an assessment of the published literature, and then a description of a hypothetical population exposed to whale watching pressure. One aspiration of the project is to develop a tool that will allow science-based comparisons between different scenarios; as such, it may also allow a ranking or prioritisation of the most serious impacts to mitigate. Simmonds solicited comments from the sub-committee on the validity of the hypothetical case and requested suggestions for real-world situations where the assessment tool might be tested in the next phase, where both cetacean and welfare experts will be part of the assessment panel.

In discussion, the sub-committee had no comment on the hypothetical case, but offered two suggestions for populations where this approach might be applied – the southern resident killer whales in Washington, USA and the bottlenose dolphins of Bocas del Toro, Panama, both of which (the former in particular) have a growing body of empirical data to inform such an approach. It was noted that there may be linkages between this project and the MAWI initiative Item 2.1), as this approach addresses impacts on health, and these linkages could be explored at the proposed third workshop. It was also suggested that this approach might inform the threats mapping project reported in Avila *et al*. (2018) (Item 2.3), adding a dimension of intensity of risk rather than just presence/absence. Finally, it was noted that a focus on welfare can resonate more than population-level impacts with some policy-makers.

Attention: SC

The sub-committee ***recommended*** *that the Whale Welfare Assessment Tool (currently being developed at the Royal Veterinary College, University of London, in the context of the IWC Whale Killing Methods and Welfare Issues Action Plan), for which a hypothetical whale watching case study was trialled (Annex X, item 2.2), be applied to real-world whale watching situations. The southern resident killer whales in Washington, USA and the bottlenose dolphins in Bocas del Toro, Panama were proposed. These two populations are subject to intense whale watching pressure and may be suffering welfare and health impacts related to this pressure. Both locations have data relevant to the assessment tool and therefore seem ideal as pilot projects for its application.*

2.3 Consider documented emerging areas of concern (e.g. habituation, new areas/species, new technologies, in-water interactions) and how to assess them

Simmonds reported on the work of the intersessional correspondence group on habituation (Table 3, now 'human-induced behavioural changes of concern'). The group had considered how to define habituation and sensitisation and also the range of problems that could arise from human-induced changes to cetacean behaviour. The group noted that behavioural and nutritional state may affect how individual animals react. For example, animals that are resting may show a greater response to disturbance than animals that are highly motivated to remain in the area for feeding purposes. This latter lack of response may be elevated in animals that may be nutritionally stressed. Therefore, lack of a visible change of behaviour does not necessarily mean that disturbance has not occurred. For example, an animal may not have an energy surplus to enact aversive behaviour. Moreover, certain life stages may be more or less sensitive to disturbance. For example, females with calves may display heightened sensitivity to disturbance compared to juvenile males and may have less ability to remove themselves from the vicinity of the disturbance. There are also individual differences in responses.

The group noted that human-induced behavioural changes encompassed several areas of concern, including:

(1) directed feeding of cetaceans by people;
(2) inadvertent provisioning via cetaceans removing caught fish or bait from a fishing line (depredation);
(3) opportunistic feeding near commercial fisheries, including gear that attracts fish (FADS) and discards of bycatch or bait;
(4) discards of catch during recreational fishing; and
(5) the generation of 'solitary sociable' cetaceans.

In discussion, the sub-committee **agreed** that the intersessional correspondence group should continue, with a broadened mandate to consider human-induced behavioural changes that cause concern. Its terms of reference were updated as follows: (1) continue to monitor the relevant literature; (2) seek to produce a new review of information for the Committee across the whole range of interactions; (3) review the appropriate terminology; and (4) continue to consider the relevance of this topic to the work of the sub-committee, including how this topic might best be studied (see Table 3). The sub-committee **agreed** that, while dolphins do not always exhibit behavioural change when exposed to various human activities, there may still be an impact. Regardless, as habituation occurs when an initial behavioural change is extinguished with time, the change in the intersessional group's name and focus was deemed appropriate. Rather than add a standing agenda item at this time, this topic can be covered under Item 2.3 (emerging issues of concern) for the near future.

The question of distinguishing between 'learned helplessness' and habituation was raised; it was **agreed** that the group would consider experimental or observational ways of distinguishing these two phenomena (see the group's new Terms of Reference in Table 3). In general, the sub-committee **encouraged** the group to focus its intersessional discussions on how researchers can study these phenomena in order to improve our understanding of them.

SC/67b/WW03 presented information on an in-depth report (CMS, 2017a) prepared by the Convention on Migratory Species (CMS) Aquatic Mammals Working

Group (AMWG) on the impacts of recreational in-water interaction with aquatic mammals (aka 'swim-with' activities). The AMWG also made recommendations to the 12th Meeting of the Conference of the Parties (CoP) on how CMS could address this growing concern. The AMWG report represented a global review of in-water interactions with aquatic mammals and contains a detailed overview of known locations and species subject to 'swim-with' operations. Based on the findings in the report, the CMS CoP adopted a resolution (12.16) and decisions (12.50-52), available at *http://www.cms.int/en/cop12docs*. Resolution 12.16 urges countries to adopt appropriate measures, such as national guidelines, codes of conduct and if necessary, national legislation or binding regulations, to manage all in-water interactions. It encourages Parties to ensure that these activities do not have negative effects on the long-term survival of populations and habitats, and have minimal impact on the behaviour of animals. The Resolution further encourages Parties to facilitate research allowing an assessment of the long-term effects and biological significance of disturbances, including the development and use of suitable modelling techniques. The Resolution encourages Parties to periodically review new information so that impacts can be appropriately mitigated. Decision 12.50 requests Parties to provide the CMS Secretariat with national measures they have adopted regarding in-water interactions with aquatic mammals. The CMS Secretariat will issue a call for such submissions to CMS Parties during its intersessional period. Decision 12.51 requests the Scientific Council to develop guidelines on in-water interactions with CMS-listed species. The preparation of the guidelines and other related documents is to be done in consultation with the IWC. The resulting guidelines and recommended code of conduct for operators concerning in-water interactions will be presented to the 13th Meeting of the CoP to CMS in 2020 for formal consideration.

The sub-committee thanked the CMS AMWG for its hard work on this topic and for submitting this information. The topic of swimming with cetaceans was also addressed in Item 7.1 and additional recommendations were made during discussion of that agenda item.

Attention: SC, CC, S

Given the substantial effort the Convention on Migratory Species (CMS) Secretariat has made in preparing several documents for the Committee to consider this year, the sub-committee ***recommended*** *a continuation and an expansion of this exemplary collaboration between the IWC and CMS Secretariats and their various committees. The sub-committee* ***endorsed*** *the intention of CMS to work with the IWC Scientific Committee on guidelines for in-water interactions with aquatic mammals and notes the sub-committee can provide the scientific underpinning for these guidelines. It* ***recommended*** *that the sub-committee's intersessional correspondence group on swim-with-whales work intersessionally with the CMS Aquatic Mammals Working Group and that the former present the draft guidelines to the sub-committee for comment at a future Committee meeting, whenever the draft guidelines are ready for review. These guidelines would be a joint product of the IWC and CMS and hosted by both websites as a global resource.*

See also Item 7.1 for additional recommendations related to swimming with cetaceans.

Sprogis *et al*. (2017) and Irvine and Kent (2017) were reports commissioned and presented to Western Australia management authorities as part of an effort to assess the impacts of trial 'swim-with-whale' commercial operations focused on humpback whales in Ningaloo Marine Park. Sprogis *et al*. (2017) evaluated short-term behavioural responses of the whales to swimmers and also compliance with the guidelines established for the trials. Regarding compliance, the report authors made reference to the IWC's guiding principles, which discourage 'in-path' approaches to whale groups ('in-path' approaches, to place swimmers in the water in front of a whale group, comprised 89.8% of vessel approaches during the Ningaloo trials). Irvine and Kent (2017) reported on calf distribution in the area of the trials, concluding that a majority of vessels would encounter mother-calf groups (which the guidelines discouraged swimming with) within 1km of the reef edge of Ningaloo Marine Park, while very few would do so beyond 1km of the reef edge.

In discussion, it was noted that this situation was raised by Kaufman at SC/67a. The authors of these two reports were unable to attend SC/67b; therefore, the reports were presented simply to serve as examples of a model precautionary approach to developing swim-with commercial operations. Stack noted that the permitted experimental study, described by Kaufman last year, would go forward as planned in Hervey Bay with her as lead researcher. She will be reporting its results as soon as possible, hopefully at SC/68a.

As part of an effort to identify areas of emerging risk for marine mammals, Avila *et al*. (2018) geo-referenced and encoded available information from more than 1,780 papers on marine mammal threats in a database. A series of risk maps were developed from this database, linking information about species-specific vulnerabilities to large-scale species distributions, thus providing an assessment of how threat levels for marine mammals vary in space. Risk areas were produced based on binary (presence/absence) range maps using the core habitat. Direct human activities, including tourism activities (affecting 64 species), were the major source of threats. Tourism activities were defined as recreational activities, including whale watching from vessels, but also sport fishing, diving, recreational vessels and aircraft, and live capture for public display. Higher risk areas for tourism activities, where more than 75% of the species presented were potentially exposed, were in the coastal area of the Mediterranean Sea, in the north of Russia, north of Canada, around the Antarctica Peninsula and also several small areas around South America, southern Africa and Australia. However, risk areas differed by taxa. For odontocetes, southeast Asia, southeast Africa and northeast Australia had a greater number of higher risk areas, while for mysticetes, these were mainly in northeast Australia.

The sub-committee praised this work's impressive effort, which will assist educators, naturalists and students, as well as managers and policy-makers, in understanding potential global threats to marine mammals and cumulative impacts. Avila noted that these maps do not assess actual impacts, only the presence or absence of threats, and that her work had also identified geographical areas where there are gaps in the scientific literature regarding impacts on cetaceans. It is therefore a starting point for assessing impacts, not a study of impacts per se. The sub-committee **drew attention to** fig. 1, noting that tourism that may affect marine mammals is almost everywhere on earth and data on impacts are lacking from many of these locations.

3. CONSIDER INFORMATION FROM PLATFORMS OF OPPORTUNITY OF POTENTIAL VALUE TO THE SCIENTIFIC COMMITTEE

3.1 Review new information

SC/67b/WW04 reported preliminary findings resulting from a collaboration between photographers on board whale watching vessels and researchers from Instituto de Conservación de Ballenas and Ocean Alliance in Península Valdés, Argentina. A photographic catalogue of 3,200 individually identified southern right whales has been created through annual aerial surveys in this calving ground since 1971. In order to increase the sample size and to improve population estimates, photographs taken by professional photographers on whale watching vessels are being incorporated into the catalogue through a cooperative agreement. The photographers contributed 460,000 images taken almost daily during tours between June and December 2003-2016. A first set of 1,180 photographs (0.25% of the photos received) taken between 2003 and 2007 were compared to the aerial survey catalogue using 'Big Fish', a software programme developed by the Australian government. Researchers found 151 identifiable whales, of which 105 (86 adults and 19 calves) were incorporated into the database as new individuals and 46 were previously known whales. This emphasises the relevance of images from whale watching operations. This initial analysis has provided new information on: (1) age of known individuals; (2) mother-calf relationships; (3) calving intervals of known females; and (4) individuals over broader time periods. Further analyses will inform understandings of residency times of different age and sex classes, social bonds and health condition based on skin lesions and scars. The resulting expanded database will help to improve conservation strategies and boost 'citizen science' and community work in Península Valdés, and highlights the value of whale watching vessels as platforms of opportunity for cetacean research.

The sub-committee welcomed this development, noting it is an excellent example of the use of platforms of opportunity to advance the science on a species, and expressed appreciation for the wealth of data these images provide researchers. However, it was noted that, after suffering through a deficiency of data, the researchers now must sort through a surfeit of data, which will take considerable time and money to review and process. Minton noted that the topic of citizen science is included in the Handbook.

The sub-committee discussed several options for increasing the efficiency with which these images are filtered and processed, including: (1) training multiple students (graduate and undergraduate) to filter the images, at least to the degree of identifying 'suitable' images for matching to the catalogue (actual matching may require more expertise); (2) developing computer algorithms that can filter the images, at least to the degree of 'shows appropriate head profile with callosities: yes/no'; (3) using members of the public, as citizen scientists, through online platforms to filter the images, similar to the algorithm – this is often done for terrestrial and astronomical studies, essentially 'crowd-sourcing' image filtering and applying methodologies to take account of the lack of expertise inherent in this option (a subset of this option is to train people to filter the images); and (4) adapting more sophisticated software, such as 'Fluke Book' (see e.g. SC/67b/PH03), to conduct actual matching of images to the right whale catalogue.

There was discussion about the pros and cons of all these options. The project to date has mostly employed option 1, but may use some or all of the other options as the project proceeds. A few other related points were made, including training photographers to take 'suitable' photographs in the first instance, as a means of pre-filtering images; developing novel algorithms that are species specific; and keeping sight of the need to offer constructive feedback to the public on the results of their efforts when employing citizen scientists. Sironi expressed gratitude for the many constructive suggestions. The sub-committee **encouraged** the researchers to network with other researchers around the world, particularly humpback whale researchers dealing with similarly large numbers of photographs and multiple catalogues, to improve the processing time for this large number of images.

SC/67b/WW07 summarised two papers on platforms of opportunity. De Boer *et al*. (2018) provided an example where effort-corrected data on marine megafauna was collected by a wildlife tour operator (over a five-year period). Those data could be used to analyse cetacean habitat use off the coast of Cornwall, UK (especially common bottlenose dolphins, *Tursiops truncatus*, short-beaked common dolphins, *Delphinus delphis*, harbour porpoises, *Phocoena phocoena* and Risso's dolphins, *Grampus griseus*). The data showed that coastal Cornish waters appeared to be an important nursing area for harbour porpoises and Risso's dolphins, suggesting these locations might benefit from marine protected area status. The authors also highlighted that the protocols they used allowed the efficient collection of data and might be applied by others using platforms of opportunity.

In brief discussion, it was noted that this was another example where data gathered from whale watching vessels was able to inform cetacean management and conservation efforts. It was also noted that the paper cross-referenced earlier recommendations from the sub-committee, which had encouraged the development of such protocols (see Item 8).

Brown *et al*. (2018) provided information on humpback whale (*Megaptera novaeangliae*) sightings from whale watching vessels within the New York-New Jersey Harbour Estuary, an extremely busy waterway. There has been a rapid increase in numbers of whale sightings in the harbour area in recent years (one in 2012, six in 2014, eight in 2015 and 31 in 2016), with sightings generally occurring in the summer and even more so in the autumn. Historical whaling records do not report humpback whales from this region, so it is possible this may be a new use of this habitat. Animals were generally believed to be juveniles based upon size. During half of the sightings, lunge feeding on Atlantic menhaden (*Brevoortia tyrannus*) was observed, in the cases where prey species could be identified (19.6%). The authors expressed concern that observations of whales overlap with major shipping channels and this presents a potential risk to both whales and vessels. Whale watching-gathered data is being used to assess the potential ship strike threat in this region.

The sub-committee again thanked Parsons for preparing the annual whale watching research digest and presenting this information. It reiterated its suggestion that the digest be used to identify potential invited participants for future meetings (IWC, 2018b).

4. WHALE WATCHING IN EAST AFRICA AND WIDER INDIAN OCEAN

CMS (2017b) presents the proposal for Concerted Action for Arabian Sea humpback whales. This proposal was passed with strong support from Arabian Sea humpback whale range states. The proposal notes that humpback whales are the target of one emerging whale watching operation in the south of Oman and highlights the likelihood that the population could become the target of future whale watching activities if more becomes known about its distribution and potential hot spots are identified. There is an emphasis on the need for regulators and scientists to work with the industry to ensure that whale watching does not add to the many other pressures on this small, isolated, non-migratory and endangered population. Details of the whale watching operation in Oman were presented to the sub-committee last year in Baldwin *et al*. (2017).

In discussion, it was suggested that, rather than develop a novel smartphone app (see CMS, 2017b, p.15), an existing app, such as Whale and Dolphin Tracker (Currie *et al*., 2016; Currie *et al.,* 2017), could be translated for use by operators and the public in Oman; this suggestion was welcomed by the Omani researchers. The researchers noted that the whale watching operator in the South of Oman is still adhering to the best practice guidelines in his interactions with humpback whales, a credit to the training that was provided by sub-committee members Kaufman and Carlson with support from the IWC. At the same time, however, there are still concerns about the dolphin watching industry in Oman, with some operators sliding back into poor habits despite training workshops conducted in past years. This appears primarily due to the high turnover of vessel operators/captains. Another training workshop in Oman would be welcome and Pacific Whale Foundation offered to assist in organising and conducting one if requested.

Attention: S, SC, CC, CG-R Oman

The sub-committee ***recommended*** *that building capacity to conduct needed research and to ensure consistent training of whale watching operators be a high priority for Omani authorities and other parties working on the recovery of the endangered Arabian Sea humpback whale population. Boat operators for cetacean watching operations appear to turn over at a high rate in this area and therefore training workshops should be regularly offered and conducted.*

The sub-committee welcomed the offer from the Pacific Whale Foundation to help organise and conduct another training workshop and ***recommended*** *a more comprehensive plan be implemented by the Omani authorities, working with the IWC and other interested parties, to build local capacity for such training.*

The sub-committee ***agreed*** *to retain a review of whale watching in east Africa and the wider Indian Ocean region in its work plan and will conduct an intersessional review of whale watching in these areas, to be presented at SC/68a, regardless of the venue for the meeting.*

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5. REVIEW WHALE WATCHING STRATEGIC PLAN (2018-2024) AND JOINT WORK WITH THE CONSERVATION COMMITTEE

5.1 Review and provide recommendations on the draft Strategic Plan

SC/67b/WW02, a draft of the next iteration of the IWC Strategic Plan (2018-2024) on Whale Watching, was provided to the sub-committee for its review and comment. This was accomplished primarily during a SC/67b pre-meeting (held 21 April 2018), attended by several members of the sub-committee, one of whom is also a member of the Conservation Committee's Standing Working Group on Whale Watching (SWG). The sub-committee's **agreed** comments are attached as Appendix 2.

Attention: CC

The sub-committee ***draws the attention*** *of the Conservation Committee's Standing Working Group on Whale Watching (SWG) to Annex N, Appendix 2. This appendix is the sub-committee's full set of comments on the draft Strategic Plan (2018-2024) on Whale Watching. The most important comments and recommendations from the appendix are the following:*

The addition of Action 1.5: Develop a communications strategy to actively promote IWC whale watching resources (e.g. the Handbook, reports and training opportunities), with approaches tailored to target key audiences. These audiences include the public and whale watching managers, researchers, operators, and on-board naturalists. Communication actions could include preparing publicly accessible summaries of IWC whale watching reports, improving the whale watching pages on the IWC website (which will happen soon with the new Whale Watching Handbook), and promoting resources on social media, at key meetings and via press releases to industry bodies and trade publications. The implementation of this action could be coordinated intersessionally via the Secretariat. A joint intersessional working group, which includes key Secretariat staff, could develop a communications strategy for consideration at IWC/67 (the Brazil Plenary meeting) and/or the joint session of the CC/SC at SC/68a.

(1) The replacement of the actions of Objective 2 in the draft Strategic Plan with the following:
  - *(a)* ***Action 2.1*** *Continue the Modelling and Assessment of Whale Watching Impacts (MAWI) initiative, to develop tools and methodologies to assist researchers and managers in their efforts to assess potential impacts of whale watching on cetaceans and to mitigate them. This initiative is ongoing and could focus on:*
    - *(i) investigating modelling methods to link short- (e.g. behavioural reactions) and medium-term (e.g. changes in population distribution) responses with potential impacts from whale watching to long-term (i.e. >10 to 20yrs) consequences (e.g. vital rates);*
    - *(ii) establishing standard data collection methodologies, including from platforms of opportunity; and*
    - *(iii) identifying key locations for whale watching research projects and programmes, taking into consideration logistics, capacity and management urgency.*
  - *(b)* ***Action 2.2*** *Develop a long-term integrated research programme to better understand the potential impacts of whale watching on the demographic parameters of cetacean populations. Seek to:*
    - *(i) investigate whether there is a causal relationship between whale watching exposure and the survival and vital rates of exposed cetacean individuals and populations; and*
    - *(ii) understand the mechanisms involved in causal effects, if they exist, in order to define a framework for improved management.*
  - *(c)* ***Action 2.3*** *Develop processes and mechanisms for whale watching activities to collect and provide scientifically robust and useful data to researchers and research programmes; and*

(d) ***Action 2.4*** *Develop an approach (e.g. hold an intersessional workshop; establish a joint intersessional working group) to integrate social and ecological scientific research within the IWC to inform whale watching management and promote potential benefits. This is a coordinated action between the SWG and the sub-committee.*

In particular, Action 2.2 will require a dedicated person to guide and coordinate the development and implementation of a research programme or plan. The best option would be for the SWG to contract with someone, full- or part-time, to carry out this task. The sub-committee is aware there are budgetary concerns. Therefore, it ***recommended*** *that the search for funding for this and all other actions in the Strategic Plan be focused, broad-ranging and innovative. An alternative if budgetary issues are prohibitive is to have the research programme developed intersessionally by an intersessional correspondence group or the sub-committee convenor and co-convenor.*

Lastly, the sub-committee ***reiterated*** *its previous recommendation to improve the coordination between the SWG and the sub-committee in the development and implementation of a Strategic Plan on Whale Watching. This year's 21 April pre-meeting to review the draft Strategic Plan was intended to improve coordination. It did provide the sub-committee with an opportunity to contribute to the draft Strategic Plan but it did not completely achieve the goal of coordination, as a limited number of SWG members were able to attend the pre-meeting.*

Regarding the reiteration of a previous recommendation to improve coordination between the Conservation Committee's SWG and the sub-committee, it was suggested that the Secretariat could facilitate an intersessional meeting, perhaps conducted via Skype or other video conferencing, with members of the intersessional correspondence group on communications with the Conservation Committee (which the sub-committee **agreed** should continue; see Table 3) and key members of the SWG. One suggestion was to plan a pre- or post-meeting associated with IWC/67 in Brazil this autumn. The sub-committee's emphasis on improving communications between the SWG and the sub-committee is directly relevant to developing and implementing the Strategic Plan (2018-2024).

5.2 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

See Item 5.1. The sub-committee redrafted Actions 2.1 through 2.4 of Objective 2 in the draft Strategic Plan, which essentially outline how the sub-committee will collect the information to inform scientific advice to the Conservation Committee on whale watching. Procedures for providing this advice will be discussed and determined cooperatively with the Conservation Committee, during the joint meeting immediately after SC/67b and intersessionally through the intersessional correspondence group (Table 3).

6. WHALE WATCHING HANDBOOK

6.1 Review and provide comments on the IWC's Whale Watching Handbook

SC/67b/WW08 provided an update on progress with the development of the Whale Watching Handbook (Handbook) and an overview of the content that has been drafted. In 2017 funding was made available for the development of the online Handbook through contributions to the Voluntary Conservation Fund from the UK and the USA. Developing a Handbook has been a longstanding recommendation of the sub-committee, as well as the Conservation Committee's Standing Working Group on Whale Watching (SWG). The Convention on Migratory Species agreed to fund the translation of the Handbook into French and Spanish.

After a consultation process, web designers built the architecture of the site and, over several months, content was drafted and compiled with contributions and support from SWG and sub-committee members, as well as subject matter experts. An overview of all the content developed for the site in various tables was presented. The five main categories of content include:

(1) Original content drafted for the Responsible Management, Preparing for a Trip, and Industry Support sections of the Handbook: drafted after consulting a wide body of whale-watching literature, including published articles and workshop reports.
(2) 20 Case Studies highlighting aspects of management of whale watching around the world: drafted in consultation with at least one stakeholder involved in the whale watching industry in each relevant location.
(3) 20 Species Accounts for the species most frequently targeted by whale watching: produced in two formats; a longer illustrated online format and an A4 factsheet format available for download as a resource to be used by whale watchers or guides during tours.
(4) Country Profiles: either compiled or reviewed by the relevant country's Commissioner or delegation member. To date, 25 have been drafted and 12 have been reviewed and thus uploaded to the provisional Handbook site.
(5) Downloadable content: including a searchable table of over 300 peer-reviewed/scientific articles on whale watching, tables with links to guidelines and regulations from almost all of the featured countries on the website, tables with links to region-specific species guides and tables with (internal and external) links to content of specific interest to managers (e.g. workshop reports, global reports on whale watching) or industry (e.g. certification schemes, sustainable eco-tourism resources).

During presentation of SC/67b/WW08, the structure and user-interface of the site was demonstrated with a brief online presentation, as it is still housed on a provisional site and is not yet publicly accessible.

Both the content and web infrastructure as specified under the Terms of Reference and contracts for the Handbook are nearing completion. Content needs to be completed and finalised by the beginning of June in order to allow translation of the original English language content into French and Spanish to commence.

While Scientific Committee input is invited on all aspects of the Handbook, sections of particular relevance to, and on which the Scientific Committee is specifically invited to provide input, include the table of studies documenting impacts of whale watching and the list of scientific literature included in the site's searchable literature database. It is hoped that the sub-committee will be able to review these on an annual basis and suggest updates as appropriate, as well as pass on information about updated guidelines, case studies or species information as and when appropriate.

The sub-committee expressed thanks to Minton for this excellent presentation and offered hearty congratulations for the near-completion and tremendous quality of the Handbook. The product is comprehensive, scientifically substantive, user-friendly and well-designed. In discussion, it was clarified that the Handbook is a living resource and will be updated and revised as needed. The Handbook will be presented to the Commission at IWC/67 for its consideration, along with a plan to update it with additional case studies, country profiles and other content.

Several suggestions for fine-tuning and improving the already-admirable Handbook were offered, starting with a request to add a case study on watching, provisioning and swimming with river dolphins in the Amazon (see Item 9). Ecuador could be another country profile. It was noted that input from small-capacity operators in developing countries is as necessary as input from larger-capacity operators from developed areas – this resource needs to be useful and applicable to all. It was suggested that a periodic review process, perhaps every three years, where a set of criteria would be applied to content to determine what needs updating and what could even be removed, be developed. An annual review, given the breadth of content, could prove an overwhelming task. A clearly outlined periodic review process could also facilitate requests for funding the ongoing maintenance of the Handbook. A final suggestion was to also translate the Handbook into Chinese, Japanese and Arabic.

Attention: CG-R

To ensure the IWC Whale Watching Handbook comes to the attention of the international whale watching community, including managers, operators and the public, the sub-committee ***recommended*** *that all Contracting Governments provide a link to the Handbook on the relevant agency pages of their own government websites once the Handbook goes 'live'.*

Various fund-raising options to maintain the Handbook (e.g. maintaining Minton's contract at a level adequate for periodic reviews) were also discussed, including investigating possible funding sources in new regions developing whale watching networks, such as the Indian Ocean. Also, NGOs and others could sponsor the Handbook, but it would be essential to apply ethical criteria when considering potential sponsors using this fund-raising method. Contacting entities that use this method, such as National Public Radio in the USA, who have clearly addressed conflict issues, could be a useful first step in pursuing this option. The intersessional correspondence group on strengthening IWC finance and the Secretariat is investigating this and other types of fund-raising methods, which must be considered carefully from a governance viewpoint, and this includes the consideration of ethical guidelines.

Attention: SC, S, CC, C-R

The sub-committee ***recommended*** *that the Conservation Committee and the Commission develop a plan for identifying and securing long-term funding for the further development (e.g. translations into additional languages) and the ongoing maintenance (e.g. periodic reviews of content) of the IWC Whale Watching Handbook. The Handbook must be updated regularly to remain a vibrant, living document.*

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7. REVIEW REPORTS FROM INTERSESSIONAL WORKING GROUPS

7.1 Swim-with-whale operations

SC/67b/WW01 reported on the intersessional activities of the swim-with-whales intersessional correspondence group. The group was tasked to pursue: (1) efforts to increase the response to the IWC questionnaire survey reported on at SC/66b (Gero *et al*., 2016); (2) further information on a global survey of whale watching operations to be conducted by the World Cetacean Alliance (WCA); and (3) progress on field research on the impacts of swim-with-whale activities on large whales, specifically at sites in Hervey Bay, Australia (IWC, 2018b). With regard to the first point, at SC/67a the sub-committee recommended working with the Conservation Committee and the IWC Secretariat to contact ministries of tourism or environment of each IWC Contracting Government directly. It also recommended that the intersessional group collaborate with CMS, IORA and ACCOBAMS to improve distribution of the questionnaire. Initial outreach was made to CMS, which was undertaking its own review of in-water interactions with aquatic mammals. The subsequent email exchange resulted in the preparation and submission of SC/67b/WW03 and CMS (2017a). The IWC Secretariat suggested waiting to contact other secretariats until the CMS outputs were discussed at this meeting. The CMS Secretariat will soon be requesting Parties to submit national in-water interaction guidelines and/or regulations. CMS has agreed to distribute the IWC questionnaire with this request; the intersessional group will follow up on this and report any progress at SC/68a. Regarding the second point, the WCA was contacted by email in March 2018; its global survey is complete but data are not yet analysed. The intersessional group will report on the results at SC/68a. Regarding the third point, see Item 2.3 and the update on research in Hervey Bay from Stack.

The sub-committee **agreed** that the intersessional correspondence group on swim-with-whale operations should continue (Table 3). It was noted that in some locations, the guidelines the sub-committee will be developing in collaboration with the CMS Aquatic Mammal Working Group (Item 2.3) on in-water interactions with marine mammals, are needed as a matter of urgency. For example, in Japan operators are beginning to target humpback whales with swim-with excursions. These operators are inexperienced at traditional whale watching and trying to safely manage customers swimming with these whales may be beyond their abilities. It was noted that managing these situations may be more a matter of decreasing human motivation to swim with these mammals with appropriate marketing, messaging or framing, rather than prohibiting the activity outright, which may not be possible politically. The MAWI initiative (Item 2.1) is addressing swim-with-whale operations as well and social science research may be a way forward for the sub-committee to address these issues.

Attention: CG-R

The sub-committee ***recommended*** *that, in jurisdictions where swim-with-cetacean activities have not been occurring or are just starting, this practice be prohibited until there is scientific evidence that supports allowing it. The risks to both humans and cetaceans are substantial if operators are inexperienced and not following any relevant guidelines. Guiding principles for whale watching, including in-water* *interactions, are being or have been developed by various regional bodies, such as the Convention on Migratory Species and UNEP in the Wider Caribbean (see Annex X, item 2.3 and UNEP-CEP, 2012), which advise that swimming with cetaceans be discouraged where it is not already established.*

7.2 Communication with the Indian Ocean Rim Association (IORA)

SC/67b/WW05 offered an update on progress to establish the Indian Ocean Rim Association Sustainable Whale and Dolphin Watching Tourism Network. A concept note for the Network was circulated to IORA member states in February 2018, inviting nominations to the Network from these countries. Australia will convene the Network in its first year of operation and will produce a biannual newsletter. Members of the sub-committee were invited to contribute content for the Network's newsletter.

In discussion, the sub-committee **agreed** that the intersessional correspondence group on communication with IORA should continue (Table 3). It was suggested that the intersessional group be tasked with providing input and content for the newsletter. A first suggestion was to write about the IWC whale watching guidelines and principles and the Handbook, when it is publicly released.

Attention: S, SC, CC, CG-A

*The sub-committee **encouraged** greater engagement between the IWC and IORA on whale watching, beyond the exchanges amongst the intersessional correspondence group (Annex X, Table 3). In the first year of this two-year work plan period, e-mail correspondence should be continued and expanded. In the second year, the sub-committee **recommended** holding an intersessional meeting between Secretariats of the IWC and IORA and appropriate experts, to develop a communications and cooperation strategy.*

8. REVIEW PROGRESS ON SCIENTIFIC RECOMMENDATIONS

8.1 Global influence of recommendations

Gleason and Parsons (2018a, b) were the result of previous recommendations to highlight threatened cetacean species that might be at particular risk from exposure to whale watching, and to document cases of whale watching management where sub-committee advice had been influential in management actions around the world. Information in these documents was sought from the MARMAM listserve and sub-committee members.

In discussion, Parsons requested updated information, as both papers are still in review at the *Journal of Cetacean Research and Management* and could be revised, and suggested that sub-committee members seek updates from their respective country delegations and national agencies as soon as possible for inclusion. One member noted that he summarised the sub-committee's recommendations each year and shared them with whale watching stakeholders in his country. It was suggested that all sub-committee members, especially national delegates, might do the same.

8.2 Tracking progress on previous recommendations

A compilation of sub-committee recommendations and agreements from the past two years (SC/67a and SC/66b) and their outcomes are presented in Table 2. In viewing these recommendations and agreements in this overarching format, it was more easily noted that for some recommendations, progress would be difficult to determine. Per the directive from the Chair and Commission, the sub-committee will make every effort in future to identify who will carry a recommendation forward and how progress will be measured.

It was also noted that the sub-committee did not complete updating its Terms of Reference (see agreement in Table 2). Historic and draft updated ToR were discussed at SC/67a (IWC, 2018b, p. 340 and p. 342), but this draft was not reviewed and accepted by the Conservation Committee or Commission. The sub-committee **agreed** that the Convenor and Co-Convenor of the sub-committee would complete this process at the joint session of the Conservation Committee and the sub-committee immediately after SC/67b and intersessionally. The draft Terms of Reference should be presented by the Chair and Co-Chair at IWC/67, so they can be finalised for SC/68a.

8.3 Update on dolphin watching in Bocas del Toro, Panama

Trejos reported that nine dolphins were found dead in 2016 and 2017 in Dolphin Bay, Bocas del Toro, Panama. Five of these dolphins were recovered and necropsied; cause of death was propeller injuries, most likely from dolphin watching vessels. One of these dolphins was a photo-identified male who was first added to the Dolphin Bay catalogue in 2004. Given the small size of this population (possibly fewer than 100 animals), this mortality is clearly unsustainable. She also described a regulations update, released in October 2017 with the support of the Ministry of Environment, which is intended to lead to stronger management of dolphin watching in Bocas del Toro.

In discussion, it was noted that the neighbouring community of Manzanillo, Costa Rica, also has dolphin watching, but operators there appear to adhere more readily to national regulations. It was suggested that an effort be made to connect these two communities and start an operator-to-operator dialogue. Parsons reported that the research team led by Laura May-Collado has recently published a paper demonstrating that the dolphins in Dolphin Bay are genetically unique (and do not cross the border into Costa Rica) (Barragán-Barrera *et al*., 2017). As reported last year, the team is measuring stress hormones through biopsy and results may be available for SC/68a. The team has also deployed three hydrophones to measure Dolphin Bay's soundscape in an effort to study noise impacts on the dolphins. The intention is to present the results of all ongoing studies in Dolphin Bay at a future Scientific Committee meeting. The research team would welcome the application of the welfare assessment tool (Item 2.3), but funding is an (ongoing) issue.

Attention: SC, C, CG Panama

*The sub-committee **reiterated** its grave concern regarding the intense and uncontrolled dolphin watching in Bocas del Toro, Panama. This concern has been expressed and reiterated for several years due to continuing mortalities, including from vessel strikes, in this small population (probably fewer than 100 animals). The sub-committee welcomes the ongoing research to monitor this dolphin population and the impacts it is facing from dolphin watching.*

Nine deaths in 2016 and 2017 are known to have occurred, five of them confirmed boat strikes; these losses *are unsustainable. The sub-committee* ***recommended*** *action from the Government of Panama as a matter of urgency. The sub-committee* ***reiterates*** *its welcome of Panama's increased responsiveness to protect the local dolphin population by minimising negative impacts from dolphin watching (IWC, 2018a) and welcomes the news that a new action plan has been proposed, with support by the Ministry of Environment, to regulate dolphin watching in Bocas del Toro. However, given the unsustainable mortalities in this population, the sub-committee* ***recommends*** *immediate and committed implementation of this action plan.*

9. WORK PLAN AND BUDGET REQUESTS FOR 2019-2020

9.1 Work plan for 2019-2020

It was noted that work on updating the IWC whale watching guiding principles (see, e.g. Carlson *et al*., 2014) has not progressed since SC/65b. The whale watching guidelines and principles (i.e. guiding principles) currently posted to the IWC website are from 1996 and urgently need updating (e.g. they do not speak to swim-with-cetacean operations or emerging technologies such as drones). Updated guiding principles are also needed for the Handbook. It was suggested that any updated guiding principles should explicitly refer to land-based whale watching with low environmental impact as an option due to its near complete lack of impact on the whales (the current draft guiding principles do not refer at all to land-based whale watching). The sub-committee **agreed** to add 'update of the whale watching guiding principles' back into the work plan. The draft guiding principles can be submitted again for discussion at SC/68a, approved by the full Committee and then forwarded to the Conservation Committee for inclusion in the Handbook and posting to the website (to replace the existing guidelines and principles).

The sub-committee also discussed maintaining emerging concerns on the work plan, such as swim-with-whale operations, new technologies such as drones, interacting with river dolphins (see below) and human-induced behavioural changes (which includes habituation and sensitisation). The standing work plan item on impacts should also endeavour to include discussion on all types of vessels employed for whale watching, including non-motorised vessels such as kayaks.

The IWC has long had an interest in, and concern about, the impacts on wild cetaceans of provisioning (feeding by members of the public) (e.g. IWC, 1999; IWC, 2001; IWC, 2002; IWC, 2003). The Committee concluded that feeding wild cetaceans is 'ecologically intrusive' (Parsons *et al*., 2006) and counter to the aim of reducing impacts of tourism activities on cetaceans (IWC, 2002). Moreover, the IWC recommended that Contracting Parties 'phase out existing [provisioning] programmes and not allow for the development of new ones' (IWC, 2002, p.345). In finalising its two-year work plan and after some discussion about an increasing number of commercial operators offering feeding and swimming with river dolphins in the Amazon, the sub-committee **agreed** to conduct an intersessional review of watching, provisioning and swimming with river dolphins, in the Americas and Asia, to be reported on at least preliminarily at SC/68a and then developed further at SC/68b (Table 4). At SC/68a, a joint session with the Sub-Committee on Small Cetaceans might be appropriate, as it will continue its review of river dolphins. The sub-committee **agreed** to convene an intersessional correspondence group on river dolphins, with Trujillo as convenor, to conduct this review, with the following Terms of Reference: monitor, assess and report on commercial interactions, including watching, provisioning and swimming with, river dolphins in the Amazon and Asia (Table 3). This may link to the work of the South Asian River Dolphin Task Team (see item 6.1 in Annex M).

The sub-committee also **agreed** to plan a joint workshop or meeting with the Conservation Committee's Standing Working Group on Whale Watching to discuss

Table 4

Summary of the work plan for the Sub-Committee on Whale Watching. Many of these items have intersessional correspondence groups (ICG) or intersessional advisory groups (IAG). Those groups will work intersessionally and provide updates at SC/68a (see Annex Y).

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Assess the impacts of whale watching on cetaceans – PRIORITY: (i) short-term impacts; (ii) mid- and long-term impacts; (iii) swim-with operations; and (iv) emerging issues of concern	-	Papers to be presented	-	Papers to be presented
Third MAWI Workshop	Workshop planning	Receive update on planning	Workshop (Convenor: New)	Report
Update IWC whale watching guidelines and principles (*https://iwc.int/wwguidelines)*	Revise guidelines and principles (guiding principles)	Papers to be presented	Additional modifications, inclusion in Handbook	Receive update
Review whale watching in the Indian Ocean	Intersessional correspondence group to contact IORA	Papers to be presented	-	-
Review whale watching in East Africa	Work to prepare review	Paper to be presented	-	-
Intersessional correspondence groups	Email correspondence and work	Receive reports	Email correspondence and work	Receive reports
Review progress on previous recommendations	-	-	-	Papers to be presented
Plan joint meeting with Conservation Committee Standing Working Group on Whale Watching (SWG) to discuss incorporation of social science in joint work streams	Meeting planning	Receive update	Meeting planning	Joint meeting with SWG
IWC Whale Watching Handbook	-	Receive updates	-	Receive updates

the incorporation of social science in the work streams of the two groups (see Table 2). This joint session can occur immediately before or after SC/68b (the second year of the two-year work plan) (Table 4). The sub-committee should seek advice from the Conservation Committee on funding this meeting, including through the Voluntary Conservation Fund and outside sources.

Other items from the 2018 work plan remain the same for 2019 and 2020. The sub-committee's two-year work plan is outlined in Table 4.

9.2 Budget requests for 2019-2020

The sub-committee's budget requests related to the proposed third MAWI workshop (Item 2.1) are summarised in Table 5.

Table 5

Summary of the two-year budget request for WW.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
	Third MAWI Workshop		£20,000
Modelling/Computing			
Research			
Database/Catalogues			
Total request			**£20,000**

10. ADOPTION OF REPORT

The report was adopted at 16:33hrs on 2 May 2018. The sub-committee thanked Suydam and New for their helpful guidance during the discussions and Rose for her exemplary rapporteuring.

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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 whale watching on cetaceans
   - 2.1 Review progress on Modelling and Assessment of Whale watching Impact (MAWI)
   - 2.2 Review specific papers addressing impacts
   - 2.3 Consider documented emerging areas of concern (e.g. habituation, 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 Review new information
4. Whale watching in East Africa and wider Indian Ocean
   - 4.1 Review new information
5. Review whale watching strategic plan (2018-2024) and joint work with the Conservation Committee
   - 5.1 Review and provide recommendations on the draft Strategic Plan
   - 5.2 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
6. Whale Watching Handbook
   - 6.1 Review and provide comments on the IWC's Whale Watching Handbook
7. Review reports from intersessional working groups
   - 7.1 Swim-with-whale operations
   - 7.2 Communication with the Indian Ocean Rim Association (IORA)
8. Review progress on scientific recommendations
   - 8.1 Global influence of recommendations
   - 8.2 Tracking progress on previous recommendations
   - 8.3 Update on dolphin watching in Bocas del Toro, Panama
9. Work plan and budget requests for 2019-2020
   - 9.1 Work plan for 2019-2020
   - 9.2 Budget requests for 2019-2020
10. Adoption of report

Appendix 2

COMMENTS AND RECOMMENDATIONS FROM THE SUB-COMMITTEE ON WHALE WATCHING TO THE CONSERVATION COMMITTEE'S STANDING WORKING GROUP ON WHALE WATCHING, ON A DRAFT OF THE STRATEGIC PLAN (2018-2024) FOR WHALE WATCHING

Last year, Wulff informed the Scientific Committee's Sub-Committee on Whale Watching (WW) that the current Strategic Plan (2011-2016) for Whale Watching was going to be revised and asked WW to review and comment on the new draft during SC/67b. On 22 April 2018, WW held a pre-meeting to review a draft of the Strategic Plan (2018-2024) for Whale Watching (see SC/67b/WW02). Below are comments and recommendations from the pre-meeting. These comments and recommendations are organised by each of the sections of the Strategic Plan. Comments and recommendations are provided on many of the sections of the Plan, but most are focused on topics directly related to the expertise of the Scientific Committee. Most of the comments and recommendations relate to 'Objective 2' and 'Implementation'.

Introduction

- The Introduction should be written in a way that clarifies the Strategic Plan (2018-2024) for Whale Watching is a product of the Commission, not specifically of either the Conservation Committee's Standing Working Group on Whale Watching (SWG) or WW. Both groups (i.e. SWG and WW) are reflected in the plan and the plan is a product of both; therefore, the Introduction should describe the establishment of the SWG, just as it does the establishment of WW. Currently, this description is in the next section (the Issue) but should be moved up to the Introduction.
- The Introduction should also clarify the distinctions between the two groups; it was suggested to add an organisational chart and also the terms of reference for each group as appendices. Perhaps language can be pulled from previous Scientific Committee reports regarding coordination between the SWG and WW. It may be useful for WW to prepare a draft of new Introduction language to this effect, for the SWG's consideration.
- The Vision notes the potential benefits of whale watching, but the Introduction focuses only on assessing impacts (in the final sentence). The Introduction should have an added sentence on assessing and promoting potential benefits from whale watching.
- The Introduction should also refer to the IWC's communication with other bodies, such as IORA or CMS, regarding whale watching.

- It would also be helpful to add a paragraph on what the first Five Year Strategic Plan accomplished (e.g. the Handbook, the portal).

The issue
- A final paragraph should be added noting that there are scientific and management concerns regarding whale watching impacts on cetacean individuals and populations, particularly for populations whose conservation status is of concern, as well as on local communities.

Legal and international framework
- The pre-meeting did not consider this section as WW does not have the expertise to offer input on this topic.

Scope and structure
- No comments.

Vision
- A paragraph should be added on the benefits of whale watching (the current paragraph below the Vision statement only discusses maintenance of healthy whale populations). For example, the paragraph could mention that whale watching can inform people of whale conservation issues. This added paragraph can also mention that there is increasing social science on the potential benefits of whale watching (e.g. research seeking to assess how best to present information to effect a permanent change in people's behaviour).

Objectives
Introductory paragraphs
- The last sentence of the first paragraph needs revision/clarification. The Handbook is the mechanism; the SWG and WW have produced the Handbook, thus the three are not equivalent. The sentence could be revised into two sentences. The first could discuss the Handbook as an important mechanism for accomplishing some of the objectives and the second could discuss the roles of the SWG and WW in preparing the Handbook and accomplishing some of the objectives.
- Actions achieved within two years are characterised as 'short-term', but those achieved within five years are referred to as 'medium-term'. However, the pre-meeting participants felt the two 'long-term' actions were actions that could be achieved during a five-year time horizon. So it was difficult to distinguish medium- from long-term. Perhaps there are only short- and medium-term actions, as these are Strategic Plans that are applicable for five or six years. The long-term action may be the achievement of the Vision.
- The term 'integrated research plan' (the second long-term action in the current draft), needs clarification. What is the plan integrated with? For example, is it integrating social with natural sciences? Integrating all stakeholders? Integrating the work of the SWG and WW? Integrating management and research? The term is further developed and defined in Action 2.1, but the meaning of 'integrated' is still not clarified.

Objective 1
- Add a paragraph to the introductory section about the benefits of whale watching (e.g. teaching people about climate change, having a smaller carbon footprint). See also the comment above regarding the sentence that equates the Handbook, the SWG and the WW as 'mechanisms'.
- Action 1.1 – The Secretariat should be added (so this Action will refer to the SWG, the WW and the Secretariat). In addition, the efforts of these three groups are primarily to improve the information, and secondarily to improve access to that information. See below regarding a new Action 1.5 (a communications and outreach strategy/plan).
- Actions 1.2 and 1.3 seem to belong more under Objective 3 than Objective 1. They are essentially descriptions of the portal, which belongs under Objective 3. While they reference information access and transfer, they are primarily about capacity building.
- We recommend adding a new Action 1.5 and provide some draft language to consider below:

  Action 1.5 – Develop a communications strategy to actively promote IWC whale watching resources (e.g. the Handbook, reports and training opportunities), with approaches tailored to target key audiences. These audiences include the public and whale watching managers, researchers, operators and on-board naturalists. Communication actions could include preparing publicly accessible summaries of IWC whale watching reports, improving the whale watching pages on the IWC website (which will happen soon with the new Whale Watching Handbook), and promoting resources on social media, at key meetings and via press releases to industry bodies and trade publications.

- A flow diagram to show how IWC whale watching information is currently being disseminated might be a useful addition to the plan. The multiplicity of IWC information sources may be hurting rather than helping the IWC in its progress toward becoming a premiere resource for whale watching guidance and advice. The communication strategy (see new Action 1.5 above) can help in the effort to summarise and organise this information to make it more accessible to key audiences; people can go to original sources for more detail if desired.
- The International Whaling Commission's website is not intuitively a place where the public, the media and others will go for whale watching information or advice/guidance. The communications strategy should include how to address this point; for example, can the Handbook have its own URL that is more intuitive and inviting for the layperson?
- The pre-meeting participants agreed that a small intersessional working group could be formed to prepare a communications strategy for consideration of the SWG and Commission.

Objective 2
- Objective 2 is under the purview of the WW because the focus is on *Research and Data Collection*. The following is a redrafting of this objective, as a discussion starting point (for the SWG and also the full WW). Here and several times above, the potential benefits were directly referenced; the Vision refers specifically to whale watching benefits, so they should be referenced throughout the Plan's text (currently only Objective 3 consistently addresses this aspect of the Vision).

  Objective 2 Research and data collection
  Continue to develop the necessary research principles and tools to assist the collection of data important to ensuring that whale watching: (1) does not significantly and adversely affect the behaviours and fitness of

individual cetaceans or populations or their habitats; and (2) realises its potential benefits e.g. educating the public, positively affecting attitudes toward conservation, improving local economies. These tasks and the actions below are for the SC WW Sub-Committee, which should coordinate closely with the CC SWG on WW.

Action 2.1 *Continue the Modelling and Assessment of Whale Watching Impacts (MAWI) initiative, to develop tools and methodologies to assist researchers and managers in their efforts to assess potential impacts of whale watching on cetaceans and to mitigate them. This initiative is ongoing and could focus on:*
- *investigating modelling methods to link short- (e.g. behavioural reactions) and medium-term (e.g. changes in population distribution) responses with potential impacts from whale watching to long-term (i.e. >10 to 20yrs) consequences (e.g. vital rates);*
- *establishing standard data collection methodologies, including from platforms of opportunity; and*
- *identifying key locations for whale watching research projects and programmes, taking into consideration logistics, capacity and management urgency.*

Action 2.2 *Develop a long-term integrated research programme to better understand the potential impacts of whale watching on the demographic parameters of cetacean populations. Seek to:*
- *investigate whether there is a causal relationship between whale watching exposure and the survival and vital rates of exposed cetacean individuals and populations; and*
- *understand the mechanisms involved in causal effects, if they exist, in order to define a framework for improved management.*

Action 2.3 *Develop processes and mechanisms for whale watching activities to collect and provide scientifically robust and useful data to researchers and research programmes.*

Action 2.4 *Develop an approach (e.g. hold an intersessional workshop; establish a joint intersessional working group) to integrate social and ecological scientific research within the IWC to inform whale watching management and promote potential benefits. This is a coordinated action between the CC SWG on WW and the WW Sub-Committee.*

Objective 3
- This section should include a reference to building capacity for research as well. The Plan could perhaps add an Action 3.5 to this effect.
- Action 3.3 – This should refer not only to international bodies but also to industry associations.
- Action 3.4 – It might be helpful to clarify (or reword) the directive to ‘Develop advice’ – for example, ‘Investigate and promote best practice’.

Implementation
Objective 1
- Action 1.5 – The implementation of this action could be coordinated intersessionally (before 2019) via the Secretariat. A joint intersessional working group, which includes key Secretariat staff, could develop a draft communications strategy for consideration at the Brazil Plenary meeting and/or the joint session of the CC/SC at SC/68a.

Objective 2
- For all Actions – Funding sources for these actions must be identified. Contracting governments or whale watching industry are several possible sources, as is the IWC Voluntary Conservation Fund. WW urges the SWG to ‘think outside the box’ and identify other diverse sources, such as Volkswagen (which offers environmental grants).
- Action 2.2 – A dedicated person is needed to spearhead and coordinate the development and implementation of a research programme or plan. The best option would be for the IWC to contract with someone (understanding there are budgetary issues). The contract could be full- or part-time. Interested Contracting Governments could be approached for funding for this contract. Alternatively, if the first option is not possible or is too costly, this coordination could be done via an intersessional working group. A final option would be for the WW convenor and co-convenor to work intersessionally to coordinate the research programme (understanding intersessional availability maybe be limited).
- For the actual preparation of a proposed research programme (Action 2.2), a small intersessional workshop, with only three to four participants, could produce this product for consideration at an upcoming SC (timing dependent on funding). This workshop could be held successively with the next MAWI workshop (see MAWI workshop report), to reduce costs (the proposal workshop participants should also attend the MAWI workshop, as one task there is to identify specific locations to carry out research projects using experimental/useful modelling approaches).
- Action 2.4 – Funding for IPs who are experts in relevant social science disciplines to IWC meetings or workshops should be secured. These experts should participate either in the SWG or the WW – we recommend the latter, as there is more infrastructural support at this time for the SC and its sub-committees.
- In summary, short-term funding needs to be secured for social science IPs, a small-group workshop to develop specific research proposals, and a third MAWI workshop. A plan for meeting these financial needs should be developed, including identifying extra-IWC funding sources – without funding, these actions cannot be implemented.

Conclusion
Finally, and generally, we once again recommend improving the coordination between the SWG and the WW in the development and implementation of a Strategic Plan on Whale Watching. We understand this coordination has been difficult logistically and financially and that the Secretariat and the Commission are seeking to address this ongoing issue. We note that this pre-meeting was intended to improve coordination. It did provide the WW with an opportunity to contribute to the Strategic Plan but it did not completely achieve the goal of coordination, as a limited number of SWG members were able to attend the pre-meeting.

Appendix 3

TERMS OF REFERENCE FOR THE SUB-COMMITTEE ON WHALE WATCHING

The Whale Watching (WW) sub-committee reviewed its historical Terms of Reference in 2017 (SC/67a) and compared them with the 2011-2016 Strategic Plan of the Conservation Committee's Whale Watching Standing Working Group (SWG). As such, the following Terms of Reference for WW align with the Conservation Committee's SWG's Strategic Plan.

(1) Review and suggest scientific studies and methods of research on the effects of whale watching on target species and their habitats:
  (a) population-level effects including impacts on demographic parameters;
  (b) whale watching vessel strikes that may cause injury or mortality (with HIM);
  (c) underwater noise (with E);
  (d) behavioural responses that have potential biological significance;
  (e) impacts on fitness, health and stress (with E); and
  (f) impacts on cetacean habitats.

(2) Review and suggest research on the effectiveness of whale watching management regimes (i.e. mitigation measures) aimed at protecting cetaceans, such as whale watching guidelines or marine protected areas.

(3) Develop scientific monitoring protocols that maximise the identification of adverse impacts to cetaceans including:
  (a) data collection by whale watching operators or other platforms of opportunity that could be used to monitor possible impacts from whale watching activities on cetaceans;
  (b) science-based metrics for impact assessments that could be used to monitor or assess the sustainability of the whale watching industry in a location; and
  (c) monitoring plans that are cost effective and meet the needs of specific areas.

(4) Review and identify suitable areas to support the development and implementation of research protocols for long-term studies on the effects of whale watching on cetaceans.

(5) 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.

(6) Review whale watching industries and identify areas, emerging issues or cetacean populations of concern and/or highlight examples of demonstrated best practices.

(7) Identify research and issues of interest to the Conservation Committee. Assist and provide advice to the Conservation Committee with its work on whale watching when requested.

These Terms of Reference create a substantial workload for WW. One way to focus discussions at annual meetings would be to only deal with a subset of the terms in each year.

Annex O

Report of the Sub-Committee on Cetacean Stocks that Are or Might Be the Subject of Conservation Management Plans (CMPs)

Members: Walløe, Urbán (co-Convenors), Al Harthi, Al Jabri, Andriolo, Aoki, Bell, Bickham, Bjørge, Brandão, Brierley, Brownell, Burkhardt, Buss, Carroll, Castro, Cerchio, Charlton, Cipriano, Collins, Cooke, Coscarella, Crespo, Dalla Rosa, DeMaster, DeWoody, Di Tullio, Domit, Doniol-Valcroze, Donovan, Double, Elwen, Ferguson, Ferriss, Fortuna, Frey, Fruet, Galletti, Gonzalez, Haug, Hielscher, Hoelzel, Hubbell, Iñíguez, Irvine, Jackson, Johnson, Kim, E.M., Kim, E., Lang, Langerock, Leslie, Luna, Lundquist, Mallette, Marcondes, Mattila, McKinlay, Minton, Morita, Moronuki, Mwabili, Nakamura, Øien, Palka, Panigada, Parsons, Punt, Simmonds, Phillips, Pierce, Reeves, R., Reeves, S., Reyes Reyes, Ridoux, Ritter, Robbins, Rojas Bracho, Rose, Sampaio, Scordino, Scott, Slooten, Slugina, Smith, Stachowitsch, Strasser, Svoboda, Taylor, Terai, Thomas, Trujillo, Vermeulen, Wade, Wambiji, Weinrich, Weller, Willson, Yaipen-Llanos, Yoshida, Zerbini and Zharikov.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Walløe welcomed the participants.

1.2 Election of the Chair and Co-Chair
Walløe was elected Chair and Urbán 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 shown in Appendix 1.

1.5 Review of available documents
The documents available for discussion by the sub-committee included SC/67b/CMP01-21, SC/67b/SM03, SC/67b/SM05, Anon. (2017), SC/67b/SDDNA02, SC/67b/SDDNA03, Minton (2018) and Madhusudhana *et al*. (2018).

2. STOCKS THAT ARE OR MIGHT BE THE SUBJECT OF A CONSERVATION MANAGEMENT PLAN (CMP)

2.1 Stocks with existing CMPs

2.1.1 SE Pacific southern right whales

2.1.1.1 NEW INFORMATION
SC/67b/CMP08 reported on the first acoustic data for southern right whales in the Eastern South Pacific. Data were recorded on a Marine Acoustic Recording Unit (Cornell University) off the southwestern tip of Isla de Chiloe from 29 January to 17 June 2012. Spectrograms were visually audited for upsweep calls. Preliminary analysis of 46 of the 139 days yielded more than 4,000 right whale upsweep calls throughout 27 of the 46 days. Attribution of upsweep calls to eastern South Pacific southern right whales was supported by the simultaneous occurrence of upsweep calls and a visual sighting 28km North from the recording device on 21 April 2012. Acoustic recording provided valuable information about call parameters and patterns as well as documenting the presence of this critically endangered subpopulation.

2.1.1.2 PROGRESS WITH THE CMP
SC/67b/CMP18 reported on advances made with respect to 'Passive Acoustic Monitoring of the Eastern South Pacific Southern Right Whale, a Key to Improve Conservation Management Plan Outputs' (PAM project) that is supported by the Scientific Committee. The PAM project was initiated to facilitate the identification of potential breeding areas along the coast of Chile and Peru by obtaining acoustic recordings from a complete annual cycle. Only two locations per year (northwestern Isla de Chiloe in southern Chile and Valparaiso-San Antonio in central Chile) will be monitored because of the limited budget. Acoustic devices have been acquired and will be programmed to record continuously from 20Hz to 24KHz, allowing for a maximum of 76 days of continuous recording, and thus, maintenance of the equipment will need to be scheduled every two-three months. Permits have been obtained and the first deployment, which will occur using small boats, is scheduled for May 2018, weather permitting. An educational and capacity building programme will be implemented at the selected sites to support other priority actions under the CMP. To date, the PAM project has received wide support. However, additional funding is needed for 2019-20 to cover field costs at future locations and partially support data analysis.

In response to questions regarding southern right whale reproductive call behaviours it was noted that they produce enough vocalisations to allow for their detection, but it remains unknown if they engage in vocalisations specific to reproduction. The sub-committee agreed that acoustics are an efficient way to research species that lack data on basic life-history characteristics such as distribution. The sub-committee highlighted the importance of this effort to collect basic data on the critically endangered population and **advised** that the work continue such that the design of future sighting surveys will be more informed.

SC/67b/CMP20 reported on advances made towards implementing priority actions of the CMP for this population. Four confirmed sightings were made in 2017, three of which were opportunistic and did not include photographs or genetic samples. The fourth corresponds to the entangled and dead whale reported last year (Galletti Vernazzani *et al.,* 2017). Advances with respect to increasing sightings in reproductive areas were made through the PAM project (SC/67b/CMP18). Advances will be made with respect to increasing capacity to respond to entangled whales in 2018 under the 'First Bi-National Combined Capacity Building on Cetacean Stranding and Entanglement Response Training under the IWC Conservation Management Plan for Eastern South Pacific Southern Right Whale' that will be held in Lima, Peru. The training will have 31 trainees from Chile and Peru plus invited trainees from Ecuador, Colombia and Panama. Press releases and mainstream articles were released in the Chilean press and a logo was developed to raise citizen awareness. In the future, posters will be developed and distributed in 2018 along the coast of Chile and Peru to increase identification capacities of cetacean species, a community manager of social networks will be appointed for a period of six months and information sessions will be conducted in locations where the PAM project is implemented. Finally, the second coordination meeting of the CMP steering committee will be conducted between 22 and 23 August in Lima, Peru.

In response to a question of whether people were involved, the sub-committee was informed that in Chile citizens, including fishers, are encouraged to report sightings to a national sighting network and that posters will be distributed to increase their awareness of how they can help collect baseline information along the coast of Chile and Peru. The network is helpful in mapping the distribution of southern right whales. However, real-time sighting information is needed to collect photographic identifications and biopsies from sighted whales because deploying effort takes time and currently sighting information can be delayed by a few days. The sub-committee discussed additional avenues to increase sightings without requiring field work and **advised** that satellite imagery be explored for sighting whales in remote areas and to locate stranded whales. The sub-committee **commended** the efforts made to implement the CMP in Chile and Peru and **encouraged** their continued coordination.

In August of 2017 a local citizen sighted and documented southern right whales and calves in the Gulf of Penas, a remote area with limited access and the location of the largest mass stranding of baleen whales ever recorded (Häussermann *et al*., 2017). Following previous recommendations by the sub-committee to collect baseline data on this stock, a funding proposal was put forward to deploy efforts in this remote area in 2018 to collect photographic identifications and biopsies of whales.

The sub-committee noted that a line-transect survey would not likely successfully detect whales in this area even if they were present. The sub-committee **advised** the use of satellite imagery or passive acoustic monitoring devices to find the presence of whales in the area. The use of satellite imagery was also suggested for finding suitable land-based vantage points as the terrain can be treacherous.

Attention: SC, CC

*The Committee **reiterates** the importance of the CMP for the conservation of this critically endangered population of southern right whales in the southeastern Pacific, **welcomes** the progress being made in the implementation of the CMP by Chile and Peru and:*

*(1) **commends** the scientific work and international cooperation being undertaken for the PAM project and looks forward to receiving the results of the acoustic studies such that future sighting surveys will be more informed and baseline information on the location of breeding grounds will be available; and*
*(2) **advises** that satellite imagery be explored as an additional means, beyond acoustic data, to inform the design of sighting surveys because it is likely that line-transect surveys would not successfully identify whales in some areas even if they were present.*

2.1.2 SW Atlantic southern right whales

2.1.2.1 NEW INFORMATION

SC/67b/CMP05 reported on the abundance and continued increase of southern right whales around Península Valdés, Argentina, the main breeding and calving ground for this species in the western South Atlantic Ocean. The rate of increase decreased from nearly 7% in 2007 to 0.5% for total number of whales and 2.4% for number of calves in 2017. The decreasing trends in the rates of increases of total whales and calves (-0.732% and -0.376%, respectively) is thought to be the consequence of changes in distribution due to density-dependence processes, described in SC/67b/CMP02. Cow-calf pairs remained in high-density areas, while other groups (i.e. solitary individuals and breeding groups) moved to adjacent areas when the average density (whales per 5km segment) reached a proposed threshold of three whales per km^2. Higher densities were recorded given a specific location and time period (e.g. 15.87 whales per km^2 in the El Doradillo area during August-September), but the overall process was best described using an average density. SC/67b/CMP/01 reported on the increasing presence of whales in Golfo San Matías (North of the Península Valdés nursing area) between 2007 and 2017. Golfo San Matías is not a core area but it was area inhabited by southern right whales prior to commercial whaling. Solitary individuals were the most abundant type of whales observed in this recolonised area and peak densities were observed from late August to early September.

SC/67b/CMP06 summarised strandings of southern right whales near Península Valdés. Seven hundred and seventy-four strandings, informed by land and aerial surveys and opportunistic sightings, have been studied by the Southern Right Whale Health Monitoring Program since 2003. As in previous years, most of the animals stranded in 2016 and 2017 were newborn calves (14 of 15 and 27 of 28, respectively). The majority of the 2016 and 2017 strandings were recorded in Golfo Nuevo (87% in 2016 and 72% in 2017) and the remaining strandings were recorded in Golfo San José. More than half of the 2016 strandings occurred during the months of July and August (56%), whereas the majority (68%) of 2017 strandings occurred later in the year (September-October). A stranding of a live juvenile was reported on 24 June 2016 in Caleta de Los Loros, Río Negro Province, and the animal died seven days later. Following recommendations and research priorities of the Scientific Committee, the data collected from post-mortem examinations are currently being been used to inform two lines of research, nutritional condition (SC/67b/CMP03) and levels of stress hormones (SC/67b/CMP04).

SC/67b/CMP03 reported on the nutritional condition of southern right whale calves from 2003 to 2017 in the Península Valdés nursing area. Blubber thickness was measured at nine body locations from 345 dead calves. Additionally, lipid content of the external blubber layer was measured in 16 living and 67 dead calves of similar length. Blubber was not thinner in high mortality years compared to low mortality years, after controlling for calf length and state of decay, and lipid content did not vary among living and dead calves. Results do not support the hypothesis that the reduced transfer of maternal fat reserves to calves led to high calf mortality in 2003, 2005 and 2007-13 and are congruent with visual assessments made during necropsies that the majority of stranded calves do not appear to be emaciated, regardless of calf mortality levels. Blubber thickness was affected by calf length, increasing at all measured body locations as calves grew, but not by sex or stranding location.

The sub-committee discussed the distribution of mortalities in the Península Valdés nursing area, highlighting how more whales die in the South (Golfo Nuevo) compared to the North (Golfo San José) even though calves found stranded in Golfo Nuevo had thicker blubber than those found stranded in Golfo San José. It was hypothesised that calf mortality, which displays strong interannual variation (e.g. 113 deaths in 2012 and 14 in 2016) and is currently decreasing, could be related to what adults are experiencing in their feeding areas (Leaper *et al.,* 2006; Seyboth *et al.,* 2016).

SC/67b/CMP04 presented preliminary results regarding the levels of stress hormones (glucocorticoids, GCs) in baleen tissue, testing the hypothesis that stress from injuries due to kelp gull (*Larus dominicanus*) attacks negatively affects the physiological homeostasis of southern right whale calves in the Península Valdés nursing ground. Baleen tissue accumulates GC as it grows and the tip of the baleen represents that which was grown prenatally. Profiles of cortisol and corticosterone were measured using baleen from a North Atlantic right whale calf that died from a vessel strike and four southern right whale calves that were found dead with varying severity of wounds associated with attacks by kelp gulls. Prenatally grown baleen from all five calves exhibited a distinctive profile of elevated GCs that declined shortly before birth, similar to GC profiles of pregnant females. Profiles from the North Atlantic calf and the southern right whales calves with no or few gull wounds (*n*=2) indicate that calves have relatively low and constant GC levels throughout their life, while calves with high numbers of gull wounds (*n*=2) had pronounced elevations of GC levels in postnatal baleen followed by a precipitous decline shortly before death, a profile suggestive of prolonged chronic stress. The presence of GC in baleen may present a promising and valuable tool for defining the baseline physiology of calves and may prove useful for addressing conservation-relevant questions such as distinguishing acute from chronic stress and, potentially, determining cause of death.

The sub-committee highlighted the importance of this work, **commended** the research being done and **recommended** that more samples be analysed such that a full report can be presented in two years time. Currently, research grants and an adopt-a-whale programme act as the main funding sources for the collection and analysis of the baleen samples. The sub-committee **recommended** that a funding proposal be submitted to the committee to assist in the funding of future work. Beyond analysing additional baleen samples, future work could investigate: (1) food stress within the pre-birth range by comparing the body condition of cows to the presence of stress hormone levels in the baleen of their offspring; (2) differences in stress signals in areas with and without whale watching; (3) relationships between stress signals and stable isotopes; and (4) the time scale of stressful events by experimenting with where GCs are extracted from on the baleen samples. Additionally, members of the sub-committee highlighted how research in waters surrounding Península Valdés will be informative for other areas where whales experience unusual events that lead to increased stress.

The presence, or lack thereof, of kelp gulls and the frequency of gull attacks in the areas utilised by southern right whales was discussed by the sub-committee. Gull attacks are most frequent in the Península Valdés nursing grounds, however, current abundances of the surrounding kelp gull populations remain unknown. Future studies on the abundance of kelp gulls are planned but are dependent on funding. It was noted that kelp gulls that use human refuse as a food source have the potential to bring non-native pathogens to the whale populations and their own colonies and these pathogens could be an additional source of stress. However, previous research did not find that pathogens contributed to changes in calf-mortality rates (Marón *et al*., 2015; McAloose *et al*., 2016).

SC/67b/CMP17 presented results of a satellite-tracking study in Argentina on southern right whales that was initiated following the Committee's recommendation (IWC, 2017). Nine individuals were instrumented with location-only satellite tags in Golfo San Matías, Province of Rio Negro, which is located nearly 200km north of Peninsula Valdés, in October 2016 (*n*=1) and September 2017 (*n*=8). Tag duration varied between 46 and 204 days (average of 117 days). Movement patterns showed marked individual variation. Five whales moved southwards towards Golfo San José and Golfo Nuevo shortly after tagging, and four whales moved North along the coast of the Buenos Aires Province and Uruguay. Movement patterns in coastal areas suggest that whales in the northern Golfo San Matías visit areas further to the South in Peninsula Valdés, but interestingly only whales tagged in the former migrated northward along the coast. All whales eventually moved towards offshore waters of the outer continental shelf and shelf break along the coast of Argentina (from the La Plata River to the islands at 51°45'S/59°00'W). Most whales tracked until later in the season (after January) migrated southeast towards the islands at 54°26'00"S/36°33'00"W and the Scotia Sea, where they remained for the duration of their tags. Behavioural states estimated by a hierarchical space-state model indicate areas of potential foraging importance in the outer continental shelf off southern South America, the South Atlantic Basin, the Eastern Scotia Sea and the northern Weddell Sea. These findings are complementary to an ongoing long-term study to understand the migratory routes and destinations of southern right whales wintering off the coast of Argentina and, overall, reveal that this species inhabits vast extensions of the South Atlantic Ocean and visits multiple potential feeding areas each season.

The sub-committee **commended** those involved in the tagging study and the efforts put forth to provide valuable life-history information regarding southern right whales, which is imperative for their conservation. The sub-committee **recommended** that more results be presented in the future and that efforts be put forth to deploy more tags to increase the robustness of the study. Future results should include the amount of variability that can be attributed to annual variability or individual variability and differences in movements between cow-calf pairs and individual animals, where the latter is known to be true for humpback whales. Researchers noted that although whales were tagged across multiple years all tags were placed during September and October, and thus, the effect of season is not hypothesised to be a factor in movement difference. Five additional lines of research were **encouraged** by the sub-committee: (1) use re-sightings across years to investigate the long-term effects of tagging; (2) ecological niche analyses to provide inference on why whales use certain areas; (3) investigate the co-occurrence of tagged whales and krill fishers because visually they appear to be utilising the same habitat; (4) compare reproductive success, nutritional condition and mortality with that of other krill predators in Antarctica; and (5) compare high-resolution tagging data with information on ocean use to inform future ocean-use protocols.

SC/67b/CMP21 presented results of a land-based survey to assess seasonal distribution and relative abundance of southern right whales near Miramar, on the southwest coast of the Buenos Aires Province, Argentina. The recent expansion of right whales into this region has attracted the attention of the local community as a potential resource for tourism-related activities (e.g. whale watching). Systematic visual surveys conducted between April 2016 and March 2018 detected southern right whales from May to October with peaks in August and September. There was no significant difference (t=-0.37, df=10, p=0.72) between the average sighting rate in 2016 ($\bar{x}$=1.22±1.33) and 2017 ($\bar{x}$=1.70 ± 2.01). The continuation of this study will provide a better understanding of the habitat use and the factors that influence seasonal patterns of southern right whale occurrence off the coast of the Buenos Aires Province.

In discussion it was noted that the municipality decided to limit whale watching to land-based activities because of the seasonality of the sightings.

Attention: SC, G

*The Committee **reiterates** the importance of continued monitoring of the southwestern Atlantic population of southern right whales and research into threats that it may face. The Committee therefore:*

*(1) **commends** the work being undertaken on understanding the mortality events and **encourages** its continuation;*
*(2) **encourages** the researchers working on stress hormones in baleen to increase their sample size, consider suggestions for additional studies provided in Annex O (Item 2.1.2.1) and present a full report to the Committee when it becomes available; and*
*(3) **commends** the telemetry work, encourages its expansion and draws attention to additional analyses that could be addressed using the telemetry data suggested in Annex O (Item 2.1.2.1).*

2.1.2.2 PROGRESS WITH THE CMP

The overall objective of the southern right whale CMP is to protect their habitat and minimise anthropogenic threats to maximise the likelihood that the population will recover to healthy levels and recolonise their historical range. The CMP was adopted in 2012 per recommendations by the Scientific Committee following a mortality event in the Península Valdés area and was implemented in 2013 in Buenos Aires. Actions related to the CMP were summarised in two parts, actions developed in Argentina (SC/67b/CMP14) and actions developed in Brazil.

SC/67b/CMP14 summarised actions related to the CMP for the period June 2017-April 2018 in Argentina. Long-term monitoring continued, and efforts were made to share data across catalogues that provide complementary information. Stranding programmes were also continued, as well as 16hrs of aerial surveys that detected 12 carcasses of right whales in inaccessible areas. Surveys, telemetry research and acoustic monitoring were used to inform movements, migration routes and the location of feeding grounds. Research on the nutritional condition, presence of stress hormones and presence of pathogens was conducted in relation to attacks by kelp gulls.

Progress was also made towards the implementation of the CMP by institutions of Brazil. Long-term monitoring has been conducted through two sightings networks and a stranding network. Aerial surveys of the second largest breeding ground for this species have been conducted by the Project Baleia Franca/Instituto Australis since 1987. Two surveys were conducted in 2017 sighting 29 individuals in July and 49 individuals in September. The aerial sightings are being used to estimate abundance and population viability. Additional opportunistic sightings that sometimes include photos and biopsies have been recorded by the Humpback Whale Institute (Caravelas, Brazil) between 12°S to 20°S since 1993. Seventeen institutions monitor the range of the distribution for strandings and reported nine strandings along the South and southeast coast of Brazil over the last three years (available from Aquatic Mammal Monitoring System). Whale entanglement is mitigated through a protocol developed in 2006 by the Southern Right Whale Protected Area Management Council that provides assistance and guidelines to coordinate actions and a contingency plan involving institutions of the Santa Catarina State. In 2016, the Council organised a theoretical and practical training course that was part of the disentanglement program conducted by the 'Global Whale Entanglement Response Network'. Boat-based whale watching has been prohibited since 2015 and a government management plan for whale watching is being finalised. Lastly, the Project Baleia Franca/Instituto Australis and the R3 Animal are conducting environmental education activities to tourists and local communities focused on informing individuals about southern right whales.

SC/67b/CMP20 reported a stranding of a ship-struck SW Atlantic southern right whale in Punta Dungenes (52.3°S, 68.4°W), which is the second reported case of a collision between a ship and a right whale in Estrecho de Magallanes. These events raise concern of anthropogenic threats to the SW Atlantic population. The stranding highlighted the migratory nature of large baleen whales and emphasised the need for researchers working on southern right whales throughout their distribution to be informed about studies being conducted in all regions. The sub-committee **recommended** collaborative efforts should be initiated to facilitate a regional population assessment of this species in the future.

The sub-committee **commended** the efforts made by institutions in Argentina and Brazil towards implementing the CMP and **encouraged** their continued coordination. The sub-committee advised that future research investigate migratory destinations of the whales that winter off Uruguay and Brazil, which remain unknown.

Attention: SC, CC

*The Committee **reiterates** the importance of the CMP for the conservation of the southwestern Atlantic population of southern right whales. The Committee therefore:*

*(1) **welcomes** the progress being made in the implementation of the CMP reported by Argentina and Brazil and supports its continuation;*
*(2) **encourages** the continued cooperation and collaboration amongst range states towards implementing the CMP and addressing mortality evens in this population*
*(3) recognising the report of a ship-struck southwestern Atlantic southern right whale in the range of the southeastern Pacific (Estrecho de Magallanes), **encourages** co-operation with those involved in the southeastern Pacific CMP to facilitate a regional assessment; and*
*(4) **encourages** the research work identified under Item 2.1.2.1.*

2.1.3 North Pacific gray whales

2.1.3.1 REPORT OF THE INTERSESSIONAL WORKSHOP (SC/67B/REP07)

Donovan summarised the report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales (SC/67b/Rep07).

The workshop was held at the Granite Canyon Laboratory, California of the Southwest Fisheries Science Center from 28-31 March 2018. The primary tasks of the workshop were to: (a) review the results of the modelling work identified at the Fourth Workshop (IWC, 2018a) and SC/67a (IWC, 2018b); (b) examine the newly proposed Makah Management Plan (submitted by the USA) for gray whaling off Washington state; and (c) to update as possible (and develop a work plan for updating) the scientific components of the Conservation Management Plan (CMP) for western gray whales (WGW).

The workshop received new information on genetic studies using SNPs that it noted would be presented at the SD sub-committee at SC/67b for a full discussion but that also contributed to discussions of priority hypotheses for the workshop. In its discussions, the workshop had agreed that incorporating photo-identification data into genetic results will greatly improve interpretation of stock structure and movements and recommended that the genetic dataset should be examined comparing whales seen only once off Sakhalin with those whales seen in multiple years.

The workshop considered updated information from photo-identification studies including consolidation of WGW catalogues. It was pleased to hear that agreement had been reached for the two catalogues to be consolidated into one catalogue under the auspices of the IWC. The workshop reiterated the importance of the ongoing long-term research and monitoring programmes being conducted off Sakhalin Island. It also received information on a possible sighting of a gray whale off Korea – the first since 1977. It was noted that an updated paper would be presented to SC/67b (SC/67b/CMP11).

The major focus of the workshop related to finalising the specifications for modelling to enable results to be available for SC/67b. A new component included the need to incorporate the recently developed Makah Management Plan (SC/67b/Rep07) into the modelling framework; the Plan is somewhat complex and the workshop focus was on understanding the intended process and ensuring that it was parameterised in an appropriate way. A further key area was finalising the stock structure hypotheses to be given priority. After a review, the workshop concluded that Hypotheses 3a and 5a would form the reference cases but that sensitivity trials would be conducted for Hypotheses 3b, 3c, 3e and 6b. The full specifications for these hypotheses are provided in SC/67b/Rep07.

In summary, Hypothesis 3a assumes that whilst two breeding stocks (western and eastern) may once have existed, the western breeding stock is extirpated. Whales show matrilineal fidelity to feeding grounds, and the eastern breeding stock includes three feeding aggregations: PCFG, NFG and WFG. Hypothesis 5a assumes that both breeding stocks are extant and that the western breeding stock feeds off both coasts of Japan and Korea and in the northern Okhotsk Sea west of the Kamchatka Peninsula. Whales feeding off Sakhalin include both whales that are part of the extant western breeding stock and remain in the western North Pacific year-round, and whales that are part of the eastern breeding stock and migrate between Sakhalin and the eastern North Pacific.

Another important component of the trials relates to bycatches and considerable effort was put into capturing the uncertainty in past and future estimates of fishing mortality based upon the available data. Abundance estimates for the eastern North Pacific and the PCFG had been approved by the Committee last year (IWC, 2017) but new estimates for the western feeding group were presented by Cooke and these were used to develop estimates required by hypotheses. It was agreed that these would need to be confirmed at SC/67a by the Committee. Modifications were also made to the mixing proportions.

The sub-committee **thanked** the members involved in the workshop for the breadth of work that was produced and welcomes future work that is planned. The factors considered in the trials are provided in Table 1, whilst the final list of trials can be found in SC/67b/Rep07.

The workshop developed a workplan to enable results to be presented at SC/67b.

With respect to the Conservation Management Plan updates, the workshop noted that the work to complete the computing specifications, especially taking into account the new Makah Management Plan, meant that there was insufficient time to update the CMP sections, also recognising that this could best be completed after the

Table 1

Factors considered in the model scenarios. The **bold** values are the base-levels and the values in standard font form the basis for sensitivity analyses.

Factor	Levels
Model fitting related	
Stock hypothesis	**3a,** 3b, 3c, 3e, **5a,** 6b
$MSYR_{1+}$ (western)	As for WFG
$MSYR_{1+}$ (north)	**4.5%,** 5.5%, Estimated (common); estimate (separately)
$MSYR_{1+}$ (WFG)	**4.5%** Estimated (common); estimate (separately)
$MSYR_{1+}$ (PCFG)	2%, **4.5%,** 5.5%¸ Estimated (common); estimate (separately)
Mixing rate (migration season in BCBC	**0.28**, 0.17, 1.00
Immigration into the PCFG	0, 1, **2,** 4
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
Projection-related	
Additional catch off Sakhalin (mature female)	0, 1
Catastrophic events	**None,** once in years 0-49, and once in years 50-99
Northern need in final year (from 150 in 2014)	**340**
Struck and lost rate	**(0.1; odd-years; 0.5 even years),** 0.5 all years
Future effort	**Constant,** Increase by 100% over 100 years
Probability of a photo (struck and lost whales)	**0.8; odd-years; 0.6 even years**
Probability of a photo (landed whales)	**0.9**
Probability of false positive rate PCFG	**0.05,** 0.1
Probability of false negative rate PCFG	**0.25**
Probability of false positive rate WFG	**0.01**
Probability of false negative rate WFG	**0.041 (stock hypotheses 3a, 3c, 3e, 6b);** 0.040 (stock hypothesis 3b); **0.049 (stock hypothesis 5a)**
Probability of a sex assignment given a PCFG match	**0.81**

modelling results became available, ideally at SC67b. Attention was drawn to the updated seasonal maps that had been developed and participants were asked to send any comments or suggestions for modifications to Donovan and Reeves.

The workshop had recommended that the Scientific Committee considers establishing a small drafting group comprised of at least the national coordinators of the Memorandum of Co-operation, Reeves (IUCN) and Donovan be convened to meet intersessionally (e.g. at IUCN headquarters) to provide an updated version of the plan after SC/67b.

An important component of the CMP effort is the need for a stakeholder workshop (tentatively forecast to occur in 2019) that helps to finalise the CMP and develops a strategy for its implementation (IWC, 2017). The workshop, which would be co-sponsored by IWC, IUCN and the signatories to the Memorandum of Cooperation, will be broad-based and include representatives of national and local governments, industry (e.g. oil and gas, fishing, shipping and tourism), IGOs and NGOs. Objectives include: (1) review and updating of the CMP; (2) establishing a stakeholder Steering Group to monitor CMP implementation; (3) arrange for a coordinator of the CMP; and (4) establish a work plan and consider funding mechanisms to implement the actions of the plan. The IWC has a Voluntary Fund for Conservation, to which donations can be specifically directed towards the gray whale CMP and related work. It is expected, however, that after the first year of CMP implementation, range states will contribute the necessary funds to advance the conservation actions listed in the plan. The workshop welcomed the support offered by IUCN with respect to organising the stakeholder workshop.

In conclusion, Donovan thanked the participants for their excellent co-operation and constructive discussions, and in particular highlighted the extensive work of Punt and Brandon. A workshop is planned to complete the updating of the IUCN/IWN CMP and to develop conservation-related questions to be addressed within the rangewide population modelling framework, which is summarised above. The sub-committee also stressed the importance of range states to the Memorandum of Co-operation having national coordinators and encouraged those who have not (e.g. the Russian Federation and Mexico) to do so. The sub-committee **endorsed** the rangewide population modelling framework and looks forward to seeing results of research that uses it to address conservation related questions ahead of the proposed meeting to update the CMP.

2.1.3.1 REGIONAL STUDIES

2.1.3.1.1 MEXICO

SC/67b/CMP09 summarised 2018 winter gray whale abundance in Laguna San Ignacio and the Bahía Magdalena Complex. Counts of single adult whales (breeding males and females without calves) were similar to that observed in recent years, but counts of cow-calf pairs were lower than expected compared to previous winters. In Laguna San Ignacio counts of single adult whales reached a maximum of 160 on 15 February which was greater and earlier than the 120 single whales seen on 3 March 2017, but less than the 213 single whales observed on 12 February 2016. The highest count of cow-calf pairs (49) occurred late in the season on 23 March. Fewer cow-calf pairs were seen in 2018 than 2017 (107 pairs) and 2016 (124 pairs). Within the Bahía Magdalena Complex, counts were performed in three areas where gray whales aggregate, Canal de Santo Domingo in the North, Bahía Magdalena and Bahía Almejas in the south. Counts were overall lower than those observed in 2017 but similar to the low counts observed in 2016. Several factors may have contributed to the low counts of cow-calf pairs but they do not necessarily equate to a population decline and could be the result of a temporary shift in habitat use.

The sub-committee **commended** the effort needed to maintain this long time series of data and welcomed the discussions it generated regarding the comparison of counts across regions through time. Some cow-calf pairs used both areas in Mexico. Approximately 10-12 cow-calf pairs were still inhabiting Laguna San Ignacio at the end of the field season and were whales that were previously seen South in the Bahía Magdalena Complex. All of the whales that were in Laguna San Ignacio in February had left the area completely before the whales seen in Bahía Magdalena Complex were seen there. NOAA gray whale calf production surveys (late-March to May) off central California have reported normal counts at the mid-point of their 2018 survey but an additional four weeks of survey effort remain. Therefore, the level of calf production in 2018 as estimated by this survey has yet to be determined. An additional calf-count survey was **encouraged** for Punta Banda, Mexico, a high vantage point that extends well beyond the rest of coastline South of Ensenada, to address apparent differences in numbers of calves observed in the lagoons with counts from California.

2.1.3.1.2 RUSSIA

The sub-committee has had long-standing cooperation with the IUCN Western Gray Whale Advisory Panel (WGWAP) and there is a joint IUCN/IWC CMP for western gray whales. Reeves again summarised activities and findings of WGWAP since SC/67a (see Appendix 3). The two meetings of the Noise Task Force and one of the full Panel of scientists continued to focus primarily on developing a robust monitoring and mitigation plan for Sakhalin Energy's Piltun-Astokh 2018 seismic survey that will take place in June and July as ice conditions allow. The Sakhalin Energy survey is the only major noise-generating activity known to be planned for 2018, unlike 2015 when both Sakhalin Energy and Exxon Neftegas Limited conducted large-scale seismic surveys near the gray whales' Piltun feeding area. The following issues, among others, were addressed by the Panel over the past year: (a) the continuing (at least through 2016) decline of amphipod biomass in the Piltun feeding area; (b) the decision of the two oil companies to eliminate both benthic sampling and acoustic monitoring from their joint programme on gray whales; (c) the potential disturbance to whales caused by Exxon Neftegas Limited's 'sealift' operation involving transits by shallow-draft tugs and barges of the area near the mouth of the lagoon where gray whales concentrate (especially cows and calves) – an operation that began in 2016 and was completed in early July 2017; and (d) the ongoing threat of entanglement in salmon fishing gear along the Sakhalin coast (although no new entanglements of gray whales were observed or reported there in 2017).

The sub-committee again thanked Reeves and the other WGWAP members for this update and **recommended** further work be conducted to update the IUCN/IWC CMP, which is documented in the work plan (see Item 3.1).

SC/67b/CMP07 reviewed findings from 2017 field studies conducted by the Russian Gray Whale Project (formerly the Russia-U.S. Program) on gray whales feeding near Piltun Lagoon in the western North Pacific off Sakhalin Island, Russia. This research program provides a 20+ year time series (since 1997) that has served as the foundation for the assessments of the population (see SC/67b/ASI02). Photo-identification research in 2017 resulted in the identification of 46 individuals, including four calves and five previously unidentified non-calves. All cow-calf pairs observed in 2017 had previous sighting histories off Sakhalin. One of these females, first identified as a calf in 2005, had never been previously been observed with a calf. This new mother contributes to a total of 34 reproductive females that have been documented since 1995. The general distribution of gray whales in 2017 was similar to 2016 but 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 and recent barge and tug traffic in and out of Piltun Lagoon, remain a concern for the well-being of the population. 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 as is apparent by the recent entanglements of two whales, one in 2013 and one in 2016 (Weller *et al*., 2011). 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.

The sub-committee noted the continued risk of whales becoming entangled in gear placed by the salmon trap-net fishery and **encouraged** efforts be put forth to decrease this risk. Previously, an entanglement workshop was conducted and accounts of fishers' ability and willingness to disentangle whales from nets have been documented on social media (e.g. the successful disentanglement of a whale from a net on the east coast of Kamchatka in 2017), and thus, future efforts might include decreasing the likelihood of whales encountering nets.

Two papers (SC/67b/SDDNA02 and SC/67b/SDDNA03) relevant to the stock structure of North Pacific gray whales were discussed by the SD&DNA Working Group this year (Annex I under agenda item 4.2) and summaries of the discussions were presented to the CMP sub-committee. SC/67b/SDDNA02 used whole genome sequences generated from samples collected from gray whales off Sakhalin Island, Russia (n=2) and near Barrow, Alaska (n=1) to evaluate the demographic history of gray whales in the North Pacific. SC/67b/SDDNA03 utilised a panel of SNPs that were designed from these genome sequences to investigate the genetic diversity and population structure of the species. While the results of both studies are consistent with the presence of two stocks of gray whales in the North Pacific, they also provide additional information relevant to evaluating the potential for admixture between these two stocks. The sub-committee welcomed the work and **advised** that it continue such that further understanding of the stock structure hypotheses can be made.

2.1.3.1.3 JAPAN

SC/67b/CMP12 reported on the recent status of conservation and research on gray whales in Japan. During the period May 2017-April 2018, no anthropogenic mortalities were reported. Two opportunistic sightings of gray whales were made near Aogashima Island (approximately 360km south of Tokyo Bay) in May 2017 and February 2018. Photographs were taken of the sightings, which were sufficient for species identification but not for photo-identification.

The source of mortality cited for the 1996 occurrence was discussed. Some members noted that the whale bore multiple harpoons and lines (Brownell and Kasuya, 1999). The authors of SC/67b/CMP12 stated that the official records of the mortality are correct (i.e. entanglement).

2.1.3.1.4 KOREA

SC/67b/CMP11 reported on the possible occurrence of a gray whale off Korea. A video clip taken of what appears to be a gray whale was uploaded to YouTube in 2015. The whale in the video was swimming near a port in Samcheok located on the east coast of Korea. Work will continue to confirm the species identification

The stock to which the sighting potentially belongs to was discussed given that the Korean stock has a small probability of existence. The sub-committee **encouraged** the collection of genetic samples should subsequent sightings be made. Additionally, the sub-committee thanked the authors for their presentation and their willingness to investigate sightings from social media as a form of 'citizen science', particularly in areas with little to no information on critically endangered species.

Attention: CG-R, SC, G

The Committee ***reiterates*** *the importance of long-term monitoring of gray whales,* ***recommends*** *that range states support such work and welcomes the information provided this year. In particular, the Committee:*

(1) ***commends*** *the work in the breeding lagoons and urges its continuation;*
(2) ***encourages*** *an additional calf-count survey for Punta Banda to address apparent differences in numbers of calves observed in the lagoons with counts from California;*
(3) ***reiterates its concern*** *at the risk of whales becoming entangled in gear placed by the salmon trap-net fishery off Sakhalin Island, recognises that disentanglement training has occurred but* ***recommends*** *that measures be taken to reduce risk;*
(4) ***encourages*** *continued genetic analyses to assist in stock structure discussions especially related to a western breeding stock;*
(5) ***welcomes*** *the continued provision of information from Japan and* ***encourages*** *researchers to continue to collect as much information on sightings as possible, including, if feasible, attempting to obtain biopsy samples; and*
(6) ***welcomes*** *the information from Korea and the willingness of researchers to investigate sightings from social media as a form of 'citizen science', which can be especially valuable for areas where occurrence is very rare animals in areas with little to no information on critically endangered species.*

2.1.3.3 CMP

The short-term objectives for the gray whale CMP include: (1) update of the CMP in light of new information; and (2) develop conservation questions that can be assessed using the new modelling framework for gray whales rangewide.

Attention: C-A, CG-R, CC, SC

The Committee ***reiterates*** *the importance of the CMP for the conservation of western gray whales. The Committee therefore:*

(1) ***recognises*** *the tremendous work undertaken in the rangewide assessment and the value of the modelling framework developed;*
(2) ***agrees*** *that the next part of the process is to develop conservation-related questions and to use the framework to address these with a view to examining results at SC68a;*
(3) ***agrees*** *that a small group meeting attended by at least the national coordinators of the Memorandum of Co-operation on gray whales, Reeves, Punt and Donovan be held to: (a) draft an update to the CMP; and (b) identify conservation-related questions to be addressed by the modelling framework and to present results at SC68a;*
(4) ***requests*** *those signatories to the Memorandum of Co-operation on gray whales who have not yet named a national coordinator to do so promptly; and*
(5) ***supports*** *the holding of a stakeholder workshop in 2019 co-sponsored by the IWC, IUCN and the states that have signed the Memorandum of Co-operation and* ***welcomes*** *the valuable assistance of IUCN in organising the workshop.*

2.1.4 Franciscana

2.1.4.1 NEW INFORMATION

SC/67b/SM03 reported on franciscana (*Pontoporia blainvillei*) bycatch in FMA Ia. Artisanal fishers from five locals (*n*=240 small boats) operating in North Espírito Santo State, Brazil were interviewed and provided information on their gear, socioeconomic status and knowledge of cetaceans. Landings information was collected from July to December in Espírito Santo (*n*=1,206 landings) revealing that trawling and gillnets were responsible for 83.9% of the targeted catch, which was largely comprised of shrimp and dolphinfish (*Coryphaena hippurus*). Bycatch of nine Guiana dolphins (*Sotalia guianensis*) and one unknown species were reported, two of which were captured in trawl nests and eight in gillnets. Bycatch was most likely underreported because fishers often omit information fearing penalties if they report bycatch. Future work will include a mark-recapture experiment using objects made of bamboo and other materials to simulate carcasses to evaluate the proportion of carcasses that reach beaches and are observed. This research was supported by the Italian government through the Small Cetaceans Research and Conservation Fund and by the Brazilian Fund for Biodiversity through a request for franciscana research within FMA I to reduce bycatch in surveyed and non-surveyed areas. The request for proposals was initiated in part by the Brazilian government so as to verify the effectiveness of the Brazilian ordinance (IN) 12 (e.g. gill-net regulations and no-take zones), which was put in place to reduce the impact of fishing on protected species.

The sub-committee discussed the overlap of Guiana dolphins with franciscanas and it was noted that they inhabit the same areas and prey on similar food items, however, the diet of Guiana dolphins is more diverse than that of franciscana (Cremer *et al*., 2012). Fishers have some difficulty distinguishing between the species. Neither species is brought back to shore by fishers because of the fear of penalties and instead, bycatch is sometimes used as shark bait. Some bycatch is reported to the strandings network which report to the SIMMAM database, which has almost 3,000 records of stranded franciscana, spanning more than 35yrs (Barreto *et al*., 2004). Actions have been taken to promote collaboration with fishers regarding the use of bycatch-related carcasses for research purposes.

The sub-committee requested additional details regarding the methods of the mark-recapture experiment and **encouraged** efforts towards an observer programme rather than the proposed experiment. If the experiment does take place, the use of actual carcasses was **encouraged** to increase the robustness of the results. At present, experiments are being carried out using bamboo models of carcasses to simulate franciscana drift rates. It was suggested that the use of actual carcasses would be more informative. The use of alternative floating material is being used because of the lack of available franciscana carcasses in adequate numbers for statistical robustness. It is believed that drift rates from alternative floating materials will be more informative than drift rates inferred from other areas or other species because the continental shelf is very wide in this area, which leads to differences in currents and other factors that make extrapolating drift rates difficult.

SC/67b/SM05 reported results of a project funded by the IWC Small Cetacean Fund and the Government of Italy to assess the characteristics of the fisheries that operate within franciscana management area (FMA) Ib, assess the compliance of fishers with IN12 and evaluate areas with a high risk of franciscana bycatch. FMA I corresponds to the northern portion of the franciscana distribution, including the coasts of Rio de Janeiro and Espírito Santo, and is geographically isolated from FMA 2-4. The FMA includes two populations, FMA Ia and Ib, with bycatch being a threat to both populations. Quantitative estimates of fishery-associated mortality were not available for FMA Ia and are greater than 10yrs old for FMA Ib. The area from Atafona (São João da Barra) to Macaé, off Cabo de São Tomé, should be considered the main area of incidental captures of franciscanas within FMA Ib. The ports of Macaé, Tamoios (Cabo Frio) and Armação dos Búzios remain unsurveyed and it is recommended that they be surveyed in the future, particularly Tamoios because the fishery in this area coincides with a high diversity of marine megafauna. Aerial surveys highlighted the use of a narrow stretch of coast, from Barra do Furado (Quissamã) to Farol de São Thomé (Campos dos Goytacazes), by franciscana and Guiana dolphins. The area is also used by many gill-net boats. The compliance of fisheries with IN12 was found to be limited and it was poorly enforced in all visited locations. Conservation of the species could improve with the potential establishment of the Mosaic Jurubatiba Whale Heritage Site, for which franciscana is the flagship species.

The sub-committee emphasised the importance of research to determine the effectiveness of management procedures, such as was done in this study.

2.1.4.2 PROGRESS WITH THE CMP

SC/67b/CMP16 summarised activities developed under the CMP for franciscana and progress made during the period May 2017-April 2018 in Argentina and Brazil. The overall objective of the CMP, which was submitted by Argentina, Brazil and Uruguay (IWC/66/CC11) and adopted in 2016, is to protect franciscana habitat and minimise anthropogenic threats, in particular bycatch. The CMP includes seven high priority actions, ranging from public awareness and capacity building through research to mitigation. Coordination with Uruguay to implement the CMP in this area will be initiated during a workshop that will take place in May 2018 with the main stakeholders. The CMP is funded by the IWC CMP Voluntary Funds and the World Wildlife Fund.

The sub-committee highlighted the usefulness of the actions included in the CMP towards future assessments of the status of franciscana, which is imperative for determining the fruitfulness of conservation efforts. Previously, it was difficult to gather information from the Buenos Aires fisheries because of the lack of unionisation and the difficulty in placing observers on unregulated vessels. An 'informal' observer programme was established in 2004 and observers currently cover 30% of the fleet. Additionally, remote electronic monitoring, which has been considered a financially viable alternative in other areas, was noted as a potentially viable option for monitoring bycatch in industrial fisheries in the area.

Attention: CG-R

The Committee ***emphasises*** *the importance of the CMP for the conservation of franciscana in the waters of Argentina, Uruguay and Brazil. The Committee therefore:*

(1) ***stresses*** *the value of the actions included in the CMP towards future assessments of the status of franciscana, which is imperative for determining the effectiveness of conservation efforts;*
(2) ***recommends*** *that research be undertaken to estimate the abundance of franciscana dolphin off Buenos Aires province, Argentina; and*
(3) ***recommends*** *that additional research be undertaken to determine the effectiveness of management measures, such as that described in SC/67b/SM05 for other ports (e.g. Macaé, Tamoios (Cabo Frio) and Armação dos Búzios – the fishery in Tamoios coincides with a high diversity of marine megafauna).*

2.2 Progress with identified priorities

2.2.1 Humpback whales in the Northern Indian Ocean including the Arabian Sea

SC/67b/CMP10 summarised the progress of the Arabian Sea Whale Network (ASWN), an informal collaboration among researchers, consultants and conservation and governmental organisations interested in the conservation of whale populations throughout the Northern Indian Ocean. Since the formation of the network in 2015, ASWN partners have expanded their efforts to collect data on whale distribution and conservation status. Research coming from Oman, Pakistan, India and Sri Lanka was presented to several sub-committees at this meeting.

The ASWN provides a mechanism with which to disseminate and advocate for research. A membership database is regularly updated to facilitate the exchange of information. A website (*arabianseawhalenetwork.org*), which is receiving increasing levels of visitor traffic from around the world, is also regularly updated. Increased awareness has led to improved reporting of incidental sightings of humpback whales throughout the Arabian Sea through social media and other means. Additionally, awareness efforts led by WWF Pakistan and other conservation bodies led to the declaration of two marine protected areas in Pakistan, Astola Island and Indus Canyon.

The Arabian Sea humpback whale is considered the network's flagship species and many activities and communications are focused on this endangered, isolated and non-migratory population of whales. For example, the regional online data platform, created in collaboration with Wild Me (*wildme.org/*) and Flukebook (*Flukebook.org*), uses artificial intelligence to match photographic identifications of humpbacks but also acts as a sightings database for all species (SC/67b/PH03). A four-day workshop was held to introduce members to and evaluate the data platform as well as update members on research activities in Oman, India, Pakistan and Sri Lanka (Minton, 2018). One of the ASWN's primary goals is to promote and foster research and collaboration in previously unsurveyed parts of the Arabian Sea humpback whales' suspected range. Ensuring the continuation of research efforts in Oman, where surveys have been conducted since 2000, is another primary goal. A whale tagged during one of these surveys increased media attention for Arabian Sea humpback whales after it crossed from the Sultanate of Oman to the southern tip of India and back again. Information regarding the whereabouts of the whale were shared across the network and led to the mobilisation of a research team in India to search for the whale.

A Concerted Action for Arabian Sea humpback whales under the Convention on Migratory Species (CMS; Anon, 2017) was drafted and passed with wide support from Arabian Sea range states at the CMS COP in October 2017. It is hoped that this Concerted Action can be implemented in conjunction with a CMP as a means to translate current research and conservation efforts and plans into concrete, government-supported conservation measures in Arabian Sea humpback whale range states.

The sub-committee **commended** efforts to develop the Concerted Action and was impressed by the level of detail it includes, already covering many of the elements required for a CMP. The sub-committee **advised** that efforts are continued to work toward a joint CMS-IWC CMP.

The sub-committee supported the collaborative efforts of members of the ASWN and **encouraged** that they continue. Specifically, it was **advised** that capacity building for local scientists be continued such that surveys can be deployed in suspected areas of humpback whale distribution and data can be gathered for future assessments. A future funding source will be needed to support coordination of the network and regional-level conservation efforts. The funding provided by Emirates Wildlife Society-WWF and WWF Pakistan for the first two years of ASWN coordination has run out.

The observer programme initiated by WWF-Pakistan (SC/67b/CMP05) that utilises crew members of tuna gill-net vessels operating along Pakistan's coast as observers now includes 85 vessels and reported 95 whale sightings in 2017. Sightings included 42 sightings of Arabian Sea humpback whales, 13 sightings of blue whales, five sightings of Bryde's whales, four sightings of sperm whales, one sighting of killer whales and 30 sightings of baleen whales that could not be identified to species level due to lack of adequate photographic or video documentation. The data revealed three main areas of concentration, between Ormara and Phor, southwest of Karachi and the Indus Canyon area. Sightings were concentrated during the months of November and December, but it is not clear if the timing of the sightings reflects the seasonal distribution of whales or the seasonal nature of fishing effort. Targeted surveys across seasons were **encouraged** to tease apart questions related to the timing of whale distributions. These sightings represent the first wide-ranging effort to collect sightings since whaling in this area and can be used to inform further studies including where to perform dedicated whale surveys. Placing university educated observers on fishing boats in this area is limited because of the basic conditions and, instead, efforts have been placed towards educating the crew on being observers even though sighting whales will always remain a task secondary to fishing. The sub-committee **advised** that the crew-based observer programme, for which funding expires in December 2018, be continued.

SC/67b/CMP13 reported on the research of Arabian Sea humpback whales in Oman. Small-vessel surveys were conducted over two weeks in November 2017 with the primary objective of instrumenting humpbacks with satellite tags and the secondary objective of assessing whale health using unoccupied aerial systems (drones). Five satellite tags were deployed, transmitting for 18 to 120 days. Four of the tagged whales remained over the continental shelf of central and southern Oman. The fifth was tracked for four months from the Gulf of Masirah (site of tagging), across the Arabian Sea to Vasco de Gama, down to the Gulf of Manar off the southern tip of India and back to the site of tagging. This satellite track represents the first record of the movement of a whale across the Arabian Sea and helped to fill gaps in knowledge about their spatial ecology and could inform locations for future research in unsurveyed areas. Analysis of high resolution images from the unoccupied aerial systems provided length-width relationships of seven whales, blow samples from three whales and coverage of tattoo-like skin disease measured on the dorsal surface (0.5-75.0%) from seven whales. The unoccupied aerial systems appeared to be successful in measuring whale health and the authors advised that it be integrated as a standard feature of future research to develop long-term metrics for tracking whale health. The authors recommend continuing the investigation of broader spatial ecology of whales across the region whilst mitigation efforts in areas of known critical habitat are expedited.

The sub-committee **commended** the efforts put forth to collect information on the movement of humpback whales in the Arabian Sea. The outcome of this work has important implications for future assessments of stock definitions and status. The sub-committee **advised** that the tagging efforts continue and that body condition results be compared to images from unoccupied aerial systems used in other study areas (e.g. North Atlantic) and that body condition be compared to stock C in the southern hemisphere, which is the presumed source population for whales in the Arabian Sea. It also **advised** that photographs be assessed for evidence of anthropogenic threats.

The sub-committee received information on preliminary estimates of survival and current abundance of Arabian Sea humpback whales. Estimates were based on capture histories of 85 whales photo-identified between 2000 and 2016 off the coast of Oman. The analyses demonstrated that sightings of whales in each field season are generally few and that sample sizes varied widely within each season. Sampling coverage in recent years has been geographically restricted to two known ‘hotspots’ and was focused on finding whales to deploy satellite tags. This non-random approach violates some key assumptions of mark-recapture models and analyses need to account for sources of heterogeneity (Hammond, 1986; Hammond *et al*., 1990; Barlow *et al*. 2011). The estimates of abundance, which were not submitted to the ASI subcommittee, were believed to be negatively biased. Future research will apply spatially-explicit mark-recapture and survival models to this dataset. The subcommittee **advised** that an intersessional working group (e-mail correspondence) be formed to review the methods thereby increasing the robustness of the estimates that will be provided to the ASI sub-committee in SC/68a.

SC/67b/CMP15 provided an update on recent sightings (n=2) and strandings (n=8) of baleen whales (humpback whales, Bryde’s whales and blue whales) from the West coast of India (including the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu). An 8m humpback whale was reported on 21 September 2017 as a live stranding and was refloated by fishermen only to strand dead two days later. There are some suspicions that this whale was not an Arabian Sea animal based on external appearance. An offshore survey was conducted as part of a marine mammal research methods workshop carried out by NOAA (lead), the University of Washington and the Government of India in December 2017. Additionally, the report summarised the presence of whales, and fishers’ perceptions about baleen whales elicited during an extensive campaign to conduct interviews among fishing communities in south Gujarat, Goa, Kerala and Tamil Nadu. Seven humpback whale ‘hotspots’ were identified, which appear to be most commonly used during the months of January to March, though sightings were reported from September onwards. In particular fishermen in Kanyakumari (West Tamil Nadu) reported seeing and hearing humpback whales, usually in the months of January to March. Three fishermen described freeing whales from gillnets. Future work will include systematic small-boat surveys that will include hydrophones as well as more intensive interview surveys in southern states.

In discussion it was noted that there were many more strandings than sightings recorded, which is likely the result of increased effort. The sub-committee concurred with the SH sub-committee that the collection of genetic information would be helpful for identifying stock structures within the area.

SC/67b/CMP19 reported on geographic and temporal (2011-13) variation in songs of humpback whales in the Arabian Sea collected from long-term acoustic monitoring off the coast of Oman. Samples were compared with samples collected from Reunion Island and Comoros Islands in the southwest Indian Ocean during the same period, as well as song fragments collected off the west coast of India in 2011. Songs from the Arabian Sea and the southwest Indian Ocean were distinct, with no evidence of shared phrases, suggesting isolation given our current understanding of humpback song dynamics. Song fragments recorded off western India were composed of two phrases present in the Oman song, suggesting continuity across the Arabian Sea. Songs of southwest Indian Ocean animals from multiple simultaneous singers were recorded off the coast of Oman over a 25-day period in August 2012 (Boreal summer, Austral winter); it was concluded that SW Indian Ocean whales moved into the Arabian Sea and this may be more common than currently thought. There was no indication of the adoption of song material and no cultural diffusion of songs into the songs of the Arabian Sea. The low level of temporal variation (i.e. no change over the three years) shown by the Arabian Sea males along with the lack of adoption of the southwestern Indian Ocean song material confirms the uniqueness and distinct nature of the Arabian Sea population. Behavioural isolation mechanisms were hypothesised to inhibit its mixing with other populations, thereby exacerbating its vulnerability to conservation threats. Continued monitoring is **advised** to: (1) detect the movement of southwestern Indian Ocean animals in Boreal winter; (2) document potential diffusion of southwestern Indian Ocean song; (3) provide a long-term dataset for the comparison of songs across Oman, Pakistan and India to assess continuity of whales in the Arabian Sea; and (4) evaluate the unprecedented temporal stasis of song in the Arabian Sea.

Madhusudhana *et al*. (2018) reported on humpback whale songs recorded off Grande Island, Goa, India (central west coast of India in the eastern Arabian Sea) during March 2017. Six of the nine days had fragments of humpback songs and were used to conduct a unit-based analysis to describe the acoustic characteristics of the units (notes) and make inferences regarding phrases. However, no phrase, theme or song-level analysis was presented due to the limitations of this sample scheme (1min every 15mins).

These recordings are informative for the designation of population boundaries, particularly given the knowledge that humpback whale songs tend to be more mutable than other baleen songs. For example, songs of whales in the southern Pacific Ocean almost always originate in Australia in the West and move to Polynesia in the East. The acoustic recordings of humpback whale presence off the West coast of India and the recorded movement of a satellite tag from Oman to the West and South coasts of India highlight the apparent importance of habitat off the coasts of India. The sub-committee **advised** that the research programme continue to monitor songs of Arabian Sea humpback whales and that additional data sets be acquired (e.g. Mahanty *et al*., 2015; Madhusudhana *et al*., 2018) for comparison purposes, particularly from the southwest Indian Ocean, if they exist, to further evaluate the continuity in song and population connectivity.

Attention: G, SG-A, SG-A

The Committee ***welcomes*** *the new information from the region on this critically endangered population and* ***commends*** *the researchers for their initiatives and collaborative efforts. In light of the information presented, the Committee:*

(1) ***encourages*** *the collection of genetic information which would be helpful for identifying stock structures within the area;*
(2) ***recommends*** *future use of unoccupied aerial systems to: (i) measure whale health; (ii) develop long-term health metrics; (iii) compare body condition to stock C in the southern hemisphere, which is the presumed source population for whales in the Arabian Sea; and (iv) assess for evidence of anthropogenic threats;*
(3) ***commends*** *the use of fishing crew as observers and* ***advises*** *that the crew-based observer programme continue; however, it is not clear if the timing of the sightings reflects the seasonal distribution of whales or the seasonal nature of fishing effort and* ***encourages*** *future research to tease apart timing of the distributions using targeted surveys;*
(4) ***advises*** *that capacity building for local scientists be continued such that surveys can be deployed in suspected areas of humpback whale distribution and data can be gathered for future assessments;*
(5) ***advises*** *the continuation of monitoring songs of Arabian Sea humpback whales and that additional data sets be acquired comparison purposes, particularly from the southwest Indian Ocean, if they exist, to further: (i) detect the movement of southwestern Indian Ocean animals in Boreal winter; (ii) document potential diffusion of southwestern Indian Ocean song; (iii) provide a long-term data set for the comparison of songs across Oman, Pakistan and India to assess continuity of whales in the Arabian Sea; and (iv) evaluate the unprecedented temporal stasis of song in the Arabian Sea; and*
(6) ***recommends*** *that an intersessional working group (e-mail correspondence) be formed to review the methods used for the preliminary estimates of abundance thereby increasing their robustness because the non-random survey approach violates some key assumptions of mark-recapture models.*

Attention: C-A, S

The Committee ***reiterates*** *its serious concern about the status of the endangered Arabian Sea humpback whale population and the anthropogenic threats it faces. It therefore:*

(1) ***commends*** *efforts to develop the Concerted Action under the CMS, noting that it already covering many of the elements required for a CMP;*
(2) ***stresses*** *the value of regional initiatives and* ***encourages*** *range states to explore future sources of collaboration; and*
(3) ***encourages*** *continued efforts between range states and Secretariats to work toward a joint CMS-IWC CMP.*

2.2.2 Other species/populations

2.2.2.1 MEDITERANEAN FIN WHALE CMP

Donovan reported on the endorsement of the concept of a CMP by ACCOBAMS for fin whales in the Mediterranean Sea. A small group will meet in the summer of 2018 to draft an outline of the CMP that will be presented at SC/68a. Additionally, ACCOBAMS is seeking information regarding the conservation status of additional species to determine if they too should have CMPs.

2.2.2.1 SOUTH AMERICAN RIVER DOLPHIN

Advice was sought regarding the development of a CMP for South American river dolphins, which currently have several actions plans endorsed by various range states. A draft CMP will be discussed at SC/68a.

Attention: CG-A

The Committee ***advises*** *that the applicable range states work towards developing a draft CMP for presentation at SC/68a.*

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3. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

3.1 Work plan and intersessional groups

The sub-committee's work plan and intersessional groups are found in Table 2.

Table 2

Summary of the work plan for the sub-committee on conservation management plans (CMP).

Item	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	2020 Annual Meeting (SC/68b)
Southeast Pacific right whales		Review progress on scientific aspects of CMP	Review progress on scientific aspects of CMP
South Atlantic right whales		Review progress on scientific aspects of CMP	Review progress on scientific aspects of CMP
Gray whales	Workshop		
Franciscana		Prepare for in-depth review	
Humpback whales in the northern Indian Ocean	Abundance estimates (email)	Review progress on the development of a CMP	Review progress on scientific aspects of CMP
Mediterranean fin whales		Review progress on the development of a CMP	
South American river dolphin		Review progress on the development of a CMP	

Table 3

Summary of budget requests for the 2018-20 period from the sub-committee on conservation management plans (CMP). For an explanation of each project see main text.

Title	2019	2020 (£)
Abundance estimates of the franciscana dolphin off Buenos Aires province, Argentina	7,140	
Workshop to complete the updating of the IUCN/IWC CMP on western gray whales and to develop conservation-related questions to be addressed within the rangewide population modelling framework	10,500	
Passive acoustic monitoring of the Eastern South Pacific southern right whale, a key to improve conservation management plan outputs	13,700	16,800
A quantitative assessment of threats to Arabian Sea humpback whales using existing photographic and UAV data	9,500	
Population dynamics of southern right whales at Península Valdés, Argentina: the influence of kelp gull lesions on the health, changes in increase and mortality rates in the context of a density-dependent process	19,130	

3.2 Budget requests

The sub-committee thanked the members of the small working group for prioritising the submitted budget requests. Five requests for funding (Table 3) were prioritised. The small working group agreed that a better process for evaluating the funding proposals is needed in the future. Perhaps most importantly, adequate time is needed for their review which would be facilitated by their early submittal.

4. ADOPTION OF REPORT

The report was adopted at 10:03 on 3 May 2018. The sub-committee thanked Walløe and Urbán for their excellent Chairmanship and Johnson for excellent rapporteuring.

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Appendix 1

AGENDA

1. Convenor's opening remarks
2. Election of Chair
3. Appointment of Rapporteur(s)
4. Adoption of Agenda
5. Review of available documents
6. Stocks that are or might be the subject of Conservation Management Plans (CMPs)
   - 6.1 Stocks with existing CMPs
     - 6.1.1 SE Pacific southern right whales
     - 6.1.2 SW Atlantic southern right whales
     - 6.1.3 North Pacific gray whales
     - 6.1.4 Franciscana
   - 6.2 Progress with identified priorities
     - 6.2.1 Humpback whales in the northern Indian Ocean including the Arabian Sea
     - 6.2.2 Other species/populations
8. Work plan and budgets requests for 2019-20
9. Adoption of report

Appendix 2

ACTIONS RELATED TO THE SOUTHWEST ATLANTIC SOUTHERN RIGHT WHALE CMP IN BRAZIL (2016-18)

Juliana Di Tullio and Fábia Luna, SWA-SRW-CMP coordinators

Collaborators: Karina Groch, Luciano Dalla Rosa, Eduardo Renault-Braga, André Barreto, Elisa Seyboth, Camila Domit, Eduardo Secchi, Miguel Iñiguez Bessega, Alexandre Zerbini, Milton Marcondes, Salvatore Siciliano, Pedro F. Fruet.

Monitoring Actions

MON-01: Ensure long-term monitoring of abundance, trends and biological parameters.

(1) The Project Baleia Franca/Instituto Australis, located in the State of Santa Catarina, southern Brazil, has been monitoring southern right whales with aerial surveys since 1987. This area holds the largest breeding ground of this species in Brazil and the second largest in the western South Atlantic. This area includes an Environmental Protection Area (EPA; Brazilian Government Federal Decree of 14 September 2000) created to manage human activities in a region that is key to the life cycle of southern right whales in Brazil. Results of the aerial surveys conducted in 2016 and 2017 are presented as follows.

- The total area monitored varies between years, but the area between Cabo de Santa Marta (28°36′35″S) and Pântano do Sul beach (27°53′00″S) is regularly monitored since 1997. Surveys followed a parallel trajectory at a distance of approximately 500m from shore and at a tentative altitude of 300m. The search for individuals was restricted to a stripe of up to 1500m from shore, where mother-calf pairs concentrate. The number of whales varied over time, particularly after 2002. In 2006 the maximum number of whales was recorded (194). However, in the last three years this number has dropped. In 2017, two aerial surveys were conducted and accounted for 29 individuals in the end of July and 49 in September. The number of individuals for the 2017 season was the lowest ever since 2002. In Rio de Janeiro there were no sightings of right whales during the last two years. And in Sao Paulo state only one sighting was recorded in 2017.
- Ongoing studies include estimation of abundance and other population parameters using Pollock's robust design applied to photo-identification data collected between 2004 and 2017, and a population viability analysis as part of a PhD by Renault-Braga.

(2) The Humpback Whale Institute, located in Caravelas, southern Bahia State, has being gathering data on southern right whales in the northern limit of the species distribution (between 12°S to 20°S) in the Southwest Atlantic. These data are being collected opportunistically during dedicated humpback whale surveys since 1993 and will continue in the next years. Photo identification data and biopsies samples are also collected. Calves are frequently observed and one female has shown some site fidelity to Abrolhos Bank, being resighted in two different years in a period of five years.

MON-02: Enhance existing strandings networks including the capacity for undertaking post-mortems.

The distribution range of the species has been monitored for strandings by 17 institutions. For example, Universidade Federal do Rio Grande-FURG has systematically surveyed the Rio Grande do Sul State coast since 1969 (Prado *et al.,* 2016). In 2011 the Brazilian Government established a National Stranding Network, which gathers stranding data for the SIMMAM web database (*www.simmam.acad.univali.br/site/).* In this database for the last three years, there were only nine strandings of right whales reported in South and southeast coast of Brazil.

MIT-01: Development of a regional entanglement response strategy.

In 2006, the Southern Right Whale Protected Area Management council developed a 'Stranding and Disentanglement of Marine Mammals Protocol' providing assistance and guidelines to coordinate actions and a contingency plan involving different institutions of Santa Catarina State. In 2016 and 2017, the council organised a theoretical and practical training course for 81 participants from 25 institutions. The 2016 training was part of the disentanglement program conducted by the 'Global Whale Entanglement Response Network' (IWC).

MIT-04: Develop mitigation actions to address major threats identified through the Sensitivity Atlas.

Boat-based whale-watching tourism in the Southern Right Whale Protected Area has been prohibited since 2015. The protocol to evaluate whale watching activities effects in whales behaviour is being developed by researchers of the protected area management council, Instituto Australis and Universidade Estadual de Santa Catarina. The necessary government management plan for whale watching is also being finalised.

PACB-01: Develop a strategy to increase public awareness. The Project Baleia Franca/Instituto Australis based in Itapirubá Norte (Santa Catarina) and the R3 Animal (NGO), in Florianópolis, are engaged in environment education activities to tourists and local communities focusing on southern right whales.

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Seyboth, E., Groch, K.R., Dalla Rosa, L., Reid, K., Flores, P.A.C. and Secchi, E.R. 2016. Southern right whale (*Eubalaena australis*) reproductive success is influenced by krill (*Euphausia superba*) density and climate. *Sci. Rep*. 6. [Available at: *https://dx.doi.org/10.1038/srep28205*].

Abstract: Annual data on southern right whale number of calves obtained from aerial surveys carried out between 1997 and 2013 in southern Brazil, where the species concentrate during their breeding season, was analysed. The number of calves recorded each year varied from seven to 43 ($x = 21.11$, ± 11.88). Using cross-correlation analysis the response of the species to climate anomalies and krill densities was examined. Significant correlations were found with krill densities ($r = 0.69$, $p = 0.002$, lag 0 years), Oceanic Niño Index ($r = -0.65$, $p = 0.03$, lag 6 years), Antarctic Oscillation ($r = 0.76$, $p = 0.01$, lag 7 years) and Antarctic sea ice area ($r = -0.68$, $p = 0.002$, lag 0 years). Results suggest that global climate indices influence southern right whale breeding success in southern Brazil by determining variation in food (krill) availability for the species. Therefore, increased frequency of years with reduced krill abundance, due to global warming, is likely to reduce the current rate of recovery of southern right whales from historical overexploitation.

Renault-Braga, E.P., Groch, K.R., Flores, P.A.C., Secchi, E.R. and Dalla Rosa, L. 2018. Area usage estimation and spatio-temporal variability in distribution patterns of southern right whales, *Eubalaena australis,* of southern Brazil. *Mar. Ecol.* 39(3):e12506.

Abstract: Area usage was estimatedand investigated spatio-temporal variability in distribution patterns of southern right whales, *Eubalaena australis*, in southern Brazil, from aerial surveys conducted between 2003 and 2012. Results showed considerable variation in area usage within and among years, and recent changes in the general distribution pattern of right whales in this calving ground. The number of right whales sighted in these aerial surveys was also modelled as a function of environmental, physiographic and temporal variables using generalised additive models, including a hurdle model (Renault-Braga, ms.). The models confirm September as the month of peak abundance in the region, and suggest, for example, that southern right whales prefer areas with low declivity and depths shallower than 10m. In addition, the Ribanceira/Ibiraquera region stood out as the area with higher numbers of whales in the region.

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Appendix 3

PROGRESS REPORT ON IUCN WESTERN GRAY WHALE ADVISORY PANEL (WGWAP) WORK FROM JUNE 2017 TO MAY 2018

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/67a, there has been no major change in the Panel's composition and remit although a continued reduction in budget has required further scaling back the Panel's range of activities. Reeves and Donovan continue as Co-Chairs and Cooke and Weller as members. As indicated last year (Reeves ***et al.***, 2018), IUCN and Sakhalin Energy agreed to extend the WGWAP project for a third five-year term from 1 January 2017.

As last year, three formal meetings took place between June 2017 and May 2018:

(1) 13th meeting of the Noise Task Force (NTF-13), November 2017 in Amsterdam, Netherlands;
(2) 18th meeting of the Panel (WGWAP-18), November 2017 in Moscow, Russia; and
(3) 14th meeting of the Noise Task Force (NTF-14), March 2018 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].

[1] *http://www.iucn.org/western-gray-whale-advisory-panel.*
[2] *http://www.iucn.org/western-gray-whale-advisorypanel/recommendations.*

The objectives of the 2017 and 2018 NTF meetings were: (1) evaluate updates on Sakhalin Energy's proposed 2018 Piltun-Astokh seismic survey; (2) agree and finalise a Monitoring and Mitigation Plan (MMP), a preparatory work plan and field protocols for that survey, including consideration of data collection and aspects of future analyses; and (3) review and reconsider previous non-seismic acoustic Panel recommendations. For its 2018 survey, Sakhalin Energy plans to have a standard streamer-type component covering a part of the Piltun and Astokh fields (area 350km²), expected to last 3-4 weeks). In addition, an ocean bottom node (OBN) survey of 1.5-2 weeks duration is planned, covering an area of about 50km^2 immediately surrounding the Company's two platforms (Piltun-A and Piltun-B). The OBN survey uses receivers deployed on the ocean floor rather than towed behind the seismic vessel. Unlike the situation in 2015 when both Sakhalin Energy and Exxon Neftegas Limited (ENL) conducted large-scale surveys near the whale feeding area, back to back, the Sakhalin Energy survey is the only major noise-generating activity known to be planned for 2018. It is expected to begin as early in June as ice conditions allow and to be completed no later than the end of July.

In its WGWAP-18 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), and of the Joint Programme, which have been collecting photo-identification data since 1995 and 2002 respectively. These data have been used as input into regular population assessments submitted to WGWAP and to the IWC Scientific Committee. Abundance and trend estimates have been generated that correspond to the various stock structure hypotheses developed for the Scientific Committee's range-wide assessment. These are presented to this meeting in document SC/67b/ASI02.

Related to these assessments and following a long-standing recommendation of the Panel endorsed by this Committee, agreement in principle has been reached to the concept of developing a combined photo-identification catalogue and related database, inclusive of information from Sakhalin and Kamchatka. This combined catalogue and database would be held under the auspices of the IWC and follow the guidelines specified in its time-tested data sharing agreement and the new guidelines for databases and catalogues.

The Panel reiterated its concern about an apparent long-term decline in amphipod biomass in the Piltun feeding area because of the implications for gray whale feeding. This decline appeared to be continuing at least through 2016. The Panel's recommendation that the joint research programme of the two oil and gas companies (Sakhalin Energy and Exxon Neftegas Limited [ENL]) explore the nature and causes of this apparent decline in greater detail and report on findings has yet to be implemented although ENL representatives have reported that a major study is nearing completion and will be submitted for publication shortly. No benthic sampling was conducted during the 2017 open-water season and none is planned for the 2018 season. The two companies have substantially scaled back their gray whale field efforts since 2016, eliminating both the benthic sampling and acoustic monitoring components and the future of the entire programme is uncertain.

At the last two WGWAP meetings, representatives of ENL provided summaries of the monitoring and mitigation work conducted in association with a major 'sealift' operation to support construction of a temporary offloading facility within Piltun Lagoon. The operation, which involved numerous transits by shallow-draft tugs and barges of the area near the mouth of the lagoon where gray whales concentrate (especially mothers and calves), was completed in early July 2017. The Panel concluded in the report of its November 2017 meeting that this had been 'a well-planned and well-executed operation'.

The issue of gray whale entanglement in fishing gear continued to be a significant concern and the document prepared for WGWAP and submitted last year (SC/67a/HIM17) has been revised and submitted for journal publication. No new entanglements were observed and reported at Sakhalin in 2017.

The ongoing collaboration between IWC and WGWAP in 2017-18 led to further progress with model testing of gray whale stock identity hypotheses, and the updating and revision of scientific components of the IUCN/IWC Western Gray Whale Conservation Management Plan to be implemented under the IWC Memorandum of Cooperation among the participating range states. Preparations for a western gray whale stakeholder workshop co-sponsored by IWC and IUCN are underway – it is anticipated to be held in early 2019.

REFERENCES

Reeves, R., Weller, D., Cooke, J. and Donovan, G. 2018. Progress report on IUCN Western Gray Whale Advisory Panel work from June 2016 to May 2017. *J. Cetacean Res. Manage.* (*Suppl.*) 19:361.

Annex P

Amended Draft to 'Annex P

Draft prepared by 'Annex P intersessional advisory group'

CHAPTER #: PROCESS FOR THE REVIEW OF SPECIAL PERMIT PROPOSALS AND RESEARCH RESULTS (FORMER 'ANNEX P')

[new section] The text on the Process for the review of Special Permit proposals and research results - commonly known as 'Annex P' - was first agreed at in 2008 (IWC, 2009, JCRM 11: 398-401). It was then modified (a) in 2014 (2015, JCRM 16: 349-53) with respect to data access (JCRM 16: 82), (b) in 2015 (2016, JCRM 17: 409-14) in light of Resolution 2014-5[1], (c) in 2016 (2017, JCRM 18: 403-9) based on the experience and suggestions from two Expert Panel reviews (2017, JCRM 17: 507-54) and (d) in 2018 (2018, JCRM 18 in press) in light of Resolution 2016-2[2].

~~**Process for the Review of Special Permit Proposals and Research Results from Existing and Completed Permits**~~

#.1 Submission of new proposals

New proposals should be submitted to the Chair of the Scientific Committee ***and the Secretariat*** at least **six months** prior to the Annual Scientific Committee Meeting (hereafter Annual Meeting) at which they are to be discussed. ***Commission Resolution 2016-2 requests Contracting Governments to submit proposals for new special permit programmes, at least six months before the Annual Meeting held in the same year as a Commission meeting.*** Proposers may request that the proposal remains confidential[3]. The proposal shall be structured in the manner given below. In order to ensure that any proposal provides information on each of the items needed for review by the Expert Panel, the Proponent will perform a self-assessment using the checklist provided in Appendix 1. A completed checklist will be attached to the proposal.

Structure of the proposal:

(1) Objectives of the study

The objectives should:

(a) be quantified to the extent possible;

(b) be arranged into two or three categories, if appropriate: 'Primary', 'Secondary' and 'Ancillary';

(c) include a statement for each primary proposal as to whether it requires lethal sampling, non-lethal methods or a combination of both; and

(d) include a brief statement of the value of at least each primary ***proposed*** objective in the context of the three following broad categories objectives:

- (i) improve the conservation and management of whale stocks,
- (ii) improve the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part; and/or,
- (iii) test hypotheses not directly related to the management of living marine resources;

(e) include, in particular for d(i) and d(ii), at least for each primary objective, the contribution it makes to *inter alia*:

- (i) past recommendations of the Scientific Committee;
- (ii) completion of the Comprehensive Assessment or in-depth assessments in progress or expected to occur in the future;
- (iii) the carrying out of *Implementations* or *Implementation Reviews* of the RMP or AWMP;
- (iv) improved understanding of other priority issues as identified in the Scientific Committee Rules of Procedure (IWC, 2006, p.180); and
- (v) recommendations of other intergovernmental organisations.

(2) Methods[4] to address objectives:

(a) field methods, including:

- i. species, number (and see (c) below), time-frame, area;
- ii. sampling protocol for lethal aspects of the proposal; and
- iii. an assessment of why non-lethal methods, methods associated with any ongoing commercial whaling, or analyses of past data have been considered to be insufficient;

(b) laboratory methods;

[1] ***https://iwc.int/resolutions***
[2] ***Resolution 2016-2 was adopted by a simple majority vote, with objections by some Contracting Governments.***
[3] ***The SC is required to review SPs (Schedule para 30) and thus confidential can only refer to not being publicly available, i.e. outside the Commission.***
[4] Where novel or non-standard methods are proposed, sufficient information must be given to allow these to be ~~properly examined~~ ***reviewed by the Expert Panel.***

(c) analytical methods, including estimates of statistical power where appropriate; ~~and~~

(d) time frame with intermediary targets***; and***

(e) information pertinent to the terms of reference of the Expert Panel to assist them in their review, including specification of the data[5] used in developing that information.

(3) Assessment of potential effects of catches on the stocks involved:

(a) a summary of what is known concerning stock structure in the area concerned;

(b) the estimated abundance of the species or stocks, including methods used and an assessment of uncertainty, with a note as to whether the estimates have previously been considered by the Scientific Committee; and

(c) provision of the results of a simulation study on the effects of the permit takes on the stock that takes into account uncertainty and projects: (1) for the expected life of the permit (i.e. n years); (2) for situations where the proposal is assumed to continue for: (a) a further n years; (b) a further $2n$ years; and (c) some longer period of years since the start of the proposal.

(4) A note on the provisions for co-operative research:

(a) field studies; and

(b) analytical studies.

(5) A list of the scientists the proposers intend to send to the intersessional review Workshop

#.2 The review process

Resolution 2016-2 'requests Contracting Governments to submit proposals for new special permit programmes, at least six months before the Annual Scientific Committee Meeting held in the same year as a Commission meeting'. The Committee notes that, if possible, earlier submission by the proponents (e.g. 9 months prior to a Scientific Committee meeting) would be welcomed since this would allow more time for Expert Panel or Committee members to request data and undertake analyses, where appropriate. Some possible general scenarios for the review process are shown in Table 1 (see also Table 1 in Appendix 4 for full details) for new proposals and Table #.2 (see also Table 2 in Appendix 4 for full details) for periodic and final reviews.

#.2.1 Intersessional Expert Panel Workshop

The initial review of a new proposal, or periodic and final reviews, shall take place at a small Expert Panel Workshop with a limited but adequate number of invited experts (who may or may not be present members of the Scientific Committee). A limited number of scientists associated with the proposal should attend the Workshop in an advisory role, primarily to present the proposal and answer points of clarification. It is important that the composition of the Expert Panel (hereafter 'the Panel') is considered balanced and fair (see below). The choice of experts shall be made by the Chair, Vice-Chair and Head of Science in conjunction with a Standing Steering Group (SSG) established by the Chair at an Annual Meeting, with special emphasis on the field and analytical methods provided in the proposal and estimation of the effect of catches on the stocks(s). The SSG shall be selected by the Chair, Vice-Chair and Head of Science, such that it represents an appropriate range of experience and expertise within the Scientific Committee. ***The SSG has normally comprised the four most recent Scientific Committee Chairs[6].*** The selection process for the Panel shall occur in the manner described below. ~~A schedule of events for the review process is shown in Table 1.~~

Table 1

Possible scenarios for reviewing new proposals (Annual Meeting refers to the Annual Scientific Committee Meeting)

Options		Stage 1	Stage 2	Stage 3	Timeframe
Option 1	Proposal submitted prior to Annual Meeting held in Commission year	Submitted 6 or 9 months prior to Annual Meeting	Workshop held 100 days prior to the Annual Meeting	Review completed at Annual Meeting following workshop	6 or 9 months
Option 2	Proposal submitted prior to Annual Meeting held in Commission year	Submitted 9 months prior to Annual Meeting	Workshop held 140 days prior to the Annual Meeting	Review completed at Annual Meeting following workshop	9 months
Option 3	Proposal submitted prior to Annual Meeting held in non-Commission year	Submitted 6 or 9 months prior to Annual Meeting	Workshop held 100 days prior to the Annual Meeting	Review completed at Annual Meeting following workshop or prior to Commission	6 or 9 months/ 18 or 21 months
Option 4	Proposal submitted prior to Annual Meeting held in non-Commission year	Submitted 9 months prior to Annual Meeting	Workshop held 140 days prior to the Annual Meeting	Review completed at Annual Meeting following workshop or prior to Commission	9 months/ 21 months

[5]Any data used in these evaluations should be specified and made available for the review. Where such data arise from catches taken under prior special permits, the procedures described in section #.2.3.1 will apply.
[6]Chairs with a clear conflict of interest are excused from this duty.

#.2.1.1 CHOICE OF EXPERT PANEL

The Scientific Committee Chair, Vice-Chair and Head of Science will take into account the comments made in IWC (IWC, 2010; 2011; 2012), recognising that some of these issues reflected availability of selected Panel members. In particular, the goal is to obtain a full, fair, independent, balanced and objective review and careful efforts will be made to avoid any inferences of potential ***or perceived*** conflicts of interest. Emphasis will be given to including outside experts (non-Scientific Committee members) but the precise balance will depend on the subject matter. The Panel membership will include experts in the relevant field and/or analytical methods used in the Permit activities which may include those that are not specialists in whales.

All members of the Panel shall sign a written agreement of confidentiality on the discussion and outcome of the review. The confidentiality agreement will terminate when the Report of the Expert Panel is received by the Scientific Committee and it becomes public (about 60 days after the workshop).

#.2.1.2 FORMAT AND OBSERVERS

Following discussions at IWC (2012), at the discretion of the Chair, Workshops will normally follow a format of two types of sessions: (1) open sessions where a limited number of scientists associated with the proposal present the proposal and answer questions; and (2) closed sessions where only the Panel members discuss the proposal and develop the report. There may be a final closing session for the Panel to ask further questions of clarification. For these reasons, Workshops will be held at a venue convenient for proponents.

Scientific Committee members are allowed to attend the same sessions, as the proponents, as observers (they will be referred to as observers from here on). These observers will not normally participate in discussions unless invited to do so by the Chair under special circumstances[7] (*cf* the rule for observers to the Committee's meeting). ***Whenever possible, restricted live streaming of the open sessions will be set up as to allow remote participation by approved observers.*** All observers***, including remote participants,*** shall sign a written agreement of confidentiality on the discussion and outcome of the review. The confidentiality agreement will terminate when the Report of the Expert Panel is received by the Scientific Committee and it becomes public (about 60 days after the workshop).

In addition, any Scientific Committee member may submit reviews or analyses relevant to the review for consideration of the Panel following the agreed time frame outlined in Tables ***#.1*** and ***2 in Appendix 4***.

The admittance of observers has logistical implications for the hosting of the Workshop. The importance of hosting the Workshop in a venue convenient for the proponents is important given the alternating open and closed sessions. Deadlines for registering interest in attendance are given in Tables ***#.1*** and ***2 in Appendix 4***.

#.2.2 Procedure for review of new proposals

A tentative timetable for the review of a new Special Permit proposal is given in Table 1 and Table 2 in Appendix 4.

The Chair shall circulate the proposal to the Vice-Chair, Head of Science and SSG, normally within **1 week** of receipt.

~~(1)~~ The SSG shall examine the proposal and in particular the field and analytical methods and, normally within **2 weeks**, suggest names for consideration for the Panel (if these experts are not members of the Committee, they shall include a rationale for their choice) and the suggestions will be available to all SSG members.

~~(2)~~ The Chair, Vice-Chair and Head of Science will develop a proposed final list (with reserves) for consideration by the SSG within **2 weeks** and begin the process of establishing the time and venue of the Workshop taking into account the availability of the proposed experts and the scientists associated with the proposal.

~~(3)~~ The SSG will send final comments within **1 week**.

~~(4)~~ The Chair, Vice-Chair and Head of Science will agree a final list (with reserves); the proposal (with a note concerning any restrictions) will be sent to the selected experts and reserves - the process thus far will have taken about six weeks ~~since~~ ***once*** the proposal has been received.

The Workshop will take place at least **100 days** before the Annual Meeting. In addition to the selected experts it will include at least one of the Chair, Vice-Chair and Head of Science, one of whom shall chair the Workshop.

#.2.2.1 TERMS OF REFERENCE OF THE EXPERT PANEL WORKSHOP FOR THE SCIENTIFIC REVIEW OF NEW PROPOSALS ~~[complete section modified at SC/66a]~~

The primary objective of ~~the Scientific Committee and~~ the Expert Panel Workshop ***(and later the Scientific Committee)*** will be to review the proposal in the light of the stated objectives following the checklist provided in Appendix 1. Recall, the three broad categories of objectives 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 particular, the review shall:

[7]Note: this has been interpreted as allowing observers who submit papers with substantial analyses to be allowed to present them in a similar manner to proponents who present papers e.g. through a short PowerPoint presentation (*cf* the 2014 JARPA II review).

(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[8];

(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[9];

(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[10], and in particular, evaluate whether sample sizes and the spatial and temporal scales[11] 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[12];

(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~~ ***deemed relevant*** by the Scientific Committee.

The Panel may develop priority recommendations and optional recommendations or suggestions. In its report, the Panel will clarify which are 'priority recommendations' and which are 'optional recommendations' or suggestions, and for each recommendation will include the order of priority of the task, identify who is expected to take action (e.g. proponents, Scientific Committee), and propose a timeline for completion.

#.2.3 Procedure for periodic and final reviews

Commission Resolution 2016-2 requests Contracting Governments to submit review documentation for ongoing and completed special permit programmes, at least six months before the Annual Meeting held in the same year as a Commission meeting. For ongoing research without a defined final year, a periodic review shall take place in accordance with either the advice provided under Item (5) of the Workshop to review new proposals or on the advice of a periodical (normally around six years) review Workshop and taking into account the availability of the proponents. The final review shall normally take place no later than three years after the final take under Special Permits. The periodic and final reviews shall be based on documents provided by the proposers and other members of the Scientific Committee **six months** before the Annual Meeting at which the Workshop report is to be presented. In order to ensure that any periodic/final report provides information on each of the items needed for review by the Expert Panel, the Proponent will perform a self-assessment using the appropriate checklist ***(Appendix 2). Guidelines for the outline of final reports are contained in Appendix 3***. A completed checklist will be attached to the report. Information on the analytical methods likely to be used in documents presented to the Workshop that might assist with the selection of appropriate experts shall be circulated **nine months** before the Annual Meeting.

A tentative timetable for periodic or final reviews is given in Table 2.

The Chair shall circulate the information on the analytical methods to the Vice-Chair, Head of Science and SSG, normally within **1 week** of receipt.

~~(1)~~ The SSG shall examine the information available on the field and analytical methods and, normally within **2 weeks**, suggest names for consideration for the Expert Panel Workshop (if these experts are not members of the Committee they shall include a rationale for their choice) and the suggestions will be available to all SSG members.

~~(2)~~ The Chair, Vice-Chair and Head of Science will develop a proposed final list (with reserves) for consideration by the SSG within **2 weeks** and begin the process of establishing the time and venue of the Workshop taking into account the availability of the proposed experts and experts associated with the proposal.

~~(3)~~ The SSG will send final comments within **1 week**.

[8]Include whether the programme objectives are sufficiently defined to enable an evaluation of the likely contribution of the different data sets to objectives.

[9]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.

[10]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.

[11]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.

[12]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.

~~(4)~~ The Chair, Vice-Chair and Head of Science will agree a final list (with reserves); the proposal (with a note concerning any restrictions) will be sent to the selected experts and reserves - the process thus far will have taken about 6 weeks since the information on analytical methods has been received.

~~(5)~~ The full ***set of*** documents ***(e.g., proposal, background information, etc.)*** shall be ~~circulated~~ ***made available to the Scientific Committee by the Secretariat*** no later than 6 months before the Annual Meeting.

~~(6)~~ Responses to those documents shall be submitted no later than one month before the Workshop.

The Workshop will take place at least **100 days** before the Annual Meeting. In addition to the selected experts it will include at least one of the Chair, Vice-Chair and Head of Science, one of whom shall chair the Workshop.

Table 2

Possible scenarios for periodic and final reviews (Annual Meeting refers to the Annual Scientific Committee Meeting).

Options		**Stage 1**	**Stage 2**	**Stage 3**	**Timeframe**
Option 1	Review scheduled for Annual Meeting held in Commission year	Submitted 6 or 9 months prior to Annual Meeting	Workshop held 100 days prior to Annual Meeting	Review completed at Annual Meeting following workshop	6 or 9 months
Option 2	Review scheduled for Annual Meeting held in Commission year	Submitted 9 months prior Annual Meeting	Workshop held 140 days prior to Annual Meeting	Review completed at Annual Meeting following workshop	9 months
Option 3	Review scheduled for Annual Meeting held in non-Commission year	Submitted 6 or 9 months prior to Annual Meeting	Workshop held 100 days prior to Annual Meeting	Review completed at Annual Meeting following workshop or prior to Commission	6 or 9 months/ 18 or 21 months
Option 4	Review scheduled for Annual Meeting held in non-Commission year	Submitted 9 months prior Annual Meeting	Workshop held 140 days prior to Annual Meeting	Review completed at Annual Meeting following workshop or prior to Commission	9 months/ 21 months

#.2.3.1 AVAILABILITY OF DATA RELEVANT TO THE PERIODIC OR FINAL REVIEW

The ***Scientific Committee shall decide on*** ~~decision to~~ hold***ing*** periodic or final reviews ~~shall take place~~ two Annual Meetings prior to the ~~Specialist~~ ***Expert Panel*** Workshop. **Two months** before the Annual Meeting prior to the ~~Specialist~~ ***Expert Panel*** Workshop, the proponents of the programme shall submit a preliminary[13] data description document that explains the data that will be available for the Workshop. That document will:

(a) outline the data that will be available, including by broad data type (e.g. sighting data, catch data, biological data***, genetics data***): the years for which the data are available; the fields within the database (e.g. for sightings data: species, date, time, school size; visibility; perpendicular distance etc.); the sample sizes;
(b) provide references to data collection and validation protocols and any associated information ***or metadata*** needed to understand the datasets or to explain gaps or limitations;
(c) where available, provide references to documents and publications of previous analyses undertaken of data collected during the programme; and
(d) contact details of who should be approached if ~~scientists~~ ***Scientific Committee members*** have questions regarding the data before submitting formal applications for them.

Members of the Scientific Committee and participants in the Expert Panel Workshop who wish to submit papers to the specialist Workshop should submit applications to the data holders in the data holders' data access protocol format via the Data Availability Group (DAG[14]). In accordance with a trial agreement reached at the 2014 Annual Meeting (IWC, 2015a, p.82), such requests should normally be developed for submission as a document to the Scientific Committee **four weeks** before the Scientific Committee meeting[15]. This will allow other members of the Scientific Committee (including the data holders) to consider alternative analyses. The final data description document and the data themselves shall be available in electronic format **one month** after the close of the Annual Meeting. The timetable is displayed in Table **#.**~~1~~***2***.

Applications for the access to data for the purpose of periodic or final review, should follow the recommended approach of Procedure B of the IWC SC Data Availability Agreement (IWC, 2004). In order to facilitate this process, requests submitted in advance (see above) will then be considered at the Scientific Committee Meeting. Initially, data requesters, data owners and the DAG will discuss the request early in the Meeting. This will provide opportunities for clarification and possible amendment of proposed studies. If there is disagreement over the acceptability of the request (e.g. whether analytical methods

[13]By use of the word 'preliminary', it is recognised that some information (e.g. exact sample sizes) may not be available but the document will be broadly complete including approximate sample sizes.

[14]In order to enable the DAG to function if one or more members are unavailable, the usual membership of the DAG (Chair, vice-Chair and Head of Science) will be expanded to include the Chair of the Special Permit working group and the Chair(s) of the most relevant sub-group(s). Any decisions (which should be few) can be taken with a quorum of three.

[15]While Committee members can still submit requests to the DAG after the meeting in accordance with the timeframe in the Tables, they should be aware that the process may take a longer time and the request may not be accepted.

are appropriate and within the terms of reference of the Workshop), this will be referred by the DAG to the appropriate sub-committee or an *ad hoc* group. In the hopefully rare event that disagreement remain***s*** after the sub-group discussion, then the DAG will be authorised to take the final decision on the request. Data forms and requests can then be signed/authorised at the meeting. Data owners will provide the data in a prompt manner (usually within two weeks of the data becoming formally available one month after the close of the Annual Meeting) in accordance with the agreed protocols[16]. ***The DAG will report annually back to the Scientific Committee on the outcome of all requests.***

#.2.3.2 TERMS OF REFERENCE OF THE EXPERT PANEL WORKSHOP FOR PERIODIC AND FINAL REVIEWS UNDER SPECIAL PERMITS ~~[complete section modified at SC/66a]~~

The primary objective of the Scientific Committee and the Expert Panel Workshop will be to review the scientific aspects of the research under Special Permits in the light of the stated objectives. In particular, the review shall:

(1) for continuing programmes, evaluate whether the design and implementation of the programme, including sample sizes, continue to be reasonable in relation to achieving the programme's stated research objectives[4,6];

(2) for continuing programmes, evaluate whether the temporal and spatial scale of lethal sampling continues to be reasonable in relation to the programme's stated research objectives[5,6,7], and non-lethal alternatives are not feasible[17] to either replace or reduce the scale of lethal sampling proposed:
   (i) compare sample sizes from the original research proposal and the achieved sample sizes, and assess the effect of any discrepancy on the ability to achieve the programme's stated research objectives.
   (ii) assess whether, in light of developments since the commencement of the programme, the objectives of the programme could be achieved by non-lethal means, or whether there are reasonably equivalent objectives that could be achieved non-lethally[5,18,19].

(3) assess the extent of the programme's scientific output, and whether this is appropriate in light of the stated research objectives and the time elapsed;

(4) assess the degree to which the programme coordinated or continues to coordinate its activities with related research projects[8,13];

(5) evaluate other contributions to important research and information needs that were not part of the original set of objectives of the research program;

(6) in the case of continuing reviews, provide advice on:
   (i) whether the programme continues to have specified intermediate targets that would allow for adequate review of progress in relation to programme objectives.
   (ii) evaluate how well the initial, or revised, objectives of the research have been met to date, and for broad categories of objectives 1 and 2 ***(see section 2.2.1 first paragraph)***, include the extent ~~to which~~ ***of*** progress ~~has been~~ regarding improvements in the conservation and management of whales.
   (iii) practical and analytical methods, including for non-lethal methods, that can improve research findings relative to stated objectives.
   (iv) appropriate sample sizes to meet the stated objectives, especially if new methods are suggested under item (ii).
   (v) effects on stocks in light of new knowledge on status of stocks.
   (vi) when future review(s) should be convened.

(7) consider any other ~~relevant~~ matters ~~as decided~~ ***deemed relevant*** by the Scientific Committee; and

(8) for final reviews, evaluate how well the initial, or revised, objectives of the research have been met, and for broad categories of objectives 1 and 2, include the extent to which results have led to demonstrated improvements in the conservation and management of whales.

As for the review of new proposals, the Panel may develop priority recommendations and optional recommendations or suggestions. In its report, the Panel will clarify which are 'priority recommendations' and which are 'optional recommendations' or suggestions and for each recommendation will include the order of priority of the task, identify who is expected to take action (e.g. proponents, Scientific Committee), and propose a timeline for completion.

#.3 Reports of Workshops (applies to new proposals, periodic reviews and final reviews)

The Chair ***of the Panel*** is responsible for the level and nature of participation of the scientists involved in the proposal, which should be limited to: (1) providing information to the invited experts in addition to that contained in the proposal or research

[16]Collaborative studies are encouraged and have produced valuable results in the past but are not mandatory. For clarification, it is noted that the reference to offers of co-authorship within the DAA is not intended to allow the data owners to veto presentation of an analysis but rather to ensure that they are offered co-authorship which they may accept or decline. If data owners do not agree with analyses then they have time to respond with papers of their own given the DAA timeline.

[17]In this case, the interpretation of 'feasible' or 'related' will be left to the opinions of the reviewers.

[18]For broad categories of objectives 1 and 2, where 'reasonably equivalent' is defined as having similar likely benefits in terms of improvements to conservation and management of whales.

[19]Evaluate the merits of replacing lethal sampling with non-lethal sampling, considering developments in non-lethal sampling protocols since the onset of the research program.

results; and (2) answering questions posed by the invited experts. The ~~specialist group~~***Panel*** should attempt to reach consensus on the individual issues referred to above, but where this is not possible, the rationale behind the disagreement should be clearly stated in the Workshop report. The final report of the Workshop shall be completed at least 80 days prior to the Annual Meeting and will be made available to the proponents for comments in line with the timetables provided (Tables 3 and 4).

#.3.1 Circulation to the Scientific Committee

The original special permit proposal, *or* the original result documents from ongoing or completed special permit research, the report of the Expert Workshop, and any revised permit proposal (following the agreed protocol), ~~or~~ any revised results, ***or any comments*** from the Contracting Government shall be submitted to Scientific Committee members no later than **40 days** before the Annual Meeting. The revised proposal, *or* revised results, will also be submitted to the members of the ~~specialist group~~***Expert Panel*** and they will be invited to submit joint or individual comments on that revision to the Annual Meeting.

#.4 Discussion at the Scientific Committee

The Scientific Committee will provide its evaluation on proposals of Special Permits programmes to the Commission in years when the Commission meets (regardless of when the review commences). The report of the Expert Panel Workshop will be discussed but not amended by the Scientific Committee. The comments of the Scientific Committee will be included in the Scientific Committee report. The original proposal and any revised proposal, the Expert Panel Workshop report (and subsequent comments on any revised proposal), and the Scientific Committee report will then be submitted to the Commission and become publicly available in accordance with the Commission's Rules.

#.5 Chronology and reference documents

A chronology and reference documents of past or expected ***Special Permit E***xpert ***Panel*** ~~('annex p')~~ workshops to review new, ongoing or completed special permit programmes ***is given in Table 3***.

Table *3*~~1~~

Past or expected ***Special Permit*** Expert ***Panel*** ~~('Annex P')~~ Workshops to review new, ongoing or completed special permit programmes.

Subject	Status	References
JARPN II (~~ongoing programme~~ ***periodic review***)	Completed in 2009	IWC (2010a; 2010b)
Icelandic (final review)	Completed in 2012	IWC (2014a)
JARPA II (~~ongoing programme~~ ***final review***)	Completed in 2014	IWC (2015a; 2015b)
NEWREP-A ***(new proposal review)***	Completed in 2015	IWC (2016a)
JARPN II (~~ongoing programme~~ ***final review***)	Completed in 2016	IWC (2017)
NEWREP-NP (new proposal review)	***Completed in 2017***	***IWC (2018)***
NEWREP-A (periodic review)	***Expected in 2021***	***N/A***
NEWREP-NP (periodic review)	***Expected in 2023***	***N/A***

Reference documents

3.6 References *of Chapter 3*

International Whaling Commission. 2004. Report of the Scientific Committee. Annex T. Report of the data availability working group. *Journal of Cetacean Research and Management (Supplement)* 6:406-08.

International Whaling Commission. 2006. Rules of Procedure of the Scientific Committee. *Annual Report of the International Whaling Commission* 2005:180-83.

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. 2011. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 12:1-75.

International Whaling Commission. 2012. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 13:1-74.

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. 2015a. 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. 2015b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 16:1-87.

International Whaling Commission. 2015c. Resolution 2014-5: Resolution on Whaling under Special Permit.2pp.

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. Resolution 2016-2: Resolution on Whaling under Special Permit. *Report of the 66th Meeting of the International Whaling Commission* 2016: 47-49.

International Whaling Commission. 2017. Report of the Expert Panel of the final review on the western North Pacific Japanese Special Permit programme (JARPN II). *J. Cetacean Res. Manage. (Suppl.)* 527-569.

APPENDIX 1

CHECKLIST: DOES THE NEW PROPOSAL INCLUDE THE FOLLOWING ELEMENTS?

1. EXECUTIVE SUMMARY	***Y***	***N***	***n/a***
• A short summary of the proposed programme (about 2 pages) covering:			
a. Primary, Secondary (and, if appropriate Ancillary) objectives and their importance;	☐	☐	☐
b. evaluation of the use of lethal sampling instead of non-lethal methods (by objective) if it requires lethal sampling;	☐	☐	☐
c. species to be taken and sample size by study area and year (and targeted component of population if applicable);	☐	☐	☐
d. summary of effect of catches on targeted stock(s);	☐	☐	☐
e. summary of co-operative research provisions.	☐	☐	☐
2. OBJECTIVES OF THE STUDY	***Y***	***N***	***n/a***
• Identification of objectives of the programme:			
a. statement objectives have been quantified to the extent possible;	☐	☐	☐
b. objectives are arranged into two or three categories, as appropriate: 'Primary', 'Secondary' and 'Ancillary';	☐	☐	☐
c. statement regarding relationships amongst objectives (where applicable);	☐	☐	☐
d. statement for each objective as to whether it requires lethal sampling, non-lethal methods or a combination of both (note that the justification is provided under Section 3);	☐	☐	☐
e. a brief explanation of the value of at least each primary objective in the context of these broad categories:	☐	☐	☐
i. improvement in the conservation and management of whale stocks,	☐	☐	☐
ii. improvement in the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part; and/or,	☐	☐	☐
iii. testing of hypotheses not directly related to the management of living marine resources; and	☐	☐	☐
f. for e(i) and e(ii), at least for each primary objective, information (quantitative where possible) on the contribution made to *inter alia*:	☐	☐	☐
i. past recommendations of the Scientific Committee;	☐	☐	☐
ii. the completion of the Comprehensive Assessment or in progress or future in-depth assessments;	☐	☐	☐
iii the carrying out of *Implementations* or *Implementation Reviews* of the RMP or AWMP;	☐	☐	☐
iv. improved understanding of other priority issues as identified in the Scientific Committee Rules of Procedure or in its reports; and	☐	☐	☐
v. recommendations of other intergovernmental organisations.	☐	☐	☐
3. STUDY AREA(S), SAMPLE SIZE AND SAMPLING DESIGN	***Y***	***N***	***n/a***
• For each objective:			
o ~~Explanation~~ ***Evaluations*** (quantitative where possible) that the objectives of the study can be achieved by the methods proposed;	☐	☐	☐
o **Specification of the appropriate study areas;**	☐	☐	☐
o **Specification of the quantities of interest (e.g. parameters used in models) that need to be determined to achieve the objective where applicable;**	☐	☐	☐
o ***Current state of knowledge about the quantities to be estimated including their uncertainty;***	☐	☐	☐
o **Specification of the sources of uncertainty in the estimation of each quantity of interest and which of these are functions of sample (including consideration of methods e.g. lethal and non-lethal techniques);**	☐	☐	☐
o **Explanation of the calculations used to determine the optimal sampling design and sample size;**	☐	☐	☐
o ***Potential magnitude of improvements in conservation and management outcomes (where appropriate).***			
• A summary of the overall justification (this may include logistical as well as scientific considerations and should focus on key parameters necessary to meet objectives) for: final study area, sampling design and sample size (explanation provided on how considerations by objective were integrated into the final overall sampling design and sample size).	☐	☐	☐
4. ASSESMENT OF POTENTIAL EFFECT OF CATCHES	***Y***	***N***	***n/a***
• Provide by species/area:			
o a summary of what is known concerning stock structure;	☐	☐	☐
o the estimated abundance of the species/stocks, including methods used and an assessment of uncertainty, with a note as to whether the estimates have previously been considered by the Scientific Committee;	☐	☐	☐
o provision of the results of a simulation study on the effects of the permit takes on the stock that takes into account uncertainty and projects for the expected life of the permit (i.e. *n* years); and (2) for situations where the proposal is assumed to continue for: (a) a further *n* years; (b) a further 2*n* years; and (c) some longer period of years since the start of the proposal.	☐	☐	☐
5. FIELD AND ANALYTICAL METHODS	***Y***	***N***	***n/a***
• **Description of field methods (by species/stock):**			
o sampling protocol for lethal and non-lethal aspects of the proposal including number, time-frame, area (including protocol to deal with predict difficulties e.g. prolonged poor weather);	☐	☐	☐
o an assessment of why non-lethal methods, methods associated with any ongoing commercial whaling, or analyses of past data have been considered to be insufficient;	☐	☐	☐
• **description of laboratory methods;**	☐	☐	☐
• **description of analytical methods (for novel techniques details may be provided in an Annex to allow full evaluation):**			
o characterisation of assumptions, key parameters, methods to deal with uncertainty, statistical power;	☐	☐	☐
o an assessment of why non-lethal methods, methods associated with any ongoing commercial whaling, or analyses of past data have been considered to be insufficient;	☐	☐	☐
• **description of use of data from other projects or programmes.**	☐	☐	☐
6. LOGISTICS AND PROJECT MANAGEMENT	***Y***	***N***	***n/a***
• **Description of intermediate targets to allow for adequate review of progress relative to objectives.**	☐	☐	☐
• **Description of overall project management including personnel and logistic resources.**	☐	☐	☐
CO-OPERATIVE RESEARCH	***Y***	***N***	***n/a***
• Assessment of the degree to which the programme will coordinate its activities with related research projects:			
o assessment of whether the degree of coordination is sufficient to ensure field and analytical methods were appropriate and best practice to achieve the stated objectives;	☐	☐	☐
o whether the degree of coordination is sufficient to avoid unnecessary duplication;	☐	☐	☐
• A note on the provisions for co-operative research:			
o field studies;	☐	☐	☐
o analytical studies.	☐	☐	☐
CONCLUSIONS	***Y***	***N***	***n/a***
• A summary evaluation of the proposed programme in the light of Annex P.	☐	☐	☐
ANNEXES	***Y***	***N***	***n/a***
• Field protocols (and if relevant how these compare with IWC guidelines).	☐	☐	☐
• Laboratory protocols (and if relevant how these compare with IWC guidelines).	☐	☐	☐
• Analytical details for new approaches or models (including formulae for estimating parameters of interest and how uncertainty was dealt with).	☐	☐	☐
• A list (by objective) of collaborating institutes, expert, projects or external data sources.	☐	☐	☐

APPENDIX 2 [NEW APPENDIX]

CHECKLIST: DOES THE PERIODICAL OR FINAL REPORT INCLUDE THE FOLLOWING ELEMENTS?

1. EXECUTIVE SUMMARY	***Y***	***N***	***n/a***
• A short explanation of the contributions of the programme in light of the topics covered by Annex P:	□	□	□
(a) Assessment of the extent of the programme's scientific output, and whether this was appropriate in light of the stated research objecti and the time elapsed;	□	□	□
(b) Assessment of the degree to which the programme coordinated its activities with related research projects; this included assessment whether the degree of coordination was sufficient to ensure that the field and analytical methods were appropriate and best practice achieve the stated objectives and whether the degree of coordination was sufficient to avoid unnecessary duplication;	□	□	□
(c) Evaluation of other contributions to important research and information needs that were not part of the original set of objectives of research programme;	□	□	□
(d) Consideration of any other relevant matters as decided by the Scientific Committee;	□	□	□
(e) Evaluation of whether the initial, or revised, objectives of the research were met, and the extent to which results have led to demonstra improvements in the conservation and management of whales, for broad categories of objectives 1 ('improve the conservation a management of whale stocks') and 2 ('improve the conservation and management of other living marine resources or the ecosystem which the whale stocks are an integral part').	□	□	□
(f) Summary of the results of programme by Objective and Sub-objectives with an indication of any limitations	□	□	□
2. INTRODUCTION ON OBJECTIVES	***Y***	***N***	***n/a***
• Identification of Objectives and Sub-objectives of the programme;	□	□	□
• A short background as to why they are important.	□	□	□
3. STUDY AREA(S), SAMPLE SIZE AND SAMPLING DESIGN	***Y***	***N***	***n/a***
• A summary of the justification for sample sizes, design and sampling areas (this may include logistical as well as scientific considerations);	□	□	□
• A summary of the justification for any changes to the above over the period of the programme (this may include logistical as well as scienti considerations)	□	□	□
• A summary of how well the achieved sampling matched the proposed sampling (in terms of design and size)	□	□	□
For programmes with multiple objectives,			
• Specification of the appropriate study areas to address each objective;	□	□	□
• Specification of the quantities of interest that need to be determined to achieve each objective where applicable;	□	□	□
• Specification of the sources of uncertainty in the estimation for each quantity of interest and which of these are/were functions of sample si	□	□	□
• Explanation of the calculations used to determine the optimal sampling design and sample size for each objective (including consideration methods e.g. lethal and non-lethal techniques) and then how this was integrated into the final sampling design and sample size;	□	□	□
• An overview of how the achieved sampling followed the proposed design and numbers (and an explanation as to why if it did not);	□	□	□
• An analysis of the effect of sample size changes (if they occurred during the programme) on the ability to meet objectives and sub-objective	□	□	□
4. A CHAPTER FOR EACH OBJECTIVE CONTAINING:	***Y***	***N***	***n/a***
• The field methods;	□	□	□
• The laboratory methods;	□	□	□
• Use of data from other projects or programmes;	□	□	□
• The analytical methods (including an explanation of assumptions, key parameters, how uncertainty was accounted for the previous three bu points and estimates of statistical power);	□	□	□
• The results;	□	□	□
• A discussion of the importance of the results (including caveats about conclusions that can be drawn) and how these add to and/or comp with related research from other regions;	□	□	□
• An evaluation (for the overall objective) of the results in light of the topics covered by Annex P.	□	□	□
5. ADDITIONAL RESEARCH	***Y***	***N***	***n/a***
• A summary of any results and studies that were completed that used data from the programme but was not addressing the objectives of programme itself	□	□	□
6. CO-OPERATIVE RESEARCH	***Y***	***N***	***n/a***
• A note on the provisions for co-operative research:			
o field studies;	□	□	□
o Analytical studies.	□	□	□
7. CONCLUSIONS	***Y***	***N***	***n/a***
• An evaluation for the programme as a whole in the light of the topics covered by Annex P;	□	□	□
• Consideration of any other scientific issues that arose from the programme.	□	□	□
8. ANNEXES	***Y***	***N***	***n/a***
• Field protocols (and if relevant how these compare with IWC guidelines).	□	□	□
• Laboratory protocols (and if relevant how these compare with IWC guidelines).	□	□	□
• A list of samples and data collected, and samples analysed by technique.	□	□	□
• Analytical details for new approaches or models (including formulae for estimating parameters of interest and how uncertainty was dealt wi	□	□	□
• The predetermined tracklines for sampling and sightings surveys and the rationale for those lines - for each year (and season if appropriate)	□	□	□
• The actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the ration for any new lines developed.	□	□	□
• An evaluation of how representative the realised samples may be of the study area and the biological populations involved.	□	□	□
• A list (by objective) of collaborating institutes, expert, projects or external data sources.	□	□	□
• A list and PDF copies (by objective, or for other research, topic) of published papers that use data from the programme.	□	□	□
• A list and PDF copies (by objective, or for other research, topic) of primary papers that use data from the programme that have been presen at international meetings, including the IWC Scientific Committee.	□	□	□

APPENDIX 3[NEW APPENDIX]

~~SOME SUGGESTIONS FOR POTENTIAL~~ GUIDELINES FOR AN INTEGRATED FINAL REPORT FROM A SPECIAL PERMIT PROGRAMME[20]

These guidelines are intended to assist proponents as well as reviewers ***in drafting an integrated final report from a Special Permit programme***. ***However, they could prove useful to draft periodic reports as well.*** It should be noted that several of the sections should easily be taken from the original proposal and any periodic reviews. Electronic copies of the full report, its annexes and all listed peer-review papers and cited documents should be submitted to the Secretariat according to the timeline defined in Table 1 and 2 (section #.2.1).

1. EXECUTIVE SUMMARY

This should be short summary (usually no more than 3-4 pages) of the results of ***the*** programme by Objective and Sub-objectives with an indication of any limitations and a short explanation of the contributions the programme in the following areas:

(a) The extent of the programme's scientific output, and whether this was appropriate in light of the stated research objectives and the time elapsed;

(b) The degree to which the programme coordinated its activities with related research projects; this included assessment of whether the degree of coordination was sufficient to ensure that the field and analytical methods were appropriate and best practice to achieve the stated objectives and whether the degree of coordination was sufficient to avoid unnecessary duplication;

(c) Other contributions to important research and information needs that were not part of the original set of objectives of the research programme;

(d) Any other relevant matters as decided by the Scientific Committee; and

(e) How well the initial, or revised, objectives of the research were met, and the extent to which results have led to demonstrated improvements in the conservation and management of whales, for broad categories of objectives 1 ('improve the conservation and management of whale stocks') and 2 ('improve the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part').

2. INTRODUCTION

This should include:

(a) identification of Objectives and Sub-objectives and any changes to these over the period of the programme;

(b) short background as to why they are important and why changes were made if they occurred.

3. STUDY AREA(S), SAMPLE SIZE AND SAMPLING DESIGN

This chapter should contain (a) a summary of the justification for sample sizes, design and sampling areas, including any changes to these over the period of the programme (this may include logistical as well as scientific considerations); and (b) a summary of how well the achieved sampling matched the proposed sampling (in terms of design and size).

For programmes with multiple objectives this should include:

(a) specification of the appropriate study areas to address each objective;

(b) specification of the quantities of interest that need to be determined to achieve each objective;

(c) specification of the sources of uncertainty in the estimation for each quantity of interest and which of these were functions of sample size;

(d) explanation of the calculations used to determine the optimal sampling design and sample size for each objective (including consideration of methods e.g. lethal and non-lethal techniques) and then how this was integrated into the final sampling design and sample size;

(e) an overview of how the achieved sampling followed the proposed design and numbers (and an explanation as to why if it did not); and

(f) An analysis of the effect of sample size changes (if they occurred during the programme) on the ability to meet objectives and sub-objectives.

Details should be provided as an Annex or Annexes as described in a later section.

4. A CHAPTER FOR EACH OBJECTIVE CONTAINING:

These chapters should be self-contained to the extent possible and contain sufficient levels of detail (first with sections by sub-objective if appropriate and then integrated over the main objective) to allow a review of:

(a) the field methods (and difficulties encountered - any uncertainty arising from this should be covered under (c) below);

(b) the laboratory methods (and difficulties encountered any uncertainty arising from this should be covered under (c) below);

(c) use of data from other projects or programmes (and any uncertainty arising from this - which should also be covered under (c) below);

(d) the analytical methods (including an explanation of assumptions, key parameters, how uncertainty was accounted for);

(e) the results;

(f) a discussion of the importance of the results (including caveats about conclusions that can be drawn) and how these add to and/or compare with related research from other regions; and

(g) an evaluation (for the overall objective) of the results in light of the topics covered by Chapter 3.

Self-contained chapters contain a sufficient level of detail that the reader does not have to frequently consult other material to evaluate the work – similar to the level of detail provided in a published paper. If a programme has already published papers in peer-reviewed journals comprising all or most of its results these chapters can be made by the sum of these papers with a short introduction and an overall conclusion.

5. ADDITIONAL RESEARCH

This chapter should contain a summary of any results and studies that were completed that used data from the programme but was not addressing the objectives of the programme itself.

6. CONCLUSIONS

This should include at least an evaluation for the programme as a whole in the light of the topics covered by Chapter 3 plus consideration of any other scientific issues that arose from the programme.

ANNEXES

The Final Report should include a number of Annexes including the following.

(1) Field protocols (and if relevant how these compare with IWC guidelines).

(2) Laboratory protocols (and if relevant how these compare with IWC guidelines).

(3) A list of samples and data collected, and samples analysed by technique.

(4) Analytical details for new approaches or models (including formulae for estimating parameters of interest and how uncertainty was dealt with).

(5) For each year (and season if appropriate):

(a) the predetermined tracklines for sampling and sightings surveys and the rationale for those lines;

(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; and

(c) an evaluation of how representative the realised samples may be of the study area and the biological populations involved.

(6) A list (by objective) of collaborating institutes, expert, projects or external data sources.

(7) A list (by objective, or for other research, topic) of published papers that use data from the programme (copies should be archived with the IWC Secretariat).

(8) A list (by objective, or for other research, topic) of working papers that use data from the programme that have been presented at international meetings, including the IWC Scientific Committee (copies should be archived with the IWC Secretariat).

It is assumed that the report will be in electronic format so (a) links can be given and (b) that much of this information will have been developed by the proponents at the start of the programme anyway (e.g. protocols).

APPENDIX 4 [NEW APPENDIX]

Table 1

Example timetable for the review of a new Special Permit proposal where the proposal is received at least six months before the Scientific Committee meeting held in the **same** year as a Commission meeting where the Scientific Committee starts on 1 June 2022 (a). If the proposal is received over 18 months prior to Annual Meeting held in the same year as a Commission meeting (e.g. by 30 November 2020), either timetable (b) or (c) would be followed. If the timetable (c) was followed (i.e. a workshop held on 22 February 2021), this would allow an extra year for proponents to refine their responses to any recommendations from the Expert Panel or the Committee, if necessary, before the Committee's evaluation is presented to the Commission in 2022.

The column with example dates (a) assumes proposal submitted 6 months ahead, that with example dates (a_1) assumes proposal submitted 9 months ahead and that the Workshop is held 100 days prior to the annual meeting and that with example dates (a_2) assumes proposal submitted 9 months ahead and that the Workshop is held 140 days prior to the annual meeting.

Action	Schedule of events	Example dates (a)	*Example dates (a_1)*	*Example dates (a_2)*	Example dates (b)	Example dates (c)
(1) Chair receives Special Permit proposal from proponents (proponents can request that it is confidential)	At least 6 months but ideally at least 9 months prior to Annual Meeting	30 November 2021	*30 August 2021*	*30 August 2021*	30 November 2020	30 November 2020
(2) Proponents submit document summarising the data (and format/resolution) used to justify the proposal's design and impact on stocks – Procedure B of the Data Availability Agreement applies	At least 6 months but ideally at least 9 months prior to Annual Meeting	30 November 2021	*30 August 2021*	*30 August 2021*	30 November 2020	30 November 2020
(3) Chair distributes proposal to Vice-Chair, Head of Science, SSG and Scientific Committee	Within 1 week of receipt	7 December 2021	*7 September 2(*	*7 September 2021*	7 December 2020	7 December 2020
(4) SSG suggest names for the Expert Workshop to the Chair	Within 2 weeks	21 December 2021	*21 September 2021*	*21 September 2021*	21 December 2020	21 December 2020
(5) Chair, Vice-Chair and Head of Science develop proposed list of experts and reserves and send to SSG	Within 2 weeks	4 January 2022	*4 October 2021*	*4 October 2021*	4 January 2021	4 January 2021
(6) Final comments from SSG to Chair	Within 1 week of sending list to SSG	11 January 2022	*11 October 2021*	*11 October 2021*	11 January 2021	11 January 2021
(7) Final Panel selected and invitation and documents : to them by Chair	Within 2 weeks of sending list to SSG	18 January 2022	*18 October 2021*	*18 October 2021*	18 January 2021	18 January 2021
(8) Scientific Committee observers indicate interest to the Chair in participating in the Workshop	At least 50 days before Workshop	4 January 2022	*4 January 2022*	*24 November 2021*	4 January 2021	4 January 2021
(9) Committee member's reviews/analyses due at the Secretariat	At least 30 days before Workshop	25 January 2022	*25 January 2022*	*14 December 2021*	25 January 2021	25 January 2021
(10) Committee member's reviews/analyses sent to Specialists and Proponents by Secretariat	Within 1 week	1 February 2022	*1 February 2022*	*21 December 2021*	1 February 2021	1 February 2021
(11) Hold Workshop	>100 days prior to Annual Meeting (Column (c) >140 days)	22 February 2022	*22 February 2022*	*12 January 2022*	22 February 2021	22 February 2021 or 2022
(12) Final Workshop report made available to Proponents by Chair	20 days after the workshop	13 March 2022	*13 March 2022*	*1 February 2022*	13 March 2021	13 March 2021 or 2022
(13) Proponents comments on report sent to Chair	40 days after the workshop (Column (c) 70 days after workshop)	1 April 2022	*1 April 2022*	*19 March 2022*	1 April 2021	1 April 2021 or 2022
(14) Distribution of the Proposal, Workshop report and comments from Proponents to the Committee by the Secretariat	>40 days prior to Annual Meeting (Column (c) 55 days prior)	22 April 2022	*22 April 2022*	*8 April 2022*	22 April 2021	22 April 2021 or 2022
(15) Any further Committee member's reviews/ analyses due at the Secretariat	Committee document deadline	25 May 2022	*25 May 2022*	*25 May 2022*	25 May 2021	25 May 2021 and 2022
(16) Any additional analyses by Proponents in response to Expert Panel recommendations	Committee document deadline	25 May 2022	*25 May 2022*	*25 May 2022*	25 May 2021	25 May 2021 and 2022
(17) Discussion within the Committee	Annual Meeting	From 1 June 2022	*From 1 June 2022*	*From 1 June 2022*	From 1 June 2021	From 1 June 2021 and 2022
(18) Submit evaluation to the Commission meeting via Annual report	About two weeks after meeting	28 June 2022	*28 June 2022*	*28 June 2022*	28 June 2021	28 June 2022

Table 2

Example timetable for the periodic and final review of Special Permit programs where review documents are received at least six months before the Scientific Committee meeting held in the **same** year as a Commission meeting where the Scientific Committee starts on 1 June 2022 (a). If the review documents are received over 18 months prior to a Commission meeting (e.g. by 30 November 2020), either timetable (b) or (c) would be followed. If the timetable (c) was followed (i.e. a workshop held on 22 February 2021), this would allow an extra year for proponents to refine their responses to any recommendations from the Expert Panel or the Committee, if necessary, before the Committee's evaluation is presented to the Commission in 2022.

Action	Schedule of events ***(max time lapsed after the previous event in the list)***	Example dates (a)	Example dates (b)	Example dates (c)
Announce intention to conduct periodic and final reviews	2***4 months prior to discussion of Expert Panel report and Proponent proposal at an*** Annual Meeting	1 June 2020	1 June 2019	1 June 2019
Proponents submit a preliminary data description document explaining the data to be available for the ***Expert*** Workshop	2 months before the Annual Meeting prior to the Workshop	1 April 2021	1 April 2020	1 April 2020
Requests for use of data submitted as papers	4 weeks prior to meeting	4 May 2021	4 May 2020	4 May 2020
Final data description documents and data themselves available in electronic form	1 month after end of Annual Meeting	14 July 2021	14 July 2020	14 July 2020
Information on likely analytical methods to be submitted to the Workshop sent to the Secretariat	9 months prior to Annual Meeting	31 August 2021	31 August 2020	31 August 2020
Distribute documents to Vice-Chair, Head of Science and SSG	(1 week)	7 September 2021	7 September 2020	7 September 2020
SSG suggest names for the specialist Workshop	(2 weeks)	21 September 2021	21 September 2020	21 September 2020
Announcement of review to IWC and call for observers		12 October 2021	12 October 2020	12 October 2020
Chair, Vice-Chair and Head of Science develop list of specialists and reserves	(2 weeks)	12 October 2021	12 October 2020	12 October 2020
Final comments from SSG	(1 week)	19 October 2021	19 October 2020	19 October 2020
Invitation and documents to specialists	(1 week)	26 October 2021	26 October 2020	26 October 2020
Indications of interest by Scientific Committee observers		2 November 2021	2 November 2020	2 November 2020
Receipt and circulation of results/review documents from Special Permit research (including to IWC Scientific Committee members)	>6 months prior to Annual Meeting	30 November 2021	30 November 2020	30 November 2020
Observers confirm wish to attend		3 December 2021	3 December 2020	3 December 2020
Committee member's reviews/analyses due at the Secretariat	(1 month)	4 January 2022	4 January 2021	4 January 2021
Committee member's reviews/analyses sent to Specialists and Proponents		11 January 2022	11 January 2021	11 January 2021
Hold Workshop	>100 days prior to Annual Meeting	22 February 2022	22 February 2021	22 February 2021 or 2022
Final Workshop report made available to Proponents	>80 days prior to Annual Meeting	13 March 2022	13 March 2021	13 March 2021 or 2022
Distribution of result documents, Workshop report and comments from Proponents to the ***Committee by the Secretariat***	***60 days after the workshop and*** >40 days prior to Annual Meeting	22 April 2022	22 April 2021	22 April 2021 or 2022
Any further Committee member's reviews/ analyses due at the Secretariat†	***Committee deadline for document submission***	***25 May 2022***	25 May 2021	25 May 2021 and 2022
Additional analyses by Proponents in response to Expert Panel recommendations‡	***Committee deadline for document submission***	25 May 2022	25 May 2021	25 May 2021 and 2022
Discussion within the Committee	Annual Meeting	From 1 June 2022	From 1 June 2021	From 1 June 2021 and 2022
Submit evaluation to ***the*** Commission via Annual report	As soon as SC report available	28 June 2022	28 June 2021	28 June 2022

*Normally to the nearest Friday.
†Such analyses and discussions may arise at following Committee meetings.
‡Proponents may also respond to recommendations arising from the Committee's and Panel's reviews in following meetings.

Appendix 5

JAPAN'S STATEMENT CONCERNING THE PROPOSED REVISIONS OF ANNEX P, ESPECIALLY ON ITS OPPOSITION TO REFLECT RESOLUTION 2016-02

Japan did not block the consensus of the modification of Annex P for the following reasons. First, the timing of submission of proposal and its review process (commencement through completion) is not limited to the same year as a Commission meeting, as is confirmed in *Option 3* and *4* of Table #.1 of Annex P. Second, Japan's concern on the unrestricted and continuing access to all data collected under special permit programs has been resolved in a reasonable manner.

However, Japan reiterates its position that Resolution 2016-2 should not be given effect, because there is no scientific reason to add the engagement of the Commission to the review process, and making such modification with a resolution would be inconsistent with Paragraph 30 of the Schedule and the Convention. It must also be noted that the said resolution was adopted with significant number of objections and abstentions.

For these reasons, Japan maintains the position that no reference to Resolution 2016-2 should be made in Annex P. However, Japan did not oppose the proposed text as a compromised solution, with the spirit of cooperation.

Japan has always cooperated in good faith with the process of review by the Scientific Committee. Japan appreciates the engagements of scientists who have been offering constructive opinions to ensure scientific integrity and soundness of special permit programs. On the other hand, Japan cannot but note that scientific discussions have too often been frustrated by political interventions at Commission meetings during the history of the IWC. Therefore, while Japan always respects and welcomes revisions of Annex P to make the process more scientifically constructive both for the proponents and reviewers, Japan cannot agree to a proposal that invites political interventions to the review process.

When the draft of the Resolution 2016-2 was discussed at the IWC/66, Japan expressed its objection thereto as it was aimed, together with Resolution 2014-5, at unduly limiting the implementation of Special Permit scientific research programs regardless of scientific value and in a manner inconsistent with the Convention. Japan emphasized that it is Paragraph 30 of the Schedule that sets out the binding procedure for review of Special Permit proposals.

Resolution 2016-2 also requests unrestricted and continuing access to all data collected under special permit programs. However, such request for data access, particularly for those used for the development of the new program, is overly stringent compared to the ordinary process of scientific peer review where access to raw data is not requested taking due account of the property rights.

Resolution 2016-2 was nonetheless adopted by vote at the IWC/66, despite the opposition of a significant number of Member States (17 votes against) and with a significant number of abstentions (10). Japan's view remains unchanged and is that Resolution 2016-2 is an attempt to add further conditions, not envisaged under the Convention and its Schedule, for granting special permits. Implementation of Resolution 2016-2 would in effect modify the current review process, by granting the Commission a power it does not have under the Convention and its Schedule.

Japan reiterates its full commitment to cooperating with the Scientific Committee in accordance with the Convention and its Schedule. Japan will thus continue to share information and to discuss the scientific aspects of its Special Permit researches, as it has always done, in a manner consistent with the Convention.

Annex Q

Report of the Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises

Members: Zerbini (Convenor), Givens (co-Convenor), Al Harthi, Allison, Andriolo, Aoki, Archer, Baba, Baker, Bell, Bickham, Brandon, Brierley, Brownell, Burkhardt, Buss, Butterworth, Canadas, Carroll, Charlton, Collins, Cooke, Coscarella, Cubaynes, Dalla Rosa, De Freitas, De la Mare, DeMaster, Di Tullio, Diallo, Domit, Doniol-Valcroze, Donovan, Double, Ferguson, Ferriss, Fortuna, Galletti, Genov, George, Goto, Gunnlaugsson, Gushcherov, Hielscher, Hughes, Iñíguez, Inoue, Jackson, Jaramillo-Legorreta, Jarman, Kato, Kim, Kitakado, Lang, Lundquist, Mallette, Marmontel, Matsuoka, McKinlay, Miller, Miyashita, Mizroch, Morishita, Morita, Moronuki, Murase, Mwabili, Øien, Olson, Palka, Panigada, Park, Pastene, Porter, Punt, Reeves, Robbins, An, Scheidat, Scordino, Scott, Slooten, Slugina, Strasser, Svoboda, Taguchi, Tamura, Taylor, Thomas, Trejos, Vikingsson, Wade, Walløe, Walters, Wambiji, Weinrich, Weller, Wilberg, Willson, Yasokawa, Yoshida and Zharikov.

1. INTRODUCTORY ITEMS

1.1 Opening remarks

The Standing Working Group on Abundance Estimates, Status and International Cruises (ASI) was established following discussions within the IWC Scientific Committee (IWC, 2017, p.94) 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 is also 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 also considers survey design and data analysis related to abundance estimates of IWC-related projects. The Terms of Reference of the Working Group were listed in IWC, 2018 (p.389).

Following the current Committee's guidelines, reported abundance estimates that may be used by the Committee need to be reviewed and categorised with respect to their level of usage. These categories are:

- 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.
- Category P: provisional estimates.

In reviewing abundance estimates, the Working Group was instructed to allocate the abundance estimates available to this meeting into one of the categories above for inclusion in the IWC Table of Accepted Abundance Estimates.

1.2 Election of the Chair

Zerbini and Givens were elected co-chairs.

1.3 Appointment of Rapporteurs

McKinlay was appointed rapporteur with assistance from Weller.

1.4 Adoption of the Agenda

The adopted Agenda is provided in Appendix 1.

1.5 Documents available

The following documents were available to the Working Group: SC/67b/ASI/01-03, 05-17; SC/67b/AWMP/01-rev1, 12, 16; SC/67b/NH/04; SC/67b/SM/07, 09; SC/67b/SH/05, 08/rev-1; Doniol-Valcroze *et al.* (2015); Frasier *et al*. (2015); da Silva *et al*. (2018) and Hansen *et al*. (2018).

2. REVIEW INTERSESSIONAL WORK

2.1 Process to review abundance estimates

The Working Group notes that its Terms of Reference include the review of estimates of abundance, trends in abundance and status (e.g. current abundance relative to pre-exploitation abundance) presented to the Scientific Committee (SC). These estimates are often needed for other sub-committees or working groups within the SC to complete their agendas, both at the annual meeting and intersessionally (e.g. workshops). In addition, many estimates are expected be included in the IWC 'Table of Accepted Abundance Estimates', which is presented to the Commission on a biennial basis and made available to the general public (e.g. via the IWC website).

Abundance estimates can be produced by applying statistical methods to survey data (e.g. line-transect surveys, mark-recapture techniques) or they can be obtained, for example, from population dynamics models. Often, such estimates are computed using standard methods, but it is not uncommon for the SC to receive estimates calculated using novel methodologies, especially considering the high technical standards evident in many IWC SC analyses and discussions. In addition, for the proper computation of trends in abundance, the review of multiple estimates, which are in some cases produced using different methods, or methods that have evolved over time, is needed. Therefore, providing adequate reviews of such estimates can be complex and time-consuming. For this reason, development of a process to facilitate the review of abundance estimates (and other relevant information) would optimise the work of ASI and allow other sub-committees or working groups to finalise their agendas more efficiently.

A structured process to review estimates of abundance (and other relevant information) is outlined in Tables 1 and 2. This process ranks the information available to the ASI Working Group in an order consistent with how the information shall be used by the SC. In summary, estimates will be identified and ranked in order of priority. Reviews will be conducted during the SC annual meeting or intersessionally. If the work is done intersessionally, a report with an evaluation of the estimates by the ASI Working Group will be provided at the following SC annual meeting (similarly to the review of the abundance estimates of humpback whales in Iceland reported in SC/67b/ASI/02).

The Working Group **agreed** that the process to review abundance estimates by the ASI Working Group, as

Table 1

Proposed steps to review abundance estimates by the ASI working group.

Step	Description
1	Estimates of abundance requiring review are identified (by the responsible party specified in Table 2).
2	Estimates are prioritized according to four levels defined in Table 2. Prioritization of the estimates would be conducted by the SC Chair and Vice-Chair, the Head of Science and the Convenors of the relevant working groups/sub-committees and the review conducted under the auspices of the ASI working group.
3	One or more documents (e.g. SC papers, reports, publications) containing a description of the methods used to compute the abundance estimates (or estimates of trends or status) are provided to the ASI e-mail group according to the timeline specified in Table 2.
4	Reviews will occur according to the timeline proposed in Table 2.

Table 2

Proposed levels of prioritisation and timelines for provision of the estimates to the ASI working group and completion of reviews by this group.

Priority level for review	Purpose	Party responsible for identification and communication of the estimates	Timeline for provision of estimates to the ASI Group	Timeline for provision of the reviews by the ASI group
1	Estimates of abundance required by the sub-committees to complete their work during the annual meeting (within this highest priority will be given to estimates required to provide management advice).	Convenors of sub-committees/working groups, SC members	By the beginning of the annual meeting.	At the Annual SC meeting.
2	Estimates of abundance needed for SC meetings or workshops to complete their agendas within the intersessional period.	Convenors of sub-committees/working groups, SC members.	At the Annual SC meeting.	At the Annual SC meeting (if sufficient time is available) or intersessionally prior to the beginning of the intersessional meeting or the workshop
3	Estimates of abundance needed for future SC annual meetings and meetings/ workshops thereafter.	Convenors of sub-committees/working groups, SC members.	At the Annual SC meeting or during the intersessional period.	Reviews would be completed intersessionally by a small group appointed by the SC Chair, Head of Science, and the ASI convenors and provided to the SC at the next annual meeting.
4	Estimates of abundance already included in the IWC Table of Abundance Estimates or those to be included but are not immediately required by any sub-committee or working group to complete their agenda.	IWC Secretariat (C. Allison).	At the Annual SC meeting or during the intersessional period.	Reviews would be completed intersessionally by a small group appointed by the SC Chair, Head of Science, and the ASI convenors and provided to the SC at the next annual meeting.

described in Tables 1 and 2, should be adopted by the Scientific Committee.

Attention: SC

*The Working Group **agreed** to adopt a process to optimize the review of abundance estimates received by all Sub-Committees and Working Groups of the Committee described in Tables 1 and 2 above.*

2.2 Minimum requirements for presentation and review of abundance estimates

The Working Group considered the minimum requirements for presentation and review of abundance estimates proposed in SC/67b/ASI14 and reproduced in Table 3. To allow proper review of abundance estimates an adequate description of the data collection and of the analytical methods is required. This description must include details on the survey design, survey platform, data collection procedures, data processing and analysis, statistical methods used compute the parameters of interest, and assumptions considered. Table 3 summarises proposed minimum requirements for presentation and review of abundance estimates by the Working Group and for inclusion in the IWC Table of Accepted Abundance Estimates.

The Working Group **agreed** that the minimum requirements set out in Table 3 for the presentation of abundance estimates to be assessed by the Working Group should be adopted.

Attention: SC

The provision of proper review of abundance estimates by the Committee requires adequate description of the data collection protocols, data processing and analytical methods. The Working Group agreed on minimum requirements developed for the presentation and review of abundance estimates described in Table 3 above.

2.3 Process to validate non-standard software/methods

The Working Group noted that comprehensive validation of an abundance estimate is a process that would include many aspects of the associated analysis under consideration: for example, the data used (to ensure that these were correct and correctly entered), the options selected (e.g. as a software package might offer) for the analysis, the model and estimation approach underlying the analysis, the software and code used, and the results (as to whether their interpretation was correct). Note that even use of a widely accepted software package does not guarantee correct results; some options included in such packages may not have been subject to thorough testing of some form.

Both time limitations and costs preclude this full process from being conducted for every abundance estimate to be reviewed. The only obligatory requirement in every instance should be that the options selected for the analysis are fully detailed, *inter alia* to allow a check that they were appropriate for the circumstances. Table 3 of SC/67b/ASI/14

Table 3

Description of minimum requirements for presentation and review of abundance estimates for inclusion in the IWC consolidated table.

Topic	Description
Survey region	Describe the geographical region to which the estimate applies and identify whether this region fully or partially covers the range of the stock(s) under consideration, at the time the study was conducted.
Time period	Describe the time period (e.g. year, season) to which the estimate (or set of estimates) applies/apply.
Sampling period	Specify the time period during which sampling was conducted. If sampling occurs in multiple years, specify whether temporal and geographical consistency was achieved across years, and list other factors that potentially reduce comparability of data collected across the sampling period.
Survey design	If applicable, include figures/maps showing the proposed and realized survey design for the whole study area and, if applicable, for different strata. If realized coverage is inconsistent with that proposed, include a description of the factor(s) that precluded the survey to be completed as planned.
Method	Identify the method used to compute the estimates. Examples include: design-based distance sampling, spatial models applied to line transect data, mark-recapture methods, shore-based counts, population models, and combinations of these.
Survey platform and data collection	Provide an adequate description of the survey platform and details of the data collection procedures and data processing. For line-transect surveys: • A description of the survey platform (e.g., size of vessels, including the height of the survey platform(s) or type of aircraft and whether they are equipped with bubble or belly windows). • “Searching” modes (e.g., naked-eye, binoculars, towed arrays), searching strategy (e.g., passing or closing model, presence of independent observers/platforms) and methods for estimating perpendicular distance (e.g., reticles, angle boards, clinometers, acoustics). • Indicate whether observers/acousticians were experienced or whether training had been provided. • Describe how visibility and environmental conditions during the survey (e.g. weather, Beaufort sea state) were assessed and recorded. • If applicable, provide a description of experiments conducted to estimate visibility (perception/availability) bias on the trackline. • Describe how data were stored (e.g., paper sheets, data-logging software). For mark-recapture methods: • Describe data types (e.g., photo-identification of natural markings, genotyping from biopsy samples) • Describe sampling methods (e.g., digital cameras, video, crossbow, rifle) • Specify ancillary information collected for each animal, such as sex, adult/juvenile/calf and criteria used; • Specify what ancillary data were collected, such as date, time, and position, and effort (e.g., hours/km surveyed) in each sampling occasion. For other methods: • Describe survey methods, data types, and auxiliary information to an extent that allows adequate evaluation of the sampling procedures.
Correction factors	If applicable, specify whether correction factors were applied to the estimates to account for a missing proportion of the population. These include: correction for visibility bias on the trackline (availability and/or perception) in ship-based or aerial line transect surveys, proportion of animals in the population not presenting natural marks (e.g. ‘proportion of unmarked animals’) or not susceptible to marking in the case of mark-recapture models. In addition, if bias from other sources (e.g. responsive movement in ship surveys, heterogeneity in capture probability in mark-recapture) is expected, provide a quantitative/qualitative description of the bias correction methods. If correction was imperfect, provide a qualitative assessment of the direction of uncorrected bias.
Data processing	If applicable, describe criteria or exploratory analyses performed to select the data included in the analysis. Examples include: choices for truncation distances, how sightings of species identified with low confidence were treated, how potential issues with identifiability and quality of photographs were dealt with, and criteria used to censor data.
Modelling approach	Models and model parameters should be clearly defined and statistical methods to estimate these parameters and the uncertainty associated with these estimates should be described in detail, especially if novel methods are used. Any assumptions associated with the estimation method, the data (e.g. population-level assumptions), or the sampling should be clearly stated. Sensitivity analyses should be considered for exploring the impact of key assumptions. If the estimation method is standard, references to the original work should be provided to facilitate the review. Application of novel methods would benefit from a brief discussion contrasting them with more established techniques (e.g. why this new method is expected to offer an improvement over established approaches). Model diagnostics appropriate to the methods used should be considered and discussed. If multiple models are used, provide a description of all models, specify model selection technique (e.g. AIC, BIC) and whether inference is based on a single model, multiple models or model averaging. Clearly specify covariates that are used to model certain effects (e.g. detection probability in distance sampling surveys or capture probability in mark-recapture studies).
Parameter estimates	Provide values or estimates for all quantities required to compute the abundance estimates. For example, in line transect sampling these would include effort, number of sightings, detection probability, expected group size and correction factors for visibility bias. For mark-recapture models, examples of parameters of interest are capture probabilities, survival, and recruitment. If abundance is computed for different strata, provide stratum-specific parameter estimates whenever applicable. Estimates should be presented in a clear fashion (e.g. in a Table) and should always be accompanied by a measure of uncertainty (e.g. CVs, confidence intervals, posterior credibility intervals). If applicable, indicate estimates of model parameters for which uncertainty was not computed and explain why.
Recommended estimates	In many cases, multiple abundance estimates from a single survey are presented (e.g. corrected and uncorrected for visibility bias, including and excluding lower quality data). If applicable specify in the text which estimate is recommended to be accepted as the best estimate for a given species/population/stock in a particular time period and state the reasons why that estimate is preferred.
Caveats	List known caveats related to the estimate(s) of abundance, each with appropriate explanation.

reviews the important components of an abundance estimation analysis to be considered by the Scientific Committee.

Priorities would always need to be identified on the basis of several factors, including:

- The importance (of the result) with respect to Commission priorities. For example, an abundance estimate used for providing management advice is usually more important than one pertaining to a small portion of a large stock in a limited region.

- The cost, in time and money, to complete the validation.
- The degree to which the estimate and/or software or code has been corroborated by other means. One may have more confidence in the internal calculations of a software package if it has been widely used. When several completely independent methods produce similar estimates, the priority for validating one of them may also be lower.
- The degree to which the methods are clearly and completely elucidated in the accompanying document(s).
- According greater priority to methods and/or software likely to have multiple applications than to those intended for a single application only.

Prioritisation of abundance estimates according to the factors outlined above will be carried out by the group appointed to review abundance estimates following the process described in Item 2.1.

The Working Group also **agreed** that it may be useful to develop a set of simulated datasets which can be used to test new methods. Such a framework was successfully used for the TOSSM project used by the SD/DNA sub-committee for genetic analyses. The feasibility of this approach will be considered further in a pre-meeting to be held immediately before the 2019 SC meeting.

A funding proposal to document and ensure the longevity of existing C++ code previously developed for simulating line transect survey data was presented. Although the software was originally developed in the context of abundance estimation for Antarctic minke whales, the code is generic and would be useful for many different types of species and surveys. This code is already well developed but is at risk of becoming unusable unless it is properly archived and documented. The software is flexible, allowing, *inter alia*, simulation of environments (Beaufort conditions, gradients), how animals act (school size, diving behaviour, distribution patterns, behaviour in relation to vessels), and how surveys operate (number of sightings teams, speed of ship, passing or closing mode). The Working Group noted that the proposal was made in direct response to the Working Group agreement to consider developing simulated datasets to test new abundance estimation methods (above). This software would likely fulfil the line-transect portion of that project.

In considering the proposal, the Working Group felt that it: (i) was well defined with specific goals; (ii) provided the opportunity to maintain and modernise a major project previously completed with SC support; (iii) might provide a stimulus for further external funding to support additional software improvements and extensions; and (iv) would be beneficial to the current and future work of the Working Group, particularly in relation to assessing and developing methods for abundance estimation (see Work Plan, Item 7 in Table 7).

The Working Group considered this project to be imperative and **recommended** that the Committee endorsed this as a high priority budget item.

The Working Group **agreed** that a pre-meeting be organised immediately prior to the 2019 Scientific Committee meeting to consider the requirements and possible processes for the validation of non-standard software/methods used in abundance estimation. An intersessional e-mail group under Butterworth was established to organise the pre-meeting.

Attention: SC

*Considering the high technical standards of the work of the Committee, the Working Group often receives estimates of abundance computed using novel methodologies and customised software and code. The Working Group **agreed** that a pre-meeting be organised prior to SC68A to develop a process to validate non-standard software and non-standard methods for estimation of abundance.*

2.4 Process to consider estimates computed from population models

Due to time constraints in the current meeting, the Working Group **agreed** that this item be considered at the pre-meeting to be organised prior to the 2019 SC meeting as referred to in Item 2.3.

Attention: SC

*The Working Group noted that a process to consider estimates of abundance computed from population models was needed. The Working Group **agreed** that the development of this process would be discussed during a pre-meeting organised prior to SC68A*

2.5 Process to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the SC

The Working Group **agreed** that estimates already included in the IWC Table of Accepted Abundance Estimates but not yet reviewed by the SC would be reviewed according to the process described in Item 2.1.

Attention: SC

*Abundance estimates already incorporated in the IWC Table of Accepted Abundance Estimates may require review by the Committee in the future. The Working Group **agreed** that these estimates would be reviewed following the process developed in Item 2.1.*

2.6 Amendments to the RMP Guidelines

The 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme', hereafter referred to as the 'RMP Guidelines' (IWC, 2012) constitutes a document prepared by the Scientific Committee to state the requirements and to guide the collection and analysis of survey data to compute abundance estimates for use in the Revised Management Procedure (RMP).

The Working Group noted that there was a requirement for the 'RMP Guidelines' to be modified in order to incorporate spatial modelling approaches to estimate abundance. It was noted that this work would have budgetary implications. The proposed modification to the RMP guidelines was not intended to capture any changes that might be required in relation to use of mark-recapture estimates, in that only model-based estimates would be considered at this time. The Working Group **agreed** that a suitable candidate would be found to amend the RMP Guidelines and that this would be undertaken by an intersessional e-mail group led by Fortuna, which will include as members the Chair and Vice-Chair of the Scientific Committee, the Head of Science and the co-Convenors of the Working Group.

Attention: SC

The 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management

Scheme' need to be modified to consider estimates of abundance using model-based methods. The Working Group ***agreed*** *that an intersessional e-mail group will develop instructions and select a candidate to amend these Guidelines.*

2.7 Review national cruise reports with IWC oversight

The Working Group considered the proposals set out in SC/67b/ASI/14 in relation to assessing and reporting National Cruises. National cruises are an integral part of the work conducted by the Scientific Committee and the results of these cruises are often relevant for many of the SC sub-committees and working groups. They frequently yield information on multiple species (e.g. large whales and small cetaceans) or stocks, which are treated differently by the various groups within the Committee.

It was proposed that cruise reports are reviewed by the ASI working group if they:

(a) Provide new abundance estimates.
(b) Describe new research methods relevant for computing abundance estimates.
(c) Require advice from the SC with respect to methodological approaches related to estimation of abundance.

Other information provided in the cruise report (e.g. data on distribution, population structure) would be reviewed in the context of the ongoing work in other sub-committees (e.g. Northern Hemisphere Whale Stocks [NH], Southern Hemisphere Whale Stocks [SH]), whenever that is relevant to their agendas. In order to optimise the work of the Scientific Committee, it was suggested that reports of multi-year cruises are submitted to the ASI Working Group only once per biennium, preferably in years between Commission meetings (i.e., SC "A" years). Cruise planning reports would continue to be reviewed by the ASI Working Group with an emphasis on the methodology proposed for estimation of abundance.

In discussing these issues, the Working Group considered the extent to which summaries of national cruise reports should be included as a table or appendix to the ASI working group report. It was suggested that only limited summaries would be required, except in cases where something unusual happened on the cruise that would warrant consideration by ASI. In the latter case, the Convenor of ASI, in consultation with the Head of Science, would assess on a case-by-case basis those national cruises that might potentially require more detailed attention.

It was noted that some national cruises are important for the operation of the RMP (e.g. Iceland surveys by standard methods every five years), are conducted under IWC oversight, and the Scientific Committee has an obligation to review, accept or change those cruise plans.

In considering the reporting and assessment requirements for national cruise reports, the Working Group **recommended** that governments submit national cruise reports biennially in years between Commission meetings (i.e. SC 'A' years), with the exception of those cruises with particular issues identified by IWC oversight, in which case the cruise report may be required to be assessed by the ASI Working Group. The Working Group also **agreed** that cruise reports will be summarised in the Working Group's report in a simple table giving the name of the name of cruise, where/when it happened, and a reference. It was also **agreed** that the Convenors of the Working Group, in consultation with the Head of Science, may in some circumstances identify cruise reports that require more detailed assessment and reporting, including those that provide abundance estimates, describe new research methods for abundance estimation, or require advice on new methods for estimating abundance. Finally, the Working Group **agreed** that the RMP Guidelines should be modified to accommodate these procedural changes to the frequency and extent of the Working Group's assessment of national cruises conducted under IWC oversight.

Attention: SC, CG-R

The Committee ***recognises*** *the value of information provided by national cruises with IWC oversight. The Committee noted that a process to optimise the review of national cruise reports is needed and*

(1) ***recommends*** *contracting governments to submit reports of multi-year cruises with IWC oversight biennially, in years between Commission meetings (e.g. SC 'A' years);*
(2) ***agrees*** *that cruise reports will be summarised in a table;*
(3) ***notes*** *that that in certain circumstances, cruise reports may require additional evaluation; and*
(4) ***agrees*** *that the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' should be modified at next year's meeting to accommodate procedural changes with respect to the submission and review of national cruise reports.*

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 BERING-CHUKCHI-BEAUFORT SEAS BOWHEAD WHALE

SC/67B/AWMP/01Rev1 reported on the analysis of photo-identification data collected from a 2011 aerial survey of Bering-Chukchi-Beaufort Seas bowhead whales. The 2011 data were scored and 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 six years. These data were used to estimate bowhead adult survival rate and population abundance using Huggins models embedded in a Robust Design capture-recapture analysis. The estimated adult survival rate was 0.996 with approximate lower confidence bound 0.976, which is consistent with previous estimates and with research showing that bowhead lifetimes can be very long. Estimated 2011 abundance was 27,133 (CV=0.217, 95% CI 17,809 to 41,337) adding to the evidence (e.g. Givens *et al*., 2016) that the stock is abundant, increasing from previous years, and unlikely to be harmed by limited subsistence hunting.

The Working Group noted that this abundance estimate updated a previous one discussed at last year's meeting (IWC, 2018) using a revised correction factor to account for the proportion of unmarked animals in the population (p*). In discussion, a question regarding the reason p* from 2011 differed from other years was raised. In response, it was noted that the decreasing trend in p* over the period of the surveys may be the result of strong population growth with increasing numbers of young whales that are less likely to be prominently marked compared with older whales. Another possible explanation was that, in 2011, most marked animals arrived later in the season, while survey coverage was greatest earlier in the season. This latter possibility was thought unlikely to be an important factor in determining p* because the estimation procedure corrected for survey coverage. Another question pertained to why the 2011 estimate of p* was preferred over an inverse variance weighted average of values for all primary periods. In response, it was noted the model produced a separate marked whale abundance estimate for 2011, and the most appropriate correction factor for that estimate would be the p* specific to that year, since p* in 2011 differs from values seen in previous decades. Nevertheless, an alternative estimate using the inverse variance weighted average was provided, but this estimate was not accepted.

The Working Group concluded that the SC/67b/AWMP/01Rev1 estimate was suitable for providing management advice and using with the *Bowhead SLA*. It also noted that there is a second abundance estimate, also for 2011, using entirely independent data from an ice-based survey (Givens *et al.*, 2016), and this estimate is already endorsed by the Committee and used in the *Bowhead SLA*. The Working Group **recommended** that the photo-id estimate be referred to the Standing Working Group on the AWMP for consideration of whether it should be incorporated in *SLA* calculations, and if so, how it would be used in conjunction with the ice-based estimate.

SC/67b/AWMP12 provided an update on plans to conduct a population survey for Bering-Chukchi-Beaufort Seas bowhead whales. The last successful survey was conducted in 2011. Because the Committee wants population estimates every 10 years, the next survey and estimate need to be completed by 2021. Two different types of surveys will be attempted in 2019. The first is an ice-based count to be carried out during April and May. This method has been used most frequently in the past but changes in sea ice have increased concerns about safety and suitability of the ice. A visual count is planned but the acoustic component will not be attempted in 2019 to reduce risk and expense. Instead, the visual count will be corrected for whales outside visual range using previously collected acoustic data.

In response to a question on the reliability of using past acoustic data to correct future ice-based counts, it was explained that even though the distribution of shorefast-ice is changing, the whales always approach the survey area from the southwest and pass close to the ice edge near Utqiaġvik. This means their passage near to observation stations is restricted and that previous acoustic data should be suitable for correcting the visual counts. It was further noted that several of the past BCB bowhead ice-based survey estimates have also relied on existing acoustic data and the methodology was well-established within the Scientific Committee.

The second planned 2019 survey for BCB bowheads is a line-transect survey across the US and Canada Beaufort Sea and Amundsen Gulf during August. NOAA and the North Slope Borough Department of Wildlife Management convened an expert workshop in March 2018, to begin planning for this survey. The workshop report is provided in SC/67b/AWMP/16. Workshop objectives were to: (1) identify known gaps in information needed for a successful survey; (2) identify research that could be conducted to address those information gaps; (3) recommend survey design and protocols; (4) discuss analytical methods that could be used to produce the most precise, unbiased abundance estimate possible from these data; and (5) estimate the survey cost and identify project partners. SC/67b/AWMP/16 also summarises progress made on all these topics.

The Working Group established a small group to formulate general advice and help draft survey protocols appropriate for the likely types of bowhead sightings, particularly with respect to the presence of infrequent high-density feeding aggregations. The use of updated data collection and recording equipment was recommended. The importance of simulation testing of planned protocols (to assess the impact on the abundance estimate) was emphasised. The Working Group **agreed** with the recommendations of this group, which are detailed in Appendix 2.

3.1.1.2 EAST CANADA-WEST GREENLAND BOWHEAD WHALE

Doniol-Valcroze *et al.* (2015) provides an estimate of the 2013 population size of the EC-WG stock of bowhead whales based on an aerial survey conducted by the Department of Fisheries and Oceans (DFO) in the eastern Canadian Arctic. The survey involved three aircraft for the full month of August and also targeted Baffin Bay narwhal stocks. This was the first attempt to cover the full extent of the summer distribution of the EC-WG bowhead whale stock. The study area was stratified based on geographic boundaries as well as presumed densities of narwhals and bowhead whales (systematic parallel transects for high density strata and equally spaced zigzags for low density areas). Distance sampling methods were used to estimate detection probability away from the trackline. Perception bias was calculated with a mark-recapture model based on duplicate sightings from the double platform experiment and g(0) for the combined observers was estimated at 0.97. Abundance in Isabella Bay was estimated using density spatial modelling to account for its complex shape and uneven coverage. The majority (79%) of bowhead whales sighted were single. Estimates were corrected for availability bias using a new analysis of 22 satellite-linked time-depth recorders transmitting information on the diving behaviour of bowhead whales in the study area in August 2012 and 2013. Those data allowed for specific correction factors to be developed for each stratum. However, this instantaneous correction did not take into account the time-in-view of sightings because the available dive data did not include direct measures of surface and dive times. The fully corrected estimate for the EC-WG population was 6,446 bowhead whales (CV 26.4%). The precision of this estimate was improved by the large number of sightings (242 vs. 34 in the 2002 survey). Due to weather, the coverage remained incomplete (Fury and Hecla Strait and Northern Foxe Basin could not be surveyed) and therefore the abundance might have been underestimated. However, information from concurrent satellite tracking of 11 individuals suggests that only a small proportion of the population was outside the survey area during August 2013.

The Working Group thanked Canadian scientists for attending the meeting to present their work, appreciating the scope of the study and its importance for assessing the species. It was noted that the estimates presented were relatively precise for those typically observed for aerial surveys, to which the authors responded that the high precision arose due to a combination of factors, including that most sightings occurred in areas with good survey coverage and in clear weather, and that effort was stratified effectively. Results indicated that most of the variation arose from encounter rates along tracklines.

Consequently, the Working Group **endorsed** the abundance estimate of 6,446 bowhead whales (CV 26.4%) for the EC-WG bowhead stock as Category 1. The Working

Group **agreed** that the results of Doniol-Valcroze *et al.* (2015) should be referred to the Standing Working Group on the AWMP for consideration for use with the *West Greenland Bowhead SLA*.

Frasier *et al*. (2015) describes analyses of genetic capture-mark-recapture data to estimate the abundance of the EC-WG stock of bowhead whales, as an alternative to aerial surveys, which have had difficulties in covering the entire summer distribution of this population. Over the period 1995–2013, 1,177 biopsy samples were collected at Canadian and Greenlandic sites representative of the range of movements observed in EC-WG bowhead whales. These samples resulted in the identification of 992 individuals, but only 49 recaptures were made between years and across different areas. The low number of recaptures, by itself, suggests a large population size. Bayesian methods were used to estimate abundance using either the full dataset or a recent five-year period, but given that the population has been increasing, the assumption of a closed population over the full study period was not met. An analysis taking into account the spatial distribution of samples provided estimates of abundance for each location but had difficulties estimating movement rates and abundance in unsampled locations due to the low number of recaptures. Future plans include to continue to increase sample size and expand to new sampling locations.

The Working Group welcomed the presentation of this work. In response to a question on the extent to which missing location information and the potential for asymmetric migration of animals might affect the precision of estimates, it was noted that satellite tagging had helped to identify movement patterns and supported the model assumption that migration was symmetric, but that uncertainties associated with location-specific estimates meant that a location-independent estimate derived from all the data was preferred. It was further noted that the estimates presented in Frasier *et al.* (2015) were not used for management purposes by Department of Fisheries and Oceans Canada (DFO), a decision that may have been influenced by the fact that another estimate derived from more traditional methodologies existed.

The Working Group noted that two datasets were used to compute abundance estimates in Frasier *et al.* (2015): one spanning 19 years ('full') and another spanning five years ('five-year'). It was noted that using a closed mark-recapture population model over 19 years is a substantial violation of the closed population assumption (no births, deaths, immigration or emigration). Barlow *et al*. (2011) used simulation to estimate biases in closed population estimators for a three-year study of humpback whales in the North Pacific and estimated a +5.4% bias due to using a closed model for an open population. If this scales linearly with time, positive bias of roughly 34% could occur in a 19-year period. It was suggested that only the five-year analyses be considered. It was also noted that the location independent analyses was computed with a Bayesian implementation of model M_0 from Otis *et al*. (1978). However, model M_{th}, with time varying capture probability and individual heterogeneity in capture probability (Chao *et al*., 1992) has been shown through simulation studies to provide less biased estimates when there is a reasonable amount of heterogeneity in the population (Schwarz and Seber, 1999). In considering these factors, the Working Group **recognised** the value of the methodological approach and **encouraged** authors to further develop their models and submit their results in the future.

3.1.1.3 NORTH ATLANTIC HUMPBACK WHALE

The Working Group noted that the intersessional workshop on the development of Strike Limit Algorithms for Greenland hunts (SC/67b/Rep06) had thoroughly reviewed an estimate of abundance for western Greenland (WG) humpback whales in 2015 presented in Hansen *et al*. (2018) (Table 4). The Working Group **endorsed** the conclusions of the workshop that this estimate is suitable for use in management, including all aspects of the SLA development and application and **agreed** to accept the estimate as Category 1.

Table 4

Summary of new agreed fully-corrected line-transect abundance estimates (see text) for common minke, fin and humpback whales in West (WG) and East (EG) Greenland.

Species/Sub-area	Year	Estimate	CV	Approx. 95% CI
Fin				
WG	2005	9,800	0.62	3,228-29,751
WG	2007	15,957	0.72	4,531-56,202
WG	2015	2,215	0.41	1,017-4,823
EG	2015	6,440	0.26	3,901-10,632
Common minke				
EG	2015	2,762	0.47	1,160-6,574
WG	2007	9,066	0.39	4,333-18,973
WG	2015	5,095	0.46	2,171-11,961
Humpback				
WG	2015	993	0.46	434-2,272

SC/67b/ASI/09 presents abundance estimates of humpback whales from the shipboard Iceland – Faroese survey area of the sixth North Atlantic Sightings Survey (NASS) conducted in June/August 2015. Tracks were designed using Distance for the two dedicated vessels. A third vessel simultaneously conducting fisheries surveys, followed tracks designed for these and covered the area west of Iceland during the first and last part of the survey, and around Iceland during the middle part. Two independent platforms with a minimum of two observers each operated independently on all vessels. Most humpback whale sightings were made during the latter part of July north of Iceland and in the Faroese survey area. A few sightings were made in June and August west of Iceland with no indication of a change in density there. No sightings were made in the southwest area. There is therefore little chance that a shift in distribution during the survey could have biased the results. For sightings with multiple estimates of perpendicular distance, the one providing the most accurate measurement of distance, group size estimate and highest confidence in species identification was selected for analysis. This occurred in eight cases where the first sighting was not selected, but exploratory analysis indicated that the choice of the record would have a small effect on the abundance estimation. Using conventional line transect methodology and excluding tracks from the fishery survey vessel that were compromised, a combined estimate for all vessels and the two independent platforms corrected for perception bias using mark-recapture methods was 10,031 (CV 0.36; 95% CI 4,962-20,278). As requested by an intersessional correspondence group (see below) the estimate for the 2007 survey using all levels of species ID confidence (which was not available when an estimate of humpback abundance for 2007 was first presented in Pike *et al*., 2010) is also given in this paper. This estimate was 18,105 (CV 0.43; 95% CI 7,226-45,360). Availability bias was considered small for this species in these surveys.

SC/67b/ASI/03 reported the findings of an intersessional correspondence group (ICG) tasked with reviewing abundance estimates for humpback whales around Iceland, including those presented in SC/67b/ASI/09. The purpose of the review was to determine the best estimates for assessing trends in the population over time. Several papers were reviewed, including Pike *et al*. (2002, 2005, 2009, 2010, 2018) and Paxton *et al*. (2009). The review concentrated on an estimate using 2007 data that was presented to SC67a last year (Pike *et al*., 2010) but not formally assessed, and an estimate using 2015 data in Pike *et al*. (2018). A number of issues were considered, including survey design, analysis decisions, analysis methods, model goodness-of-fit, the potential for reactive movements of animals in response to the survey and corrections to counts for perception and availability bias.

In summary, the ICG was satisfied in relation to all the issues considered and recommend that estimates for 2007 and 2015 for the area covered by the surveys be classified as Category 1. After considering the advice from the ICG and reviewing the new analyses presented in SC/67b/ASI/09, including an updated version of Pike *et al*. (2018), the Working Group **endorsed** the perception bias corrected 2007 abundance estimate of 18,105 (CV=0.43; 95% CI 7,226-45,360) and the perception bias corrected 2015 abundance estimate of 10,031 (95% CI 4,962–20,278), both applicable to the Icelandic/Faroese study area. Because these estimates were computed with data from shipboard surveys it is assumed that availability bias has a negligible effect in these estimates.

3.1.1.4 NORTH ATLANTIC MINKE WHALE

The Working Group noted that abundance estimates of North Atlantic minke whales from areas CG and WG in Greenland presented in Hansen *et al*. (2018) (Table 4) were also extensively reviewed by intersessional workshop on the development of Strike Limit Algorithms for Greenland hunts (SC/67b/Rep06). The workshop concluded these estimates were suitable for providing management advice. The Working Group **endorsed** this conclusion and **agreed** these estimates should be accepted under Category 1.

3.1.1.5 NORTH ATLANTIC FIN WHALE

SC/67b/Rep06 also thoroughly discussed updated aerial survey estimates for West and East Greenland fin whales provided in Hansen *et al*. (2018). The main change to the estimates considered by the Working Group last year (IWC, 2018) is the correction of fin whale abundance for availability and perception bias to give a fully corrected abundance estimate in 2015 of 2,215 (95% CI: 1,017- 4,823). It was agreed that the availability bias correction factor was also appropriate to correct for previous fin whale estimates computed from aerial surveys. The workshop on the development of Strike Limit Algorithms for Greenland hunts (SC/67b/Rep6) recommended the fin estimates in Table 4 for use in conditioning, trials and actual application of SLAs. The Working Group **endorsed** the conclusions of the Workshop and **agreed** the fin whale abundance estimates listed in Table 1 should be accepted as Category 1.

3.1.1.6 NORTH PACIFIC BRYDE'S WHALE

SC/67b/ASI/15 provided updated g(0) estimates for North Pacific Bryde's whales. The new g(0) estimates were used to update previous abundance estimates that assumed g(0)=1. The g(0) estimates were obtained by applying mark-recapture distance sampling methods (MRDS) to sighting data from Independent Observer (IO) mode conducted during the IWC-POWER surveys in 2015 and 2016. Results of the sensitivity test for the g(0) estimate for the best model were 0.863 for TOP barrel and IO platforms, and 0.672 for TOP barrel. Following suggestions from the Intersessional Workshop on the North Pacific Bryde's whale Implementation Review, a weighted harmonic mean of the g(0) estimates under 'good' and 'bad' Beaufort sea states were obtained for areas 1E, 1W and 2. The workshop agreed that similarity between dedicated sighting surveys by NRIFSF (National Research Institute of Far Seas Fisheries) and those under JARPNII was sufficient to allow application of the IWC-POWER survey estimates of g(0) for the TOP Barrel only (SC/67b/Rep02). Previous abundance estimates assuming g(0)=1 were updated using g(0)-corrected for Beaufort sea state conditions. The updated abundance estimates are given in Table 5.

In response to questions on several aspects of the work presented in SC/67b/ASI/15 it was noted that a dedicated researcher operated from the upper bridge to identify duplicate animals, and that abundance estimates had been corrected for Beaufort state on a per-year basis to accommodate differences between northern and southern survey areas. Two sets of abundance estimates were provided, one corrected by the per-year estimates of g(0) and another with g(0) constant across all years. It was noted that although the intersessional workshop on North Pacific Bryde's whale Implementation Review had recommended the latter (IWC, 2018b), the workshop had also requested that year-specific Beaufort correction be performed, and that has now been performed.

In discussion the Working Group was advised that the RMP Sub-Committee planned interpolations to extend some of these estimates beyond the area covered by the surveys in question, to progress its work on the current Implementation Review for this population. The results from these interpolations would be reported to next year's meeting for their review by the Working Group.

In considering the estimates, and taking into account the recommendations of the recent Implementation Review, the Working Group **agreed** the abundance estimates computed with year-specific Beaufort-corrected g(0) estimates (Table 5) should be accepted as Category 1.

3.1.1.7 NORTH PACIFIC HUMPBACK WHALE

SC/67b/NH/04 provided a preliminary report on the abundance of humpback whales in a summer feeding ground in the North Pacific. Abundance estimates were derived using sighting data from 2010-2012 and 2017 surveys of the International Whaling Commission Pacific Ocean Whale and Ecosystem Research (IWC-POWER). A design-based line transect method was primarily used for the estimation of density and abundance. In addition, a spatial modelling approach was tested as a model-based method using

Table 5

Accepted line transect abundance estimates for North Pacific Bryde's whales.

Year	Area	Estimate	CV	95% CI
1995	1W	12,149	0.41	5,579-26,454
1995	1E	15,695	0.42	7,079-34,801
1995	2	4,340	0.45	1,876-10,039
2000	1W	6,894	0.47	2,872-16,549
2000	1E	19,200	0.56	6,929-53,204
2000	2	6,083	0.61	2,030-18,229
2011	1W	25,158	0.38	12,202-51,872
2011	1E	9,315	0.33	4,957-17,505
2014	2	6,491	0.36	3,254-12,950

generalized additive models (GAMs) with potential covariates of longitude, latitude, SST and distance from the coast. The different methods produced somewhat different estimates and further research is warranted to improve the spatial modelling. The authors of the paper will work to examine and update estimates so that they might be used for future in-depth assessment of this species in the North Pacific Ocean.

The Working Group noted that the model-base abundance estimates were appreciably higher than the design-based estimates. The author acknowledged that the model-based estimates included some novel covariates and should be considered preliminary and subject to further refinement. Exploring alternate underlying distributions for grid abundance estimates and/or school counts (e.g. count processes) could improve model fit. The Working Group **encourages** further development and exploration of model-based approaches, their comparison with traditional design-based approaches, and would welcome the presentation of new estimates in the future.

3.1.1.8 WESTERN GRAY WHALE

SC/67b/ASI/02 presented abundance estimates for western North Pacific gray whales that correspond to the various stock structure hypotheses developed at the series of range-wide workshops. An individual-based population model was fitted to individual data from photo-identification programmes operating off NE Sakhalin and (in some years) SE Kamchatka, supplemented by sex determinations from biopsy, tracking of individuals to wintering grounds, and photo-ID matches between Sakhalin/Kamchatka and Baja California, Mexico. Abundance estimates are presented for the Western Feeding Group and for the Western Breeding Stock in 1995 and 2015. Abundance estimates for the Western Feeding Group in 2015 range from about 130 to about 300 whales (aged 1yr and over) depending on stock structure hypothesis, while abundance estimates for the putative Western Breeding Stock are all less than 100.

As requested by the Working Group last year, a full specification of the model used was provided in an Appendix of SC/67b/ASI/02. The formal model is generic: case-specific applications such as to gray whales are specified in the form of model inputs.

In response to a question about the effect of sex not being known for all animals, the author explained that the sex ratio at birth was assumed to be 50:50 but the probability that any given animal of unknown sex is, say, female will depend on the sighting history according to the formulae in the Appendix of SC/67B/ASI/2.

In response to a question about the likelihood formulation, the author explained that a two-step process was used. First, an approximate likelihood was obtained by treating each individual's biography as independent of the others. This approximate likelihood was then used to guide the sampling from the posterior distribution. The maximum-likelihood estimates use the approximate likelihood, which was essentially the same formulation as that used in previous iterations of the model for gray and right whales. The posterior distributions of the population trajectory use the full likelihood, but the approximate likelihood is used to enhance the efficiency of sampling of the full likelihood and thereby reduce runtime.

The Working Group expressed their appreciation to Cooke for following up on last year's recommendation to provide a consolidated explanation of the estimation method, including full details of the likelihood function and how posterior samples are generated. The Working Group noted that for abundance estimation using population models of this kind, formal validation of the method and the software would be a major task with budgetary implications. This matter was discussed further under Agenda Item 2.3 where alternative, possibly easier, validation approaches, such as the use of test data sets, was considered.

The Working Group noted that because nearly all the animals in the Sakhalin population had been individually identified, the surveys approximated a census of the entire population, and hence the estimates were not much greater than simple counts. It was also noted that a previous version of the model had been positively reviewed by researchers from St. Andrews University under an IUCN contract. In considering how the estimates might be used, the Working Group recalled that estimates were explicitly tied to the stock structure hypotheses postulated by the IWC Scientific Committee's Range-wide Review of the Population Structure and Status of North Pacific gray whales (SC/67b/Rep07).

The Working Group **endorsed** the Western Feeding Group population estimates (Year=1995, N=74, CV=0.05 and Year=2015, N=200, CV=0.03) computed for the base-case stock-structure hypothesis (3a) provided in SC/67b/ASI/02 for use in the Committee's rangewide modelling exercises for North Pacific gray whales. The Working Group **agreed** that the analysis method and abundance estimates would be further reviewed at a pre-meeting workshop scheduled to occur before next year's meeting to determine how best to use the results for providing management advice.

3.1.1.9 SOUTHERN HEMISPHERE BLUE WHALE

SC/67b/SH/05 reported a capture-recapture abundance estimate of New Zealand (NZ) blue whales using photo-ID data collected in the South Taranaki Bight (STB) region during January and February in three different years. A total of 90 blue whales were photo-identified across these years (2014: n=22; 2016: n=26; 2017: n=42). The program Multimark in R developed by McClintock (2015) was used to generate a Bayesian closed population abundance estimate. Multimark allows for the integration of multiple 'mark types', including both left- and right-side photos to compute a single abundance estimate with an increased sample size. The model included covariates of sampling period to account for heterogeneity in capture probability, and survey effort to account for variation in capture effort. A closed population estimate was generated due to a lack of information on immigration and emigration rates, and because: (1) no matches have been made between individual blue whales identified in New Zealand and those identified in Australia or Antarctica; (2) the NZ population has significant genetic differentiation from all other known Southern Hemisphere blue whale populations; and (3) all inter-annual individual resights within the NZ's EEZ have at least one match to the STB region indicating population mixing in this area. The authors used a closed population model to provide a conservative abundance estimate of blue whales in NZ.

The Working Group noted that while simultaneously considering left- and right-side photographs had increased effective sample sizes for mark-recapture estimation of population size, the estimate was still only based on nine recaptures, resulting in a large CV. The Working Group also noted that the estimate would not be immediately used and **agreed** it should be evaluated by an intersessional correspondence group for presentation at next year's meeting. This group will be appointed following the process described in Item 2.1 above.

SC/67b/SH/08 used photo-identification data of Antarctic blue whales from 1990/91 to 2014/15 in a capture-recapture analysis to produce estimates of super-population abundance for the circumpolar Antarctic. Photographs were collected during IWC, IWC-SORP, Institute of Cetacean Research (ICR) and South African Antarctic Blue Whale Survey (SAABWS) cruises. An estimate for the IWC Management Area III 1992/93 to 2013/14 was also produced. Population estimates were computed separately based on the left- and right-side photos. As the true population structure(s) is currently undetermined, different assumptions were made about Antarctic blue whale spatial population boundaries and mixing. For the circumpolar model, all Antarctic blue whales were treated as a single population and assumed to mix uniformly throughout Antarctica. The blue whales in Area III were treated as a distinct population with a higher probability of being re-sighted in Area III than in other Antarctic management areas. The R package RMark version 2.1.12 was used as an interface to program MARK version 8.0 to apply the POPAN open-population model. The authors provided circumpolar estimates of Antarctic blue whales for the years 1990/91 to 2014/15, and estimates of abundance for Area III for 1992/93 to 2013/14. As more photo-ID data become available in the future, the reliability of the capture-recapture estimates should improve.

The Working Group queried several issues in relation to the estimates presented in SC/67b/SH/08 Rev2, including the population- and sampling-level assumptions associated with the estimation, the fact that confidence intervals extended below zero, and the time period over which the estimate applied (i.e. were the estimates instantaneous or aggregate?). In response, it was noted that data were sparse towards the beginning of the series, and these estimates should be considered only preliminary; as more data are collected, more sophisticated methods may be possible. The Working Group considered that the estimation software used was well established and sound, but that more detail needed to be provided about how it was used. They noted that a simple model is likely to be more beneficial because these sparse data would be unlikely to support more complicated approaches. It was further noted that an assumption of a circumpolar super-population is unlikely realistic for these data and that a simple model assuming a single survival and recruitment rate may be appropriate.

The Working Group thanked the authors for the work and **encouraged** them to revise the estimates, taking into account the points raised in discussion, including considering a simplified model and fully specifying assumptions underpinning the estimates.

3.1.2 Small cetaceans

3.1.2.1 MAUI DOLPHIN

SC/67b/ASI/05 presented an analysis of the genetic capture-recapture data for Māui dolphins (*Cephalorhynchus hectori maui*). The data were analysed in two ways: (i) the minimal model of Baker *et al.* (2013) involving a single recruitment and mortality rate; and (ii) an individual-based population model which incorporated an age at first calving of 7yr and a minimum inter-calf interval of 2yr. The detailed specifications of the generic individual-based model and the fitting method are given in the Appendix to SC/67b/ASI/02, while the options used for the Maui dolphin analysis are provided in SC/67b/ASI/05. The best-fitting model using the AIC criterion had constant, sex-specific mortality rates and no individual heterogeneity. It showed that the population had very likely been declining over the period 2001-16, reaching 57 (SE 6) for the aged 1+ population in 2016. However, a scenario in which the population was assumed to stabilise by 2016 could not be excluded. Because the available data were insufficient to discriminate between different values for the intrinsic rate of increase (r_0) and carrying capacity (K), projections were made using plausible ranges of values for these parameters (r_0 =0.02, 0.04, 0.06; K=200, 500, 1,000). Regardless of the choice of r_0 and K values, the results showed that a reduction in anthropogenic mortality of 80% relative to the average level for 2001-16 was needed to ensure that the population decline is arrested or reversed with 95% probability.

The Working Group welcomed and noted the importance of this research in light of the species' critically low population size. The Working Group noted that validation of the abundance estimates obtained from the full individual-based population model would likely involve a considerable amount of work (see item 2.4). However, it was noted that the population estimate of 57 (SE 6) for 2016 is similar between the more sophisticated model used in SC/67b/ASI/5 and simpler open mark-recapture models (Baker *et al.*, 2013). That estimate is also very similar to the closed population model estimate of 63 individuals (Baker *et al.,* 2016) endorsed by the Working Group last year. The latter, however, does not include a correction for mortality and hence would be expected to be slightly higher than the open model estimates. The Working Group concluded that for the purpose of estimating abundance, the choice of model was, in this case, of lesser importance than the management implications, and that the main reason for using the full individual-based model was to enable projections to be made under different mortality scenarios. The Working Group **agreed** that this supports previous Scientific Committee recommendations that there is an urgent need to minimise human induced mortality for the Maui dolphin (IWC, 2016). In considering these population estimates, and taking into account the clear need for immediate and on-going conservation actions to halt the population decline, the Working Group **endorsed** the abundance estimates of the Māui dolphin (85 individuals [95%CI: 54, 133] in 2001 and 57 individuals [95% CI : 44, 75] in 2016) and **agreed** they should be accepted as Category 1.

3.1.2.2 FINLESS PORPOISE

Document SC/67b/SM7 reported on the results of a range-wide survey to estimate population size of the critically endangered Yangtze finless porpoise (*Neophocena asiaorientalis*). Results provide evidence that the rapid decline experienced by this population between 2006 and 2012 has now slowed and that the population may be increasing. The Working Group could not review estimates of abundance and trends because the methods used to compute them were not described in the paper. The Working Group **encouraged** the authors to provide a document with a description of the methods for evaluation in the future. Further discussion of this document is presented in Annex M, item 7.2.

3.1.2.3 AMAZON RIVER DOLPHINS

Da Silva *et al*. (2018) reported on the decline of Amazon river dolphins (the boto, *Inia geoffrensis*, and the tucuxi, *Sotalia fluviatilis*) in the Mamirauá reserve, central Amazon, Brazil. Declines were estimated based on counts of dolphins in a stretch of approximately 30km in the Mamirauá

Channel. This study was developed to assess relative rates of decline, not abundance, and they occurred in a small proportion of the total range of the two species. Further discussion of this paper is given in Annex M, item 2.2.

3.2 Update of the IWC abundance table

Abundance estimates recommended for inclusion in the IWC Table of Accepted Abundance Estimates during the last biennium (2017 and 2018) are presented in Appendix 3. The Working Group **agreed** that the table continues to be updated intersessionally.

Attention: SC, S, C-A

New abundance estimates ***endorsed*** *by the Working Group for inclusion in the IWC Table of Accepted Abundance Estimates are presented in Appendix 3. The Committee* ***agreed*** *that these estimates are incorporated into that table and uploaded to the IWC website. The Committee also* ***agreed*** *that the table should continue to be updated intersessionally.*

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4. RESEARCH PROGRAMMES

4.1 POWER Cruises

SC/67b/ASI12 reports the results from the 8th annual IWC-POWER cruise that was conducted between 3 July and 25 September 2017 in the eastern part of the Bering Sea. The survey was conducted aboard the Japanese R/V Yushin-Maru No.2. Researchers from Japan, the US and IWC participated in the survey. The acoustic survey was introduced to, for the first time, acoustically monitor for the presence of marine mammals, with particular importance for detecting and locating North Pacific right whales localizations. Survey trackline coverage was 71.9 % of the original trackline with a total of 1,571 n.miles. Sightings of fin (145 schools/ 198 individuals), humpback (136/165), common minke (17/20), gray (15/22), North Pacific right (9/18, including 2/3 duplicates) and sperm (25/33) whales were observed during the cruise. Fin and humpback whales were the most frequently sighted large whale species. Gray whales were sighted early in the survey, North of 64ºN. There were no sightings of blue or sei whales during the cruise. The Estimated Angle and Distance Training Exercises and Experiments were completed. Photo-identification data were collected for 15 North Pacific right (12 unique individuals, three duplicates), 14 gray (all unique), 55 fin, 34 humpback (32 unique individuals), one minke and 56 killer whales. The majority of North Pacific right whales were sighted at the western edge of Bristol Bay and in the middle of the critical habitat. Five of the nine right whale sightings were detected and localised using acoustics. A total of 60 biopsy samples was collected from 28 fin, 18 humpback, nine gray, three North Pacific right and two killer whales. A total of 240 sonobuoys were deployed, for a total of 841 monitoring hours. A total of 12 objects of marine debris were observed, considerably less than previous cruises. The 8th annual cruise of this programme was successfully completed and provided important information on cetacean distribution, in particular gray and North Pacific right whales, in an area which is poorly-known and logistically difficult to access, and where limited survey effort had been conducted in recent decades. These results will contribute to the aforementioned objectives of the IWC/SC.

The Working Group welcomed the important new information provided, especially with respect to North Pacific right whales, and highlighted the value of the acoustics component of the research programme. The Working Group thanked the Government of Japan for generously providing the vessel and the crew for the survey. The Government of the USA was acknowledged for granting permission for the vessel to survey in their waters and for providing an acoustician and acoustic equipment. The Working Group recognised the value of the data contributed by this and the other IWC-POWER cruises, collected in accordance with survey methods agreed by the Committee 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 as discussed at the Planning Meeting described below.

Donovan introduced the report of the Planning Meeting for the IWC-POWER cruise for 2018 (SC/67b/Rep04), held in Tokyo from 4-6 October 2017. Donovan thanked Japan for hosting the meeting and the warm welcome. The Planning Meeting reviewed the available data (including preliminary results from the 2017 cruise) and status of analyses, including examination of the distance and angle experiments, and developed a work plan to take these issues forward, including obtaining consolidated abundance estimates. Parallel itineraries and plans were developed for surveying either the central or the western Bering Sea, contingent upon the outcome for a Russian permit application for 2018, which was expected to be received by 15 April 2018. Because the Russian permit was not received by this date, the 2018 IWC-POWER cruise will be held between 3 July and 25 September 2018 in the central Bering Sea. These dates include transit from and to Japan using the research vessel *Yushin-Maru No.* 2, kindly provided by Japan, which now has international clearance and can visit foreign ports (as it did during the 2017 cruise). This will be the ninth cruise under the successful international IWC-POWER programme. Together, the cruises conducted in 2017, 2018 and 2019 will cover the entire Bering Sea (Fig. 1). The 2018 cruise objectives are broadly the same as in previous years. The central Bering Sea cruise will continue to use the acoustic component successfully developed in 2017. The use of acoustics had been previously endorsed by the Scientific Committee and is 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. Koji Matsuoka of Japan has been appointed Cruise Leader. Appropriate deadlines and responsible persons were identified. It was noted that the budget for the survey in 2018 had already been approved.

The Working Group **endorsed** the 2018-2019 IWC-POWER Cruise and thanked the Government of Japan for the provision of the vessel and logistical support. The Working Group **strongly recommended** that Russia undertake all possible efforts to ensure that permits are issued to the 2019 IWC-POWER cruise to survey the western Bering Sea. The Working Group **looks forward** to receiving a report from this survey at the next Scientific Committee meeting.

SC/67b/ASI/13 proposed the line transect sighting survey cruise plans for the 2019 and 2020 IWC-POWER as short-term (up to 2019) and middle-term research programmes (after 2020). The research vessel, *Yushin-Maru* No. 2 (YS2)

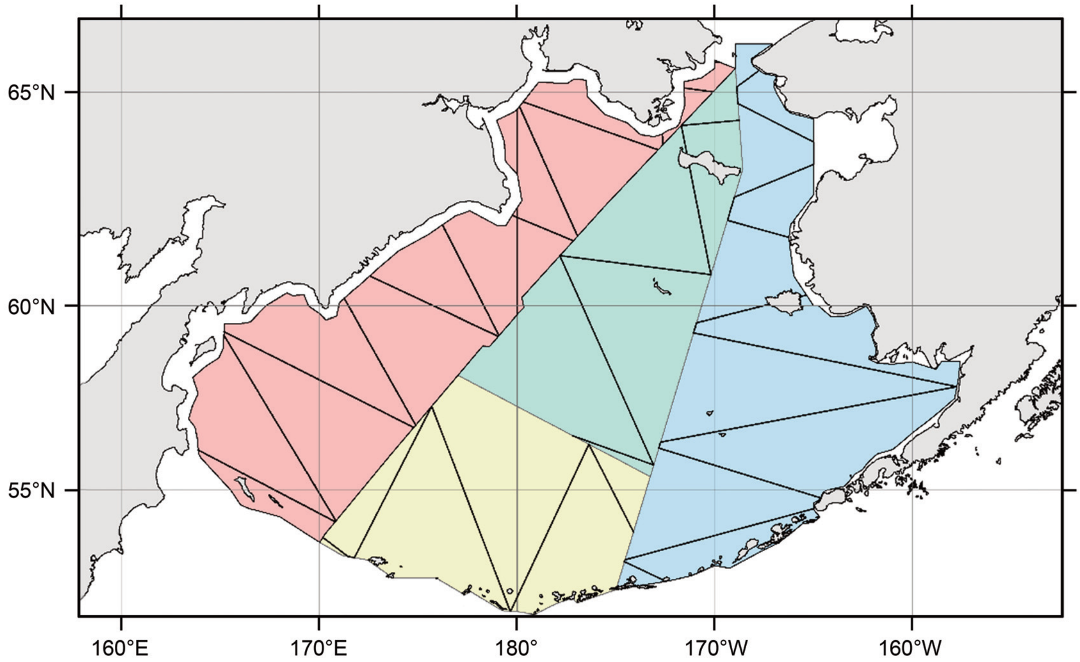

Fig. 1. Survey strata and proposed tracklines for POWER-cruises planned for the period 2017-19. The central block is divided into two strata for logistical reasons (trackline design). In 2018, either the central (green/yellow) or the western (red) block will be covered.

will be available for each cruise. Cruises will occur from July to September. Photo-ID and biopsy experiments will be components of both cruises in addition to distance sampling. The duration of the survey will be approximately 85 days involving international port refuelling and approximately 60 days in the research area. The 2019 cruise will be the last cruise for the Bering Sea and complete the initial phase of the agreed IWC-POWER programme. Details and objectives for the 2020 cruise will be discussed at the forthcoming Technical Advisory Group (TAG) meeting in 2018, in light of the results of the initial phase thus far, and consideration by the TAG of the implementation of the agreed medium-term component of the programme. A planning meeting will also occur in autumn 2019. The data and report of these surveys would be submitted to the IWC/SC meetings after the cruises. Further details of the planning of 2020 will be discussed in the planning meeting.

The Working Group welcomed news that the Government of Japan would provide support for the continuation of this important collaborative programme. It **endorsed** the proposed work plan for 2019 and 2020. Financial implications are discussed under Item 6.

Attention: SC, C-A, CG-R

The Committee ***reiterated*** *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) ***thanked*** *those governments, especially Japan who generously supplies the vessel and crew, for their continued support of this IWC programme;*
(2) ***agreed*** *that the 2017 cruise was duly conducted following the requirements and guideline of the Committee (IWC, 2012) and looks forward to receiving abundance estimates based on these data;*
(3) ***endorsed*** *the plans for the 2018, 2019 and 2020 POWER cruises and* ***recommends*** *a detailed planning meeting for these cruises;*
(4) ***strongly recommended*** *Russia facilitates the proposed research by providing permits for the IWC-POWER cruise to survey their national waters; and*
(5) ***look forward*** *to receiving a report from the 2018 survey at the next SC meeting.*

4.2 National programmes

SC/67b/ASI/06 presented the plans for a dedicated sighting survey in the North Pacific in 2018 and 2019, under the NEWREP-NP programme. The design and implementation of the survey will follow the 'Requirements and Guidelines for Conducting Surveys and Analyzing Data within the Revised Management Scheme (RMS)', as recommended by the NEWREP-NP review workshop. The original plan for 2018 was presented originally to the 2017 IWC SC meeting. The survey in 2018 will be based on two vessels, *Yushin-Maru No. 2* (*YS2*) and *Kaiyo-Maru No. 7* (*KY7*). The survey in 2019 will be conducted by the *YS2* and potentially *KY7*. SC/67b/ASI/06 specifies areas and timing of the surveys in the two years. The main objective of the surveys is to get systematic sighting data to study the distribution and abundance of common minke whales for management and conservation purposes. The report of the sighting survey in 2018 will be submitted to the 2019 IWC SC meeting.

In discussion, the sub-committee noted that the Implementation Review for western North Pacific minke whales was scheduled to begin in April 2018 and therefore any relevant data collected during the 2018 NEWREP-NP cruise would need to compiled and analysed quickly if they are to be included as part of the review prior to its completion. In addition, it was suggested that gray whale photo-identification and biopsy sampling be added to the list of species mentioned in the 'experiments' section of the document. The Working Group welcomed the survey plans, **endorsed** the proposal and **encouraged** future presentation of abundance estimates from this survey.

SC/67b/ASI/11 presented the research plan for a systematic vessel-based sighting survey in the Antarctic in the 2018/19 austral summer season, as a part of the

NEWREP-A programme. Same as in the case of the 2017/18 survey, the design and implementation of the survey will follow the ‘Requirements and Guidelines for Conducting Surveys and Analyzing Data within the Revised Management Scheme (RMS)’, as recommended by the NEWREP-A review workshop. The main objective of the survey is to get systematic sighting data for the study on distribution and abundance of large whales, which is important for management and conservation purposes. Krill and oceanographic surveys will be also conducted along the tracklines of the sighting survey. The survey will be conducted using two research vessels, *Yushin-Maru No. 2* (*YS2*) and *Kaiyo-Maru No.7* (*KY7*), in Area IV (70°E-130°E). Sighting surveys will be conducted under passing and IO modes. Routine biopsy sampling and photo-ID of large whales will be also conducted. The report of the sighting survey will be submitted to the 2019 IWC SC meeting.

In discussion, it was asked if this cruise planned to incorporate outside experts to aid with biopsy sampling (as was suggested by an earlier NEWREP-A review workshop). In response, the authors stated that biopsy sampling would be done on an opportunistic basis. The research plan for the NEWREP-A dedicated sighting survey in the Antarctic in 2018/19 was welcomed and **endorsed** by the Working Group.

SC/67b/ASI/16 reported on a research plan for a cetacean sighting survey in the northwestern Sea of Okhotsk. The period of the survey will be from 3 August to 6 September 2018 (35 days), and the vessel will cover the research area North of the Sakhalin Island to 57°N, West of 142°E, including the Shantar Islands. The research area will consist of four blocks. During the transit to the research area, the vessel will conduct the sighting survey in passing mode. The primary objective will be minke whale distribution and abundance. Photo-identification of cetaceans such as northern right whales, gray whales and humpback whales will be also be attempted.

When considering this plan there were several questions regarding the design of the survey tracklines but it was ultimately **agreed** that, given the geography of survey area, in combination with some space use restrictions related to a nature reserve, the tracklines were suitable to achieve the stated research objectives. The Working Group **endorsed** the research plan and **encouraged** the researchers to report their findings to the Scientific Committee when available.

Attention: SC, C-A

The Working Group recognises the value of information provided by national cruises. The Working Group ***endorses*** *the proposed sighting survey plans and* ***encourages*** *submission of abundance estimates from these studies the future.*

Cruise reports received by the Working Group are listed in Table 6. The Working Group **encouraged** authors to produce abundance estimates with data from these surveys and to present these estimates for review in the future.

5. METHODOLOGICAL ISSUES

5.1 Consideration of status of stocks

The Working Group did not have sufficient time to discuss this item and **agreed** to consider it at the pre-meeting to be held prior to the 2019 SC meeting referred to in Item 2.3.

Attention: SC

The Working Group recognises the need to further consider how to report status of stocks and ***agreed*** *to address this topic at a pre-meeting to be held prior to next year’s SC meeting (SC68A).*

5.2 Other

SC/67b/SM/09 describes new methodological approaches to improve estimation of abundance of river dolphins using unmanned aircraft vehicle. Drones (off-the-shelf quadcopters) flying 20m high, 50m from the side of the vessel, at 35° angle and constant 10km/h are being tested in South America to refine estimates of group size in line transect surveys for both the boto and the tucuxi. Preliminary results show improved estimates for group size using drones when compared with visual observers. Future steps include testing thermal cameras, developing an automatic identification algorithm and developing statistical methods to use drones to compute correction factors for estimates obtained from cross-channel studies or as an alternate estimation method in narrow waterways

Table 6

National cruise reports received during SC/67B.

Document number	Title	Survey Region	Cruise name	Authors
SC/67b/ASI/01	Report of the cetacean sighting survey in the northwestern Africa coastal waters of COMHAFAT zone (Guinea, Sierra Leone and Liberia) (February/March 2018) cruise report.	Northwestern Africa	COMHAFAT	Diallo S.T. and I.L. Bamy
SC/67b/ASI/07	Results of the NEWREP-A dedicated sighting survey during the 2017/18 austral summer season.	Antarctic	NEWREP-A	Toshihiro Mogoe, Futoshi Yamaguchi, Shinya Kawabe, Taiki Katsumata, Hidenori Kasai, Yasuaki Sasaki, Takeharu Bando and Koji Matsuoka
SC/67b/ASI/08	Report of the Norwegian 2017 survey for minke whales within the Small Management Area EB - the Barents Sea.	Barents Sea	Minke Whale 2017 Norwegian Survey	Nils I Øien
SC/67b/ASI/10	Result of the Japanese dedicated cetacean sighting survey in the western North Pacific in 2017.	Western North Pacific	NEWREP-NP	Koji Matsuoka, Takashi Hakamada, Yu Ueda, Takashi Kominami, Nobuo Abe, Chikamasa Ohkoshi and Tomio Miyashita
SC/67b/ASI/17	Cruise report of the cetacean sighting survey in the eastern part of the Sea of Okhotsk in 2017.	Sea of Okhotsk	Sea of Okhotsk Russian Survey	Pavel S. Gushcherov, Petr A. Tyupeleev, Maksim A. Shkarupa, Sergey V. Makrak, Vitaly I. Samonov and Tomio Miyashita

Table 7

Work Plan of the Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises for the biennium 2018/19 and 2019/20.

Item	Topic	Intersessional 2018-19	SC68a	Intersessional 2019-20	SC68b	Agenda Item
1	Review of Abundance Estimates	Review estimates identified at SC67B (New Zealand Blue Whales, Arabian Sea humpback whales)	Review intersessional progress and estimates available at SC/68A	Review estimates identified at SC/68A	Review intersessional progress and estimates available at SC/68A	3
2	Upload the estimates accepted at the annual meeting to the IWC website and continue to update the IWC Abundance Table	Update the table with estimates accepted at SC/67B		Update the table with estimates accepted at SC/67B		2
3	Review and provide advice on plans for future surveys		Receive, review and provide feedback to research plans to conduct abundance estimates		Receive, review and provide feedback to research plans to conduct abundance estimates	4
4	Pre-meeting to consider: (a) validation of non-standard software and methods; (b) estimates of abundance computed from population models; and (c) Status of populations	Meeting Preparation	Review of progress			2.3, 2.4, 5.1
5	IWC-POWER Cruise in the Bering Sea	Conduct 2018 survey and planning meeting for the 2019 Cruise	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.	Conduct 2019 survey and planning meeting for the 2020 Cruise	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.	4
6	Amend the RMP Guidelines to consider abundance estimates computed with model-based methods.	Identify a candidate to update the RMP Guidelines	Review an updated document of the Guidelines			2.6
7	Develop simulation software to evaluate methods for abundance estimates		Review Progress			2.3

The Working Group welcomed this research and **encouraged** authors to present results of their planned research in the future.

6. WORK PLAN

The work plan for the biennium 2018/19-2019/20 is provided in Table 7. Items 5, 6 and 7 have budgetary implications.

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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. Review intersessional work
   2.1. Process to review abundance estimates by the ASI group
   2.2. Minimum requirements for presentation and review of abundance estimates
   2.3. Process to validate non-standard software/methods
   2.4. Process to consider estimates computed from population models
   2.5. Process to evaluate abundance estimates already included in the IWC consolidated table, but not yet reviewed by the SC
   2.6. Amendments to the RMP Guidelines
   2.7. Review national cruise reports with IWC oversight
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 Bering-Chukchi-Beaufort Seas bowhead whale
         3.1.1.2. East Canada-West Greenland bowhead whale
         3.1.1.3. North Atlantic humpback whale
         3.1.1.4. North Atlantic minke whale
         3.1.1.5. North Atlantic fin whale
         3.1.1.6. North Pacific Bryde's whale
         3.1.1.7. North Pacific humpback whale
         3.1.1.8. Western gray whale
         3.1.1.9. Southern Hemisphere blue whale
      3.1.2. Small Cetaceans
         3.1.2.1. Māui dolphin
         3.1.2.2. Finless porpoise
         3.1.2.3. Boto
   3.2. Update of the IWC abundance table
4. Research programmes
5. Methodological issues
   5.1. Consideration of status
   5.2. New technologies
6. Work plan

Appendix 2

DETAILED RECOMMENDATIONS FOR THE BCB BOWHEAD WHALE 2018 AERIAL SURVEY

Small Working Group Report

In response to the management need for a new BCB bowhead whale abundance estimate by 2021, NOAA and the North Slope Borough Department of Wildlife Management convened an expert workshop to discuss the use of aerial line-transect surveys in the Beaufort Sea and Amundsen Gulf during 2019 to collect data for estimating the abundance of this population. SC/67b/AWMP16 is the workshop report. Workshop objectives were to: (1) identify known gaps in information needed to estimate abundance of the BCB bowhead whale population from aerial line-transect surveys; (2) identify research that could be conducted to address those information gaps; (3) recommend aerial survey design and protocols specific to BCB bowhead whales in the Beaufort Sea; (4) discuss analytical methods that could be used to produce the most precise, unbiased abundance estimate possible from these data; and (5) estimate the survey cost and identify project partners.

One relatively new phenomenon occurring in the western Beaufort Sea is the formation of ephemeral, high-density aggregations of feeding bowhead whales. These aggregations are encountered infrequently, but the number of whales observed in the aggregations may comprise a considerable proportion of the total number of whales detected during a survey year. For example, during five Aerial Surveys of Arctic Marine Mammals (ASAMM) flights conducted in the western Beaufort Sea from 24-27 August 2016, approximately 600 bowhead whales were observed, corresponding to 32% of the total number of bowhead whales observed during the full four-month survey season (July-October) – hence, this is now a non-ignorable problem. The timing and location of these aggregations cannot be accurately predicted in advance. SC/67b/AWMP16 recommended that modified survey protocols be used to sample whales in these high density aggregations. The draft whale aggregation protocols in SC/67b/AWMP/16 were reviewed by the ASI Working Group, who identified several concerns and recommended that a small group of line-transect and aerial survey experts discuss ways to modify the aggregation protocols to address those concerns.

The primary goal of this small working group was to draft protocols to conduct aerial surveys of aggregations of whales in the ASAMM study area that would enable collection of data that could be used to produce an unbiased estimate of the total absolute abundance of the BCB bowhead whale population. To achieve this goal, four fundamental issues were addressed:

(1) The need to circle to get an accurate estimate of the total number of whales and calves in a sighting. ASAMM data from 2012-2017 show that 76% of all bowhead whale calf sightings were detected only after the survey aircraft broke from the transect to circle sightings of adult whales (AWMP03).
(2) The need to circle sightings to confirm species identification.
(3) Whether the groups detected during aggregations should be (A) pooled into a single encounter, with a single perpendicular distance (e.g. the middle of the aggregation) and a single group size estimate; or (B) kept as individual events. The working group favored Option B, when feasible.
(4) What tools should be used to collect data for Option B, and how those data should subsequently be analysed. The small working group made the following recommendations:

A 'group' is defined as the object detected from the transect, regardless of proximity of individual whales to each other. For example, a group could comprise a single whale, one cow-calf pair swimming closely together, several whales located within a few body lengths of each other, or a patch of tens of whales causing a broad disturbance on the surface of the water.

When a group is detected in an area of low sighting density, the aircraft should record the declination angle and an initial estimate of group size when the aircraft is on the transect and the group is abeam. The aircraft should circle detected groups, as weather and fuel allow, to confirm species identification, obtain a final estimate of group size, and determine whether calves are present. Circling should only occur over area that has already been surveyed on effort (i.e. passed abeam). This recommendation aligns with existing ASAMM survey protocols. The observer on the opposite side of the aircraft from the sighting should avoid scanning while circling.

Any whales detected for the first time while circling (i.e. after the aircraft has diverted from the transect) that are not in close proximity to the original groups that were detected from the transect should be considered 'off-effort' sightings and should not incorporated into design-based abundance estimates.

The survey team should experiment with integrating a short lag (e.g. 10-30sec) after recording a sighting that is abeam before circling on that sighting. During the lag, standard on-effort survey protocols should be used. The purpose of this lag is to provide a brief opportunity to determine whether the initial sighting is part of a dispersed aggregation. The merits of incorporating the time lag (e.g. minimising the number of whales initially detected while circling) should be weighed against the drawbacks. Potential drawbacks include: inability to resight the initial sighting and subsequent loss of essential sighting information, such as species identification, accurate group size estimate, and determination of calf presence; and the additional time spent backtracking and circling, which reduces the available effort on transect.

When a high-density aggregation of whales is encountered, a distinct whale aggregation protocol survey mode should commence. The aggregation protocol should include the following steps:

Continue to fly directly on the transect without breaking track to circle (i.e. 'passing mode'). During this step, it is important to record an accurate declination angle, initial group size estimate, and initial species identification for individual groups, until the point when group density overwhelms the data collection process. Maximising the ability to record individual detections as separate sighting events will likely require adoption of time-saving data recording methods, such as voice recorders or the digital geometer. Once the group density precludes the ability to record separate detections as individual sighting events, observers should implement one of the following time-saving protocols: (a) pool groups into a single sighting event, recording the declination angle associated with the center of the pooled groups, the associated total number of individuals (or a categorical group size variable) and calves summed across all groups, and initial species identification; or (b) collect perpendicular distances in bins, recording the total number of individuals (or a categorical group size variable) and calves, and initial species identification for each distance bin.

When the aircraft reaches the point where whale density has obviously diminished to background levels, it should break off the transect and circle back through the aggregation, recording detailed sighting information for distinct groups located within 3km of the transect. If the groups were only detected within a much narrower strip (e.g. from 0.5 to 1.0km from the trackline), the protocols should consider attempting to search only within that band in order to exclude detailed sighting information from groups that were clearly not detected initially. The goal here is *not* to try to match groups initially detected from the transect with groups investigated while circling. Rather, this step provides data that can be used to sample the distribution of group sizes in the aggregation and better estimate average group size, uncertainty in group size estimates, number of calves, and species composition for the aggregation as a whole.

When the aggregation has been surveyed in depth (or as fuel and weather allow), the aircraft should return to the downstream point on the transect where it initially diverted to circle, and resume surveying in regular closing mode down unsurveyed transect as long as whale density remains at background levels.

The small working group recommended that these field methods be tested and modified, if necessary, during the 2018 ASAMM field season in order to provide trusted methods that could be used during the proposed 2019 BCB bowhead abundance estimation survey.

In addition, the small working group recommended that simulation trials be conducted to identify the sensitivity of the resulting abundance estimate to various components of the aggregation protocols. These simulation trials should be a priority, not an afterthought. Details that need to be addressed to make the simulations useful in evaluating the recommended aggregation protocol include: modelling the spatial distribution of whale clustering to reflect their likely distribution during the surveys; modelling the observers' search, detection, and data recording process to reflect the inherent biases associated with the passing and closing modes of the aggregation protocols.

Appendix 3

TABLE OF ACCEPTED ABUNDANCE ESTIMATES (2017-18)

Note: Shaded rows represent the abundances accepted at last year's meeting

Area	Cat.	Eval. Ext	RMP/AWMP status	Date stamp	Range of years	Method	Corr	Est.	CV	Approx. 95% CI	Original reference	Comments	Areal coverage	Programme
North Pacific Bryde's whales														
1W	1	1	C	1995	1988-96	LT	P	12,149	0.41	5,579-26,454	SC/67B/ASI15_rev2	g(0) = 0.671, CV = 0.24. Require copy of time series	-	JARPN
1E	1	1	C	1995	1988-96	LT	P	15,695	0.42	7,079-34,801	SC/67B/ASI15_rev2	g(0) = 0.689, CV = 0.23. Require copy of time series	-	JARPN
2	1	1	C	1995	1988-96	LT	P	4,340	0.45	1,876-10,039	SC/67B/ASI15_rev2	g(0) = 0.659, CV = 0.28. Require copy of time series	-	JARPN
1W	1	1	I	2000	1998-2002	LT	P	6,894	0.47	2,872-16,549	SC/67B/ASI15_rev2	g(0) = 0.719, CV = 0.20. Require copy of time series	-	-
1E	1	1	I	2000	1998-2002	LT	P	19,200	0.56	6,929-53,204	SC/67B/ASI15_rev2	g(0) = 0.584, CV = 0.33. Require copy of time series	-	-
2	1	1	I	2000	1998-2002	LT	P	6,083	0.61	2,030-18,229	SC/67B/ASI15_rev2	g(0) = 0.712, CV = 0.26. Require copy of time series	-	-
1W	X1	1	I	2011	2008-15	LT	-	15,422	0.29	-	SC/67A/RMP4	g(0)=1, superseded by estimates in SC/67B/ASI 15	78.4	POWER/ JARPN II
1E	X1	1	I	2011	2008-15	LT	-	6,716	0.22	-	SC/67A/RMP4	g(0)=1, superseded by estimates in SC/67B/ASI 15	92.4	POWER/ JARPN II
2	X1	1	I	2014	2013-15	LT	-	4,161	0.26	-	SC/67A/RMP4	g(0)=1, superseded by estimates in SC/67B/ASI 15	78.9	POWER
W N Pacific			-		2008-2015	LT		26,299	0.185	18,000-38,000	-	Combined estimate ~26,000 (sum of the three rows above)	-	-
1W	1	1	I	2011	2008-15	LT	P	25,158	0.38	12,202-51,872	SC/67B/ASI15_rev2		78.4	POWER/ JARPN II
1E	1	1	I	2011	2008-15	LT	P	9,315	0.33	4,957-17,505	SC/67B/ASI15_rev2	g(0) = 0.721, CV = 0.20. Require copy of time series	92.4	POWER/ JARPN II
2	1	1	I	2014	2013-15	LT	P	6,491	0.36	3,254-12,950	SC/67B/ASI15_rev2	g(0) = 0.641, CV = 0.29. Require copy of time series	78.9	POWER
North Atlantic common minke whales														
East Greenland	1	1	S, E, I	2015	2015	LT	P+A	2,762	0.47	1,160-6,574	Hansen *et al*. in press.	P = 0.97, CV = 0.04, A = 0.19 (CV =0.27)	-	-
East Greenland	X1	1	S	2015	2015	LT	P+A	2,681	0.45	1,153-6,235	SC/67a/Rep06	Superseded by Hansen *et al*. in press; SC/67b/FI40	-	-
West Greenland	1	1	S, E, I	2007	2007	SC	P+A	9,066	0.39	4,333-18,973	Hansen *et al*. in press.	P = 0.97, CV = 0.04, A = 0.19 (CV =0.27)	-	-
West Greenland	X1	1	S	2007	2007	SC	P+A	9,853	0.43	4,433-21,900	SC/67a/Rep06	Superseded by Hansen *et al*. in press; SC/67b/FI40	-	-
West Greenland	1	1	S, E, I	2015	2015	SC	P+A	5,095	0.46	2,171-11,961	Hansen *et al*. in press.	P = 0.97, CV = 0.04, A = 0.19 (CV =0.27)	-	-
West Greenland	X1	1	S	2015	2015	SC	P+A	5,241	0.49	2,114-12,992	SC/67a/Rep06	Superseded by SC/67b/FI40	-	-
ES	P	-	-	-	2014-16	-	-	12,846	-	-	SC/67a/RMP03	Final estimate to be calculated on completion of full survey cycle	-	-

Area	Cat.	Eval. Ext	RMP/AWMP status	Date stamp	Range of years	Method	Corr	Est.	CV	Approx. 95% CI	Original reference	Comments	Areal coverage	Programme
EW	P	-	-	-	2014-16	-	-	16,537	-	-	-	Final estimate to be calculated on completion of full survey cycle	-	-
CM	P	-	-	-	2014-16	-	-	57,472	-	-	-	Final estimate to be calculated on completion of full survey cycle	-	-
North Atlantic fin whales														
East Greenland	1	1	S, E	2015	2015	LT	P+A	6,440	0.26	3,901-10,632	Hansen *et al.* in press.	P=0.99, CV=0.007, A = 0.30, CV = 0.10	-	-
West Greenland	1	1	S, E	2005	2005	LT	P+A	9,800	0.62	3,228-29,751	Hansen *et al.* in press.	P=0.51, CV=0.21, A = 0.33, CV = 0.43	-	-
West Greenland	1	1	S, E	2007	2007	LT	P+A	15957	0.72	4,531-56,202	Hansen *et al.* in press.	P=0.86, CV=0.09, A = 0.28, CV = 0.22	-	-
West Greenland	1	1	S, E	2015	2015	LT	P+A	2,215	0.41	1,017-4,823	Hansen *et al.* in press.	P=0.99, CV=0.007, A = 0.21, CV = 0.22	-	-
West Greenland	X1	1	S	2015	2015	LT	P	465	0.35	233-929	IWC/67a/Rep06	Superseded by Hansen *et al.* in press.	-	-
North Atlantic humpback whales														
East Greenland	1	1	S, E	2015	2015	LT	P+A	4,223	0.44	1,845-9,666	Hansen *et al.* in press.	P=0.98, CV=0.02, A = 0.43, CV = 0.27	-	-
East Greenland	X1	1	S	2015	2015	LT	P+A	4,288	0.38	2,097-8,770	IWC/67a/Rep06	Superseded by Hansen *et al.* in press.	-	-
West Greenland	1	1	S, E	2015	2015	LT	P+A	993	0.44	434-2,272	Hansen *et al.* in press.	P=0.98, CV=0.02, A = 0.43, CV = 0.27	-	-
West Greenland	X1	1	S	2015	2015	LT	P+A	1,008	0.38	493-2,062	IWC/67a/Rep06	Superseded by Hansen *et al.* in press.	-	-
Iceland/Faroe Islands	1	1	S, E, I	2007	2007	LT	P	1,8105	0.43	7,226-45,360	SC/67B/ASI9	P=0.78, CV=0.13.	-	-
Iceland/Faroe Islands	1	1	S, E, I	2015	2015	LT	P	10,031	0.36	4,962-20,278	SC/67B/ASI3 and ASI9	P=0.69, CV=0.21.	-	-
Bowhead whale														
Bering-Chukchi-Beaufort	1	1	S, E	2011	1985-2011	MR: PId	-	27,133	0.22	17,809-41,377	SC/67B/AWMP1-rev1	-	-	-
East Canada-West Greenland	1	1	S, E	2013	2013	LT	P+A	6,446	0.26	3,722–11,200	Doniol-Valcroze *et al.*, 2015.	P=0.97, CV=0.02, A = sub-area specific corrections	-	-
Svalbard	3	1	-	2015	2015	LT	A	343	0.488	136-862	Vacquié-Garcia *et al.*, 2017.	Partial coverage and high CV	-	-
Okhotsk Sea	3	1	-	2016	1995-2016	MR	P+A	218	0.22	142-348	SC/67a/NH10	(require copy of time series)	-	-
Gray whales														
Western Feeding Group	1	4	-	1995	1995-2015	MR:PA	-	74	0.05	66-81	SC/67B/ASI2	(require copy of the time series), base-case stock structure hypothesis (3a), age 1+	-	-
Western Feeding Group	1	4	-	2015	1995-2015	MR:PA	-	200	0.03	187-211	SC/67B/ASI2	(require copy of the time series), base-case stock structure hypothesis (3a), age 1+	-	-

Area	Cat.	Eval. Ext	RMP/AWMP status	Date stamp	Range of years	Method	Corr	Est.	CV	Approx. 95% CI	Original reference	Comments	Areal coverage	Programme
Sakhalin Island	3	4	-	1995	1995-2015	MR:PA	P+A	74	0.06	65-82	SC/67a/NH11	(require copy of time series)	-	-
Sakhalin Island	3	4	-	2015	1995-2015	MR:PA	P+A	191	0.04	175-208	SC/67a/NH11	(require copy of time series)	-	-
Sakhalin and Kamchatka	3	4	-	1995	1995-2015	MR:PA	P+A	129	0.08	107-149	SC/67a/NH11	(require copy of time series)	-	-
Sakhalin and Kamchatka	3	4	-	2015	1995-2015	MR:PA	P+A	282	0.05	255-312	SC/67a/NH11	(require copy of time series)	-	-
N California/ N Vancouver Isl.	1	1	-	2015	-	PId	-	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.	Suitable for use in *SLA* and conditioning range-wide model. Some methodological issues.	-	-
Maui's dolphin														
North Island, NZ	1	4	-	2016	2001-2016	GMR:PA	-	57		44-75	SC/67B/ASI5	Require copy of time series	-	-
North Island, NZ	1	1	-	-	2015-16	MR	-	63	0.11	-	Baker *et al*., 2017.	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	-	-

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Annex R

Report of the Working Group on Whale Sanctuaries

Members: Parsons (Convenor), Almeida, Bell, Bjørge, Brierley, de la Mare, DeMaster, Double, Fortuna, Goodman, Hielscher, Iñíguez, Leaper, Lundquist, Matsuoka, Morita, Moronuki, Reyes, Rodriguez Fonseca, Rojas-Bracho, Rose, Suarez, Suydam, Terai, Walløe, Weinrich.

1. INTRODUCTORY ITEMS

1.1 Introductory remarks
Parsons welcomed members to the Working Group.

1.2 Election of Chair
Parsons 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
One document was available for the sub-committee to review: SC/67b/SAN01.

2. NEW SANCTUARY PROPOSALS

There were no new sanctuary proposals submitted to the Committee this year.

3. REVIEW OF THE SOUTHERN OCEAN SANCTUARY MANAGEMENT PLAN

SC/67b/SAN01 is a draft Southern Ocean Sanctuary Management Plan (Plan). The Schedule amendment establishing the Southern Ocean Sanctuary (SOS) requires the Sanctuary to be reviewed at succeeding ten-year intervals, unless otherwise revised by the Commission. The first review of the SOS took place in 2004 and the second review was completed in 2016. In 2014 the Commission adopted the following eight objectives:

(1) Contribute to the rehabilitation of a marine ecosystem damaged by the over-exploitation of whales and allow for the restoration of a complex of whale species and populations.
(2) Secure a long-term satisfactory habitat for cetaceans and other marine life.
(3) In combination with the Indian Ocean Sanctuary, fully protect at least one population of each of the great whales throughout its migratory range and life-cycle, i.e. on feeding and breeding grounds, to provide for their long-term conservation.
(4) Provide a reference area to allow for the collection of information on levels and trends on unexploited and recovering whale populations.
(5) Allow for the monitoring of the recovery of ecosystems without their being disturbed by further commercial whaling
(6) Allow for coordinated research on the effects of environmental change on whale stocks.
(7) Allow for the Comprehensive Assessment of the effects of setting zero catch limits on whale stocks.
(8) Allow for application of the Revised Management Procedure (RMP) to be phased in over limited geographic ranges and species.

The Commission also provided Terms of Reference for the review to be undertaken by the Scientific and Conservation Committees. The Scientific Committee review made the following recommendations (IWC, 2017):

- Each SOS objective should be linked to an appropriate performance measure.
- Appropriate performance measures for the SOS should be developed. These should link the objectives of the SOS with field monitoring programmes.
- Performance measures for some scientific objectives could draw on existing mechanisms, such as the In-Depth Assessment process.
- The Scientific Committee could provide suggestions for appropriate performance measures in relation to the scientific objectives of the SOS to the Commission in future, should the Commission request it.
- Outputs from existing and planned research programmes should be incorporated into the development of a management plan for the SOS and subsequent monitoring programmes.
- A Management Plan for the SOS should be developed to clearly outline the broad strategies and specific actions needed to achieve SOS objectives. This information could be collated, based on the Committee's recent relevant activities.
- Review criteria in the Management Plan should be linked to performance measures.
- The Management Plan should be refined periodically.

These recommendations were taken into account in developing this draft Plan. However, it was noted that, while the draft Plan does contain performance measures, it does not contain criteria for its own review.

The purpose of the Plan is twofold: (1) to inform the Commission and public about the sanctuary objectives and actions planned for the next ten years; and (2) to propose strategies toward the achievement of the SOS's goals using the best means available and provide clear performance measures for each proposed action.

The Plan is designed to guide the mitigation of threats faced by whales and the assessment of their recovery for the next ten years in the SOS. The operative part of the Plan is a Research and Action Plan that involves assessing and addressing threats and research on the recovery of whale populations and their habitats. The Research and Action Plan is structured based on the Commission's agreed objectives for the SOS. Each objective is linked directly to a measurable objective, action or approach and performance measure.

There was considerable discussion in the working group about the policy and scientific aspects of the draft Plan. It was clarified that this *is* a draft and the Committee is meant only to review, comment and potentially offer advice to the Commission on the scientific dimensions of the plan. Given this, the Working Group **agreed** to append the draft Plan (SC/67b/SAN01, now Appendix 2), with Objectives 1 and 8 (relating to policy) and the chapeau of Objective 5 redacted, to clarify that the Committee did not address these elements of the Plan.

A statement from the Government of Japan regarding its position on the SOS and this draft Management Plan is attached as Appendix 3.

The Working Group also discussed the potential contributions that data and results from the Japanese scientific whaling programme in the Southern Ocean (NEWREP-A) could make to the objectives and goals of the Plan. The working group **agreed** to amend SC/67b/SAN01 (see Appendix 2) to refer to NEWREP-A under Objectives 4-6.

The draft Plan recommends making it a standing agenda item of the Committee to report progress on the Plan to the Commission's biennial meetings. It was clarified that, given the working group is not convened at every Committee annual meeting, this should be more a standing directive, to cross-reference relevant deliberations, recommendations, and advice from the various sub-committees and working groups to the Plan's objectives. These relevant discussions should be highlighted in each year's Committee report for the Commission, to allow the latter to monitor and measure progress on the scientific aspects of the Plan.

Attention: SC, C-A

In its discussions of the draft Management Plan for the Southern Ocean Sanctuary (SOS), the Working Group ***recommended*** *the inclusion of a new standing item on the agendas of all of the Committee's relevant sub-committees and working groups: 'new information relevant to the SOS Management Plan'. This will assist the Commission in monitoring and measuring progress on the scientific objectives of the Plan.*

It was noted that Objectives 2-7 and the Plan's related measurable objectives, approach/actions and performance measures are highly relevant to the work of the Committee. After discussion, it was **agreed** that it would be appropriate to add language referring to the IMO Polar Code for shipping, best placed under Objective 2 (see Appendix 2). In response to comments regarding the lack of specificity of some performance measures under this and some other objectives, it was noted that there is no way to ensure outcomes of overly specific performance measures (such as a target population number) in a management plan of this nature. Therefore, performance measures that monitor progress and determine, in a binary manner (yes/no), whether progress is being made on an objective, or an objective has been reached, are more durable and practical.

Attention: C-A, CC

The Working Group ***endorsed*** *the measurable objectives, approach/actions and performance measures of Objectives 2 through 7 of the draft Southern Ocean Sanctuary (SOS) Management Plan, attached to Annex R as Appendix 2. These measurable objectives, approach/actions and performance measures are related to science and therefore within the remit of the Scientific Committee.*

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4. RESPONSES TO REQUESTS FROM THE COMMISSION ON SCIENTIFIC ASPECTS OF SANCTUARIES

There was no new information on this agenda item.

5. WORK PLAN AND BUDGET

5.1 Work plan for 2019-2020

The Working Group **agreed** that the two-year work plan would include considering new information related to the Southern Ocean Sanctuary Management Plan and providing responses to requests from the Commission on scientific aspects of sanctuaries (Table 1).

5.2 Budget requests for 2019-2020

There were no budgetary implications for the work plan, so no budget requests were considered.

6. ADOPTION OF REPORT

The report was adopted at 19:01hrs on 30 April 2018.

REFERENCE

International Whaling Commission. 2017. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

Table 1

Work plan for SAN.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual Meeting
Consider new information related to the Southern Ocean Sanctuary Management Plan	-	Cross-reference relevant information from other sub-committees and working groups	-	Cross-reference relevant information from other sub-committees and working groups
Provide responses to requests from the Commission on scientific aspects of sanctuaries	-	Review and advise in report	-	Review and advise in report

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Appendix 1

AGENDA

1. Introductory items
   1.1 Introductory remarks
   1.2 Election of Chair
   1.3 Appointment of Rapporteur
   1.4 Adoption of Agenda
   1.5 Review of available documents
2. New Sanctuary proposals
3. Review of the Southern Ocean Sanctuary Management Plan
4. Responses to requests from the Commission on scientific aspects of sanctuaries
5. Work plan and budget
   5.1 Work plan for 2019-2020
   5.2 Budget requests for 2019-2020
6. Adoption of Report

Appendix 2

DRAFT SOUTHERN OCEAN SANCTUARY MANAGEMENT PLAN

William de la Mare[1], Taylor Dearie[1], Hilary Anderson[2], John McKinlay[1], Elanor Bell[1] and Michael Double[1]

At the decadal reviews of the Southern Ocean Sanctuary (SOS) in 2004 and 2016, the Scientific Committee recommended that the SOS should have a management plan that linked objectives to measurable or identifiable outcomes. This recommendation was endorsed by the Commission. In order to progress this recommendation, the authors have developed a draft management plan for consideration by the Scientific and Conservation Committees.

Introduction

The Southern Ocean Sanctuary, established under paragraph 7(b) of the Schedule to the International Convention for the Regulation of Whaling (the Convention), was adopted in 1994. It covers the waters of the Southern Ocean around Antarctica (see Fig. 1). The exact geographic coordinates for the Southern Ocean Sanctuary are given in paragraph 7(b) of the Schedule to the Convention.

The northern boundary of the Southern Ocean Sanctuary partially coincides with the southern boundary of the Indian Ocean Sanctuary. The Indian Ocean Sanctuary covers the whole of the Indian Ocean South to 55°S. The combined effects of the two sanctuaries is to provide a high level of protection from future commercial whaling by member states of the International Whaling Commission for the populations of great whales that breed in the Indian Ocean.

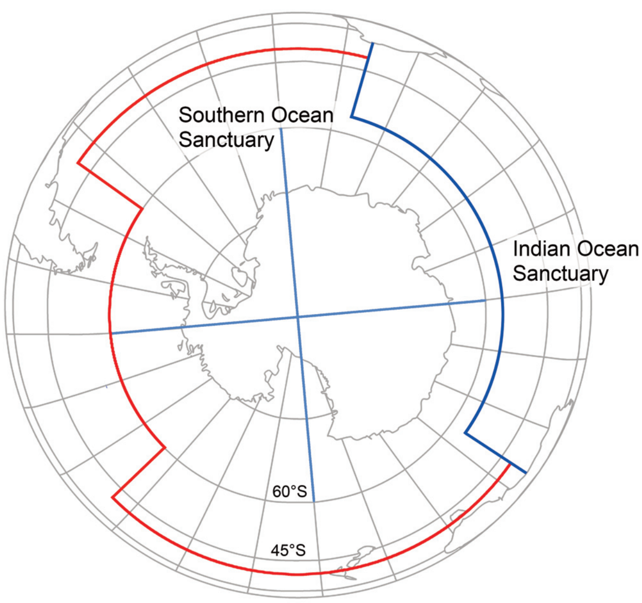

Fig. 1. Boundary of the Southern Ocean Sanctuary. The southern boundary of the Indian Ocean Sanctuary coincides with the northern boundary of the Southern Ocean Sanctuary. Factory ship whaling is forbidden in southern hemisphere waters North of 40°S.

Objectives of the Southern Ocean Sanctuary

The Southern Ocean Sanctuary proposal, put forward by France, stated that the primary purpose of the Sanctuary is to 'contribute to the rehabilitation of the Antarctic marine ecosystem by reinforcing and complementing other measures for the conservation of whales and the regulation of whaling, in particular by the protection of all Southern Hemisphere species and populations of baleen whales and the sperm whales on the feeding grounds' (IWC/44/19).

In 2014 the Commission adopted the following objectives for the Southern Ocean Sanctuary:

(1) Contribute to the rehabilitation of a marine ecosystem damaged by the over-exploitation of whales and allow for the restoration of a complex of whale species and populations.
(2) Secure a long-term satisfactory habitat for cetaceans and other marine life.
(3) In combination with the Indian Ocean Sanctuary, fully protect at least one population of each of the great whales throughout its migratory range and life-cycle, i.e. on feeding and breeding grounds, to provide for their long-term conservation.
(4) Provide a reference area to allow for the collection of information on levels and trends onunexploited and recovering whale populations.
(5) Allow for the monitoring of the recovery of ecosystems without their being disturbed by further commercial whaling
(6) Allow for coordinated research on the effects of environmental change on whale stocks.
(7) Allow for the Comprehensive Assessment of the effects of setting zero catch limits on whale stocks.
(8) Allow for application of the Revised Management Procedure (RMP) to be phased in over limited geographic ranges and species.

Review of the Southern Ocean Sanctuary and recent recommendations

The Schedule amendment establishing the Southern Ocean Sanctuary (SOS) requires the Sanctuary to be reviewed at succeeding ten-year intervals, unless otherwise revised by the Commission. The first review of the Sanctuary took place in 2004 and the second review was completed in 2016. In 2014 the Commission adopted the objectives given above and provided terms of reference for the review to be undertaken by the Scientific and Conservation Committees. The Scientific Committee in its review (IWC, 2017) made the following recommendations:

- Each SOS objective should be linked to an appropriate performance measure.
- Appropriate performance measures for the SOS should be developed. These should link the objectives of the SOS with field monitoring programmes.
- Performance measures for some scientific objectives could draw on existing mechanisms, such as the In-Depth assessment process.
- The SC could provide suggestions for appropriate performance measures in relation to the scientific objectives of the SOS to the Commission in future, should the Commission request it.
- Outputs from existing and planned research programmes should be incorporated into the development of a management plan for the SOS and subsequent monitoring programmes.
- A management plan for the SOS should be developed to clearly outline the broad strategies and specific actions

[1] *Australian Antarctic Division, Channel Highway, Kingston, Tasmania, 7007, Australia.*
[2] *Marine Policy Section, Department of the Environment and Energy, GPO Box 787, Canberra, ACT, 2601, Australia.*

needed to achieve Sanctuary objectives. This information could be collated, based on the SC's recent relevant activities.

These recommendations were taken into account in drafting the management plan.

Purpose of the Southern Ocean Sanctuary Management Plan

The purpose of this Management Plan is twofold: (1) to inform the Commission and public about the Sanctuary objectives and actions planned for the next ten years, and (2) to propose strategies toward the achievement of the Sanctuary's goals using the best means available and point out clear performance measures for each proposed action.

Structure and scope of the Southern Ocean Sanctuary Management Plan

This Plan is designed to guide the mitigation of threats faced by whales and the assessmentof their recovery for the next ten years in the Southern Ocean Sanctuary. The operative part of this Plan is the Research and Action Plan. The Research and Action Plan is key to achieving the objectives of the Southern Ocean Sanctuary concerning: (1) the assessing and addressing of threats; and (2) the research on the recovery of whale populations and their habitats.

The Research and Action Plan is structured around the Commission's agreed objectives for the Southern Ocean Sanctuary. Each objective is linked directly to a measurable objective, action or approach and performance measure.

Commission objectives

The objectives given above describe in general terms the desired outcomes of the Southern Ocean Sanctuary concerning the conservation and management of whales.

Measurable objectives

A measurable objective is one that can be objectively assessed based on outcomes that can be expressed quantitatively or can be assessed against defined criteria that allow a statement of whether or not it has been achieved. The Commission's general objectives are deemed to be met when the measurable objectives are met.

Approach/Action

An Approach/Action outlines how the measurable objectives will be progressed. Actions are activities developed and implemented to contribute to achieving the measurable objectives.

Performance measure

A performance measure is a direct measure consequent to a measurable objective that allows for a judgement to be made about progress towards meeting it.

The Research and Action Plan takes into account a number of threats faced by whale populations both inside the Southern Ocean Sanctuary, in the adjacent Indian Ocean Sanctuary and other waters in the Southern Hemisphere. These threats include by-catch and entanglement, vessel collisions, effects on whale habitat of climate change and ocean acidification, marine pollution, competition with fisheries and marine noise. The Commission has made considerable progress in its efforts to address these threats globally. This management plan provides for this progress to be evaluated in the specific context of the Southern and Indian Ocean sanctuaries.

Coverage of the Management Plan

This Management Plan focuses on all great whale species that were subject to commercial whaling within the area subsequently covered by the Southern Ocean Sanctuary[3]. The species covered by the Management Plan are listed below and a summary of the state of knowledge on these species as of 2014 is given in Adjunct A. Any reference in this plan to 'all species' means all stocks of the species listed below that spend at least part of the year in the Sanctuary.

- Blue whale
- Pygmy blue whale
- Fin whale
- Sei whale
- Antarctic minke whale
- Common minke whale
- Humpback whale
- Southern right whale
- Sperm whale
- Killer whale

Implementation of the Management Plan

The implementation of this Management Plan will require cooperation and coordination among national and international government agencies, as well as private organisations and individuals. The Management Plan is designed to provide guidance for researchers and policy makers to facilitate policy development and research within an ecosystem context, particularly through information exchange and the coordination of research.

Role of Scientific and Conservation Committees

The Scientific and Conservation Committees should include standing agenda items to report progress to the Commission's biennial meetings. This will ensure monitoring of progress of the plan and that the Commission, public, researchers and other interested parties are apprised of progress and will enable resource gaps to be identified and will improve communication among researchers, stakeholders and the general public. The Committees in light of developments may make recommendations to amend approaches/actions and performance criteria.

Communicating the Management Plan

The Secretariat with the assistance of the Scientific and Conservation Committees will compile and maintain a contact list of intergovernmental organisations, range states not members of the IWC, NGOs, polar programmes, scientists and SORP project investigators. This list will be used both to provide and to seek information relevant to the implementation of this plan. The Secretariat will establish a web page informing the public about the SOS and maintain an appropriate digest of matters relating to the progress of the management plan.

Duration of the Management Plan

The Sanctuary Management Plan should be reviewed and refined every ten years to account for ecological, oceanographic and other possible changes in an adaptive fashion.

Performance and limitations of the Management Plan

A fundamental aspect of the SOS Management Plan is to enable regular and continuing performance evaluation. Regular evaluation of progress is required in order to identify aspects that can be improved or that require more attention. Given that the recovery of severely depleted populations will take many decades, it is not realistic to suppose that the Commission's objectives will all be met in the ten-year life of this Management Plan. Consequently, the measurable

[3] Specifically, paragraph 7b states 'This prohibition applies irrespective of the conservation status of baleen and toothed whale stocks in this Sanctuary, as may from time to time be determined by the Commission'.

objectives are framed in terms of whether progress is in the appropriate direction. The success of the actions proposed by this Management Plan is closely linked to the availability of budget, secretariat support and logistic/research support from a range of agencies. Many of the actions that will contribute to the overall success of the Plan fall outside the regulatory competence of the IWC. In such cases the actions required of the IWC are to inform other agencies about steps that they might take to improve the conservation and management of whales and their habitats.

The Research and Action Plan

Objective 1: Contribute to the rehabilitation of a marine ecosystem damaged by the overexploitation of whales and allow for the restoration of a complex of whale species and populations.

Measurable objective	Approach/Actions	Performance measure
Deferred to Commission discussions		

Objective 2: Secure a long-term satisfactory habitat for cetaceans and other marine life.

This objective is interpreted in the context of the Southern Ocean Sanctuary on its own, and hence deals primarily with threats to the species on their feeding grounds in the Southern Ocean.

Measurable objective	Approach/Action	Performance measure
Encourage complementary actions from international agencies.	Liaise/transmit information about whales and their habitat with relevant organisations. Receive information from relevant organisations on actions to mitigate environmental threats. Collaborate with IMO on development of the Polar Code for shipping.	IWC designated Observers have engaged and reported on key meetings: at CEP, CCAMLR, IMO, FAO, and UNEP[1]. Secretariat transmits recommendations from the IWC to relevant organisations and seeks information about any consequent actions taken.
Encourage the sustainable management of krill fisheries by CCAMLR consistent with its ecosystem approach.	Receive information from CCAMLR about krill, status of krill predators, measured by CEMP. Transmit information about whales and their habitat to CCAMLR.	Collaboration between the respective scientific committees to examine interactions between krill and dependant species.

[1]See Adjunct B for a list of acronyms.

Objective 3: In combination with the Indian Ocean Sanctuary, fully protect at least one population of each of the great whales throughout its migratory range and life-cycle, i.e. on feeding and breeding grounds, to provide for their long-term conservation.

Measurable objective	Approach/Action	Performance measure
Encourage Contracting Governments, range States, particularly in the Indian Ocean, IGOs and NGOs to address threats identified by the IWC.	Liaise/transmit information about whales and threats with relevant organisations including range states, regional fisheries management organisations, IGOs and NGOs. Receive information from relevant organisations on actions to mitigate environmental threats.	IWC designated Observers have engaged and reported on key meetings of IMO, FAO, and UNEP. Observers have also reported on meetings of regional bodies that consider marine conservation and management. Secretariat has transmitted recommendations from the IWC to relevant organisations and sought information about any consequent actions taken.
Contribute to a reduction in whale-vessel collision rates.	(a) Initiate/promote a broad and long-term programme to evaluate the degree of overlapping between vessel routes and the distribution of whale populations. (b) Estimate rates of whale-vessel strikes and identify areas of higher risk. (c) Evaluate and propose mitigation actions if appropriate. (d) Contribute data to the IWC vessel-strike database.	Information provided to IGOs and range states on best practice to reduce risks of whale-vessel collisions. Actions taken to reduce risks of whale-vessel collisions.
Reduce mortality due to entanglements in fishing gear.	(a) Study overlap between fisheries and the distribution of whale populations. (b) Promote cooperation with fishing industry and other stakeholders in order to minimise entanglements. (c) Develop and promote best practice plans to mitigate entanglements. (d) Promote capacity building under the IWC disentanglement programme.	Information provided to IGOs, RFMOs and range states on best practice to mitigate whale entanglements.
Identify significant feeding and breeding grounds for important populations of great whales in SOS.	Improve and deploy satellite tracking and remote sensing methods for identifying whale migration routes. Collaborate with relevant research programmes to improve remote sensing to measure the distribution, production and abundance of krill.	Improved information on whale distributions and migration routes. Improved information about krill distributions. Improved information on whale foraging behaviour.

With respect to commercial whaling this objective is also attained by maintaining the existing legal protections and management measures for the combined Southern and Indian Ocean sanctuaries, and in this sense this objective has the same measurable objective and actions as set out under Objective 1.

This objective is additionally interpreted here as actions that could be taken to mitigate other threats to at least one population of each species that occur across their full migratory ranges covered by the combined SOS and Indian Ocean Sanctuary areas. Of course these actions are relevant to all ocean areas adjoining the SOS.

Objective 4: Provide a reference area to allow for the collection of information on levels and trends on unexploited and recovering whale populations.

In practical terms some of the information on recovering populations is most efficiently collected outside the Southern Ocean Sanctuary, particularly in the case of populations that migrate or breed near coasts.

Measurable Objective	Approach/Action	Performance measure
Continue baleen whale abundance research. Continue to develop acoustic methods for measuring trends for some species.	Develop cost-feasible methods for estimating the abundance of baleen whales in the Southern Ocean Sanctuary. Take account of information provided under NEWREP-A.	Information about methods, abundance and trends in abundance continues to accrue.

Objective 5: Allow for the monitoring of the recovery of ecosystems without their being disturbed by further commercial whaling.

Explanatory text deferred to Commission discussions.

Measurable objective	Approach/Action	Performance measure
Support ecosystem monitoring programmes.	Develop and maintain collaborations through SORP, CCAMLR, SCAR, SCOR, SOOS, NEWREP-A.	IWC provides information that contributes to the implementation and analyses of ecosystem monitoring programmes.

Objective 6: Allow for the coordinated research on the effects of environmental change on whale stocks.

Measurable Objective	Approach/Action	Performance measure
Contribute to long term strategic research programmes to gather relevant information about environmental change and its effects on whale stocks. Contribute to the development methods for predicting the environmental effects on whale prey, such as Antarctic krill.	Develop and maintain collaborations through SORP, CCAMLR, SCAR, SCOR, SOOS, NEWREP-A. Contribute information about whales and their habitats to relevant international research programmes.	Collaboration with relevant scientific programmes to examine effect of environmental change on marine ecosystems, including interactions between primary production, krill and dependant species.

Objective 7: Allow for the Comprehensive Assessment of the effects of setting zero catch limits on whale stocks.

Measurable Objective	Approach/Action	Performance measure
Continue to develop comprehensive assessments for SOS species.	Scientific Committee to continue its work on comprehensive assessments.	Continuing progress on comprehensive assessments.

Objective 8: Allow for application of the Revised Management Procedure (RMP) to be phased in over limited geographic ranges and species.

The context of this objective is that the decision to resume commercial whaling by amending paragraph 10e of the Schedule of the Convention alone would not enable to the resumption of commercial whaling in the SOS. Paragraph 7b (which establishes SOS) would also have to be amended before the RMP/RMS could be applied to any area currently included in the sanctuary. The intent of the objective is that the amendments to Paragraph 7b should not be considered until experience with the application of the RMP/RMS has been obtained elsewhere.

Measurable Objective	Approach/Action	Performance measure
Deferred to Commission Discussions		

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International Whaling Commission. 2014. Report of the Scientific Committee Intersessional E-mail Group on Sanctuary and Sanctuary Proposals. Paper IWC/65/CCRep08rev1 presented to the 65th meeting of the International Whaling Commission, September 2014, Portoroz, Slovenia (unpublished). [Paper available from the Office of this Journal].

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Adjunct A. Abundance and Trend Estimates for Whale Stocks Found in the Southern Ocean

Species	Stocks	Trends in abundance (period, CV, reference)	Most recent abundance estimate (Year, CV, reference)	Observation	Threats
Blue whale	Areas I-IV	2.5-8.4%/year (1978/79-1997/98, Branch, 2007)	2,280 (1991/92-1997/98, CV=0.36, Branch, 2007)		
Pygmy blue whale	Areas I-VI	NA			
Fin whale	Areas I-VI	NA	5,500 (1996, CV=XX, Branch and Butterworth, 2001)	Only includes animals south of 60°S	
Sei whale	Areas I-VI	NA	NA		
Antarctic minke whale	Areas I-VI	515,000 (1992/93-2003/04, CV=XX, IWC, 2013)			
Common minke whale	Areas I-VI	NA	NA		
Humpback whale	BSA (Brazil)	7.4%/year (1995-1998, CV=0.45, Ward et al., 2011)	6,400 (2005, CV=0.11, Andriolo et al., 2010)		
Humpback whale	BSB1 (central-west Africa)	NA	6,800 (2001-5, CV=XX)		
Humpback whale	BSB2 (central-west Africa)	NA			
Humpback whale	BSC1 (eastern Africa)	9-12.3%/year (1988-2002, Findlay et al., 2006)	6,808 (2001, CV=0.14, Findlay et al., 2011)		
Humpback whale	BSC2	NA	NA		
Humpback whale	BSC3 (Madagascar)	NA	7,406 (2006, CV=0.37, Cerchio et al., 2009)		
Humpback whale	BSC4	NA	NA		
Humpback whale	BSD (West Australia)	12.9%/year (1999-2008, CV=0.2, Hedley et al., 2010)	NA		
Humpback whale	BSE1 (East Australia)	10.9%/year(1984-2010, CV=XX, Noad et al., 2011)	14,522 (2010, CV=XX, Noad et al., 2011)		
Humpback whale	BSE2+E3+F (Oceania)	NA	4,329 (1999-2005, CV=0.12, Constantine et al., 2012)		
Humpback whale	BSG	NA	6,504 (2006, CV = XX, Felix et al., 2011)		
Southern right whale	Southwest Atlantic	~6.2%/year (IWC, 2013)	4,030 (2009, IWC, 2013)		
Southern right whale	South Central Atlantic	NA	80 (2009, IWC, 2013)		
Southern right whale	Southern Africa	~6.8%/year (IWC, 2013)	4,410 (2009, IWC, 2013)		
Southern right whale	Southwest Pacific/ Mainland NZ	NA	NA		
Southern right whale	Southwest Pacific/Sub Antarctic NZ	~7%/year	2,670 (2009, IWC, 2013)		
Southern right whale	SE Australia	NA	NA		
Southern right whale	South Central Australia/SW Australia	~6.8%/year	2,420 (2009, IWC, 2013)		
Southern right whale	SE Pacific (Chile/Peru)	NA	NA		
Sperm whales	Divisions 1-9	NA	11,599 (1991/92-1997/98, CV=0.20, Branch and Butterworth, 2001)	Only includes mature males south of 60°S	

Adjunct B. List of Acronyms

CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEMP	CCAMLR Ecosystem Monitoring Programme
CEP	Committee for Environmental Protection under the Antarctic Treaty
FAO	Food and Agricultural Organisation of the United Nations
IGO	Inter-Governmental Organisation
IMO	International Maritime Organisation
NGO	Non-Government Organisation
RFMO	Regional Fisheries Management Organisation
SCAR	Scientific Committee for Antarctic Research
SC-CCAMLR	Scientific Committee for the Conservation of Antarctic Marine Living Resources
SCOR	Scientific Committee on Oceanic Research
SORP	IWC Southern Ocean Research Partnership
SOOS	Southern Ocean Observing System (SCAR and SCOR)
SOS	Southern Ocean (Whale) Sanctuary
RMS	Revised Management Scheme
RMP	Revised Management Procedure
UNEP	United Nations Environment Programme

Appendix 3

STATEMENT OF THE GOVERNMENT OF JAPAN ON THE DRAFT SOUTHERN OCEAN SANCTUARY MANAGEMENT PLAN

Japan opposed the establishment of the Southern Ocean Sanctuary (SOS) when it was adopted in 1994 and does not support maintaining sanctuaries without scientific justification.

While Japan opposes the SOS, it understands that the Working Group to Review Sanctuaries and Sanctuary Proposals in 2016 (Sanctuary WG 2016) recommended elaboration of a Management Plan for the SOS taking into account its other recommendations.

With that understanding, Japan urges reconsideration and modification of the proposed Management Plan in accordance with the recommendations of the Sanctuary WG 2016, including the establishment of review criteria linked to performance measures and reflecting the goals and objectives of the SOS. Further, actions that fall outside the regulatory competence of the IWC should not be included in the Management Plan.

Annex S

Report of the *Ad hoc* Working Group on Photo-Identification

Members: Olson (Convenor), Al Harthi, Aoki, Bell, Brierley, Brownell, Castro, Charlton, Clapham, Collins, Coscarella, Dalla Rosa, de Andrade Freitas, Domit, Doniol-Valcroze, Donovan, Double, Elwen, Ferriss, Forestell, Fortuna, Gallego, Galletti, Genov, Iñíguez, Irvine, Jackson, Kim, Kuppusamy, Lang, Lauriano, Luna, Lundquist, Mallette, Marcondes, Marmontel, Matsuoka, Minton, Mizroch, Øien, Palka, Panigada, Reeves, Reyes Reyes, Ritter, Robbins, Rodriguez, Ryeng, Scott, Slooten, Slugina, Stack, Strasser, Svoboda, Taylor, Torres, Torres-Florez, Tullio, Urbán, Vikingsson, Wade, Wambiji, Weinrich, Weller, Willson, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Olson welcomed participants and introductions were made.

1.2 Election of Chair
The Working Group formally approved the nomination of Olson as Chair.

1.3 Appointment of Rapporteurs
Minton agreed to undertake duties as rapporteur.

1.4 Adoption of Agenda
The adopted Agenda is given in Appendix 1.

1.5 Documents available
The documents available to the Working Group were SC/67b/PH01-05; SC/67b/ASI04; SC/67b/SH08; SC/67b/SH16.

2. Humpback whale catalogues
This agenda item was opened with an update from Olson on the Antarctic Humpback Whale Catalogue (AHWC), maintained at College of the Atlantic, USA. The catalogue was established in 1987 and during the past 30 years its data have been used in dozens of studies and publications (Stevick *et al.*, 2017). With a recent loss in funding, the catalogue database is now 'frozen' and not being actively updated. The Working Group expressed strong disappointment at this news as well as the hope that the AHWC's funding situation will change and enable the catalogue to continue.

Attention: SC, G

The Scientific Committee has been informed that due to a loss of funding, the Antarctic Humpback Whale Catalogue curated by the College of the Atlantic, USA will no longer be updated. The Committee:

*(1) **draws attention** to the great value this catalogue (established in 1987) has provided to the Committee, including receiving photographs from the IWC IDCR and SOWER cruises and providing information for the Committee's Comprehensive Assessment of Southern Hemisphere humpback whales;*
*(2) **welcomes** news that the existing catalogue will remain a resource for scientists; and*
*(3) **encourages** potential funders to support future continuation of the catalogue.*

Mallette shared information about the Mid-Atlantic Humpback Whale Photo-ID Catalog (MAHWC), which includes images and sighting data collected over the last two decades from the mid-Atlantic and southeast coast of the United States (New York to Florida). The MAHWC will be hosted by OBIS-SEAMAP and will help standardize and streamline photo-ID efforts to facilitate efficient exchange of information between the MAHWC and broader regional catalogues (i.e. North Atlantic Humpback Whale Catalog and Gulf of Maine Catalog). The Working Group **welcomed** this information and recognised the growing trend in large, collaborative catalogues with the development of increased technological archiving capabilities.

2.1 Flukebook
SC/67b/PH03 described Flukebook, a non-profit, open source cetacean data archiving and photo matching tool developed under the Wildbook Platform. In 2016 the IWC approved funding for the development of a regional data platform for the Arabian Sea Whale Network (ASWN), to be implemented in collaboration with Wild Me, the developers of Flukebook. The ASWN is joining Flukebook, with two primary objectives: (1) to consolidate and more effectively manage humpback whale and other cetacean data collected in Oman over the past 20 years; (2) to provide an online platform that will allow comparison and regional-level analysis of cetacean data collected by different research groups throughout the Arabian Sea. Humpback whale photo-identification data have been uploaded from Oman, as well as a few incidental photos from Pakistan and India. The data platform has been designed according to the Terms of Reference specified by the ASWN, and a number of improvements and further refinements are being made to the platform in response to feedback gathered during a workshop held in Oman in January 2018 (SC/67B/CMP07). While the data uploaded from ASWN contributors will be accessible only to the data contributors themselves, the new data fields and functions that have been added to the Flukebook platform will become standard and available to all future users of the open-source platform.

The Working Group was impressed by the features described for this platform and the sophistication of its fluke matching algorithms for humpback whales. Questions arose regarding the merging of large datasets. The author explained that ASWN's data set is relatively small but Flukebook houses large data sets on the scale of the SPLASH study (Calambokidis *et al.*, 2008). The Working Group looks forward to updates on this work.

2.2 Happywhale
SC/67b/PH05 provided an update on the development and status of Happywhale, a web-based marine mammal photo-ID crowd-sourcing platform which has been online since August 2015. Happywhale has now received over 88,000 contributed images. To date the platform has concentrated on humpback whales although it gathers images from other cetacean species as well. Currently the computer-assisted matching system is available for humpbacks only. In addition to humpback whales, in recent months Happywhale provided

images to research scientists of a Northern right whale, Southern right whales, Antarctic blue whales, and Antarctic killer whales. Active system development has continued in the past year, focusing on both improving the user experience to make participation more rewarding, and on features to support science usage. As a result, there has been a doubling of usage rates in the last year with an increase of 110% of the total dataset as of the same time in 2017. As the system has become more widely known and better understood, image and metadata quality has increased, and more users are contributing images with embedded GPS, significantly improving the scientific value of encounter data.

The Working Group was interested in how the humpback whale fluke matching algorithms work. The platform uses the same matching algorithms developed by the WildBook platform and also used by Flukebook (briefly described in SC/67b/PH03). There was also interest in what happens with photos contributed to the platform. It was clarified that photographs uploaded to/contributed to Happwhale are subsequently forwarded on to the appropriate catalogue holders for the species and region where the sighting was made for inclusion in their respective catalogues.

Clapham described a proposed study that would utilize Happywhale to conduct large-scale comparisons of humpback whale photographs from regions across the South Pacific from Oceania to South America. The overarching question to be addressed is whether humpback whales move across the entire South Pacific, or whether whales in the eastern portion of this ocean constitute a largely discrete population. The Working Group **endorsed** this proposal (with no budget implications). Furthermore, it was **agreed** that the effort should be as inclusive as possible, including all South Pacific catalogues that wish to participate and have suitable data to submit (IWC, 2017).

3. BLUE WHALE CATALOGUES

3.1 Photo-identification of Antarctic blue whales

SC/67b/PH02 described the results of the comparison of newly available collections of identification photographs of individual Antarctic blue whales to the images of 441 individuals in the Antarctic Blue Whale Catalogue. The sources of photographs include the IWC IDCR/SOWER cruises in 1989/1990, 1993/1994, and 1997/1998, and opportunistic photographs collected by collegial scientists, naturalists, and tourists 2015-2018. Seventeen new individual blue whales were identified: 4 from the SOWER cruise in 1998 and 14 from the opportunistic photos. There were no matches between any of the newly identified whales or to the Antarctic Catalogue. The 17 new identifications bring the total number of photo-identified Antarctic blue whales up to 458 whales, represented by 342 left sides and 332 right sides. The minimum (332) and maximum (458) number of unique individuals represents 15% and 20%, respectively, of the most recent accepted estimate of abundance of Antarctic blue whales, 2,280 in 1997/1998 (Branch, 2007). All 17 of the new identifications came from IWC Management Areas underrepresented in the catalogue, Areas I and II. The photographs from 1998 are a valuable contribution to the Catalogue; a future recapture of any of the identified whales from this year would improve the estimate of survival in an abundance model. To date the longest recapture interval is 12 years, 1995-2007 (Olson *et al*., 2016). The collection of Antarctic blue whale identification photographs provide data for capture-recapture estimates of abundance (SC/67B/SH08) as well as information on the movement of individual blue whales within the Antarctic region.

The Working Group **commended** the work of the catalogue and **agreed** that it continue. There was interest in how outreach is conducted in order to promote new contributions to the database. This has occurred mainly through Happywhale, as well as direct outreach by the IWC-SORP program to the Association of Antarctic Tour Operators (IAATO).

Following discussion regarding the value of photographs contributed from citizen scientists, the Working Group **agreed** that the development of a simple guide to help tourists and operators take photos that are suitable for photo-identification. This guide could be produced in an A4 PDF format that could be laminated for use on vessels, and a short Powerpoint presentation could be prepared for naturalists to use for pre-tour or on-board presentations.

The Working Group also put forth that any photos obtained through these channels in the Antarctic be uploaded to Happywhale, which could function as a central conduit to ensure photos are disseminated to the relevant species catalogue holders. It was suggested that the relationship between Happywhale and the producers of the guide be formalized with an MoU to clarify roles, responsibilities and data ownership.

Attention: SC

(1) The Working Group ***agrees*** *that the Antarctic Blue Whale Catalogue continue its work collecting adding photo-identification data to the catalogue in order to assist with developing estimates of population abundance for Antarctic blue whales.*

(2) The Working Group ***agrees*** *that the development of a simple guide (physical and electronic versions) to help tourists and naturalists take photos that are suitable for photo-identification should be undertaken. This will support the photo-ID catalogues from the Antarctic region for use in population assessments by the IWC, particularly for blue whales, right whales, fin whales, and humpback whales.*

3.2 Southern Hemisphere Blue Whale Catalogue

SC/67b/PH04 summarised the progress made on the Southern Hemisphere Blue Whale Catalogue (SHBWC). To date, the SHBWC has a total of 1,519 individual blue whale photo-identifications represented by 1,101 right side identifications, 1,116 left side identifications and 60 tail flukes. The SHBWC has become the largest repository of Southern Hemisphere blue whale photo-identifications. Seventeen blue whale research groups are contributing photo identification data from areas off Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific (ETP), Australia, Timor Leste, New Zealand, southern Africa, Madagascar and Sri Lanka. During this period no new data were received either from new seasons or new groups. In line with recommendations made last year during SC/67A, SHBWC's work in 2017 focused on comparisons of the catalogues from Australia, New Zealand and Sri Lanka. Results based on the left side comparisons found no matches between Australia, New Zealand and Sri Lanka, reinforcing the hypothesis of separate populations. Exchange was found between three areas in Australia, suggestive of single a population. Re-sights found in New Zealand support the hypothesis of some site fidelity to this area. Further details are reported in SC/67b/SH16. Comparison of right sides is underway and expected to be completed soon. Once these priority comparisons are completed, the Australian photographs will undergo uniform quality coding, to prepare a database for a capture-recapture analysis.

In 2017 improvements made to the database software included the implementation of a tool to import from Excel the date and location data associated with the photos.

In order to support the assessment work of the Scientific Committee, in 2018 priorities for the SHBWC are to integrate the IWC photo-ID catalogue guidelines on photo-quality, update the user manual, and to compare of the catalogues from the ETP and South America (which will include new photographs expected from Chile).

The Working Group **commended** these efforts and recognised the enormous volume of work it reflects. It was **agreed** that the catalogue continue. The importance of performing regular back-ups of the database on the IWC server was pointed out. Clarifications to the wording in the User Manual were suggested and will be carried out in the upcoming months. The author explained that quality scoring of photographs will be supported by a document standardising scoring criteria with examples for each category to ensure consistency of scoring between individuals and over time. New data are expected in the next year from Chile, Madagascar, and the eastern tropical Pacific.

Attention: SC

*The Southern Hemisphere Blue Whale Catalogue provides data useful for estimating abundances and examining connectivity between feeding and breeding grounds. The Working Group **agrees** that the catalogue continue.*

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4. FIN WHALE AND OTHER WHALE PHOTO-ID CATALOGUES

4.1 Photo-identification of Antarctic fin whales

SC/67b/PH01 reported on the compilation of a new photo-identification catalogue of Antarctic fin whales A total of 1,121 fin whale photographs from SOWER cruises 2004-2008 and 22 photographs collected opportunistically near the South Orkney Islands during a CCAMLR research voyage investigating Antarctic demersal fish were examined for individual identifications. In order to assess the suitability of Antarctic fin whales for photo-ID, individuals were scored categorically in two measures of distinctiveness: (1) the number of match points per side, and (2) the 'brightness' of the chevron and blaze pigmentation on the right side. The photographs yielded 30 unique identifications, represented by 15 left sides and 19 right sides. Twenty-eight identified whales were photographed in IWC Management Areas III, IV, and V. Two whales were photographed at the South Orkney Islands in Area II. There were no matches between any of the identified individuals from different dates. The study confirmed that Antarctic fin whales are marked well enough to serve as subjects for photo-ID projects. 97% of scored whales exhibited 3 or more match points per side and 75% of the whales scored for brightness had moderately visible or highly visible chevron and blaze patterns. It was noted that the majority of the fin whale photographs from SOWER 2006/2007 are currently missing from the IWC archives. When the photos are recovered they should add another add another 20-24 identifications. The catalogue serves as a foundation for future photo-ID studies, especially those proposed for the western Antarctic Peninsula.

The Working Group **welcomed** this effort and **encouraged** the continuation of this work as it can potentially contribute to the work toward generating an abundance estimate for fin whales in the Southern Hemisphere. It was **agreed** that the missing photographs from 2006/2007 be located, including an in depth search at the IWC Secretariat and contacting researchers from the cruises. It was noted that the photographs from this season are from the second year of two back-to-back years of fin whale research in Area III, potentially providing the opportunity for site fidelity matches. A steering group was convened to search for and/or reconstruct the collection of missing photographs from 2006/2007 and from other SOWER years.

A suggestion was made (as above) to develop clear instructions that could be shared with Antarctic tour operators so that on-board naturalists and tourists with suitably advanced camera equipment and skill would be aware of the types of photos that are needed to contribute to photo-identification efforts.

Attention: S, SC, SH

*(1) The Working Group **encourages** continuation of the Antarctic Fin Whale Catalogue which can potentially provide data toward estimating abundance or identifying movement patterns.*
*(2) The Working Group **agrees** that an exhaustive search be conducted to locate SOWER photos that are missing from the IWC archives, including those of fin whales.*

4.2 Photo-identification studies of gray whales, NE Sakhalin Island, Russia

SC/67b/ASI04 presented the results of photo-identification studies conducted annually on the Sakhalin feeding aggregation of North Pacific gray whales between 2002 and 2017. The research takes place off the northeast coast of Sakhalin Island as part of an industry-sponsored ENL-SEIC joint monitoring program. With the addition of nine calves in 2017, the Joint Program's Sakhalin gray whale catalog now contains 283 identified individual gray whales. The population can be divided into a group of 175 whales that come to Sakhalin Island for feeding on a regular basis, a group of 27 whales recorded at intervals greater than 3 years and a group of 71 individuals that have been recorded only once.

The 2017 data were collected by three teams in order to cover all of the Piltun and Offshore feeding areas. One vessel-based team conducted photographic surveys in the Piltun and Offshore feeding areas while two onshore teams, split between the southern and northern parts of the Piltun feeding area, moved along the coast in vehicles taking imagery of the whales they encountered directly from shore. DJI Phantom 4Pro drones with video cameras were added to the onshore teams' equipment. In most cases, the drone was used at an average distance of 800m from the shore, although they were able to go as far as 2.5km from the shore. The standard flight height was 8 meters. With the availability of vertical perspective photographs from the drones, a new catalog was created with video imagery of 35 individuals.

Questions arose regarding the cross-platform matching of images. The author indicated that there were no difficulties resolving the photos obtained from the three different platforms, and that it was also easy to compare with aerial photos with those obtained only from boats in previous years. The Working Group was impressed with these results.

Concern was expressed that the low-flying drones (standard height of 8m) could be causing stress to the whales, particularly mothers with calves. USA regulations require a minimum sustained height of 100ft. Although the author did not report any visible behavioural response to the drones, other researchers cautioned that stress responses (e.g., increased levels of stress hormones) may not be immediately detectable.

Researchers working with gray whales in Mexico are also starting to use drones for photo-identification and assessment of health/body condition, as are researchers working with Arabian Sea humpback whales off the coast of Oman. Custom-designed drones with high resolution cameras and LIDAR to allow photo-identification and health assessment from a higher position are currently very expensive, and researchers expressed an interest in promoting ways to adapt off-the-shelf drones for whale research purposes. The Working Group **agreed** that the increasing prevalence of drone use in whale research projects around the globe merits further discussion in SC/68A.

SC/67b/CMP/7 (see Annex O Item 2.1.3) provides details on a concurrent photo-ID study of this population of gray whales. At this year's meeting (Annex O) it was reported that the two catalogues will be unified under the auspices of the IWC.

5. GUIDELINES FOR IWC CATALOGUES AND PHOTO-ID DATABASES

5.1 Development of Appendices

At last year's meeting SC/67A, the Working Group finalised the IWC Guidelines for Photo-Identification Catalogues (IWC, 2018). The Guidelines outline 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 intended for use by projects of large whales. Because they are not guidelines on field or laboratory techniques, a selection of Appendices would be an appropriate and useful resource attached to the Guidelines.

The Working Group discussed and reviewed items for inclusion as Appendices in five categories: (1) cataloguing software; (2) image matching software; (3) seminal papers defining individual identification, by species; (4) photo quality guides; and (5) photo/data collection apps. The Working Group **agreed** to continue working on the appendices intersessionally.

6. INTERSESSIONAL WORKING GROUPS

One intersessional correspondence group and two steering groups convened during SC/67A were relevant to the aims of the *ad hoc* Working Group. ICG-17 was convened to facilitate filling data gaps in Chile and Australia regional holdings of the SHBWC and to assess data readiness for use in abundance estimates. Progress was made and and an assessment of data readiness was provided in SC/67B/PH04. Relatedly, SG-12 was formed to ensure continued work on photo-identification catalogues needed towards population assessments. A particular focus was to assess temporal and spatial progress of catalogues and the preparation of Australian catalogues for quality coding. Progress was made and details were provided in SC/67B/PH04. SG-13 was created to begin compiling technical appendices for the IWC Photo-identification Guidelines for Catalogues. A compilation of appendices was begun and continued forward during SC/67B.

See Table 1 for a list of intersessional e-mail correspondence groups for the intersessional period 2018-2019, which will report back to SC/68A next year.

7. CONCLUSIONS AND RECOMMENDATIONS

The Southern Hemisphere and Antarctic photo-identification catalogues for blue whales are potential sources of data for estimating abundances and examining connectivity between feeding and breeding grounds. The Working Group **encourages** the continuation of these catalogues.

The continuation of a new Antarctic fin whale photo-identification catalogue was **encouraged**. It was **agreed** that the missing fin whale photographs from SOWER 2006/2007 be located if possible in order that they can be added to the catalogue. A steering group was convened to search for and/or reconstruct the collection of missing photographs from 2006/2007 and from other SOWER years.

It was **agreed** that the development of a simple guide (laminate hard copy and Powerpoint format), in order to help tourists and naturalists take photos that are suitable for photo-identification should be undertaken**.** This would support the photo-ID catalogues from the Antarctic region for use in population assessments by the IWC, particularly for blue whales, fin whales, right whales, and humpback whales.

The Working Group **agreed** that a future agenda item (for SC/68A) on the use of drones for photo-identification would be useful to inform continued discussions of IWC standards for photo-identification databases.

8. WORK PLAN AND BUDGET REQUESTS FOR 2019-2020

8.1 Work plan

The Southern Hemisphere Blue Whale Catalogue and the Antarctic Blue Whale Catalogue will continue matching and adding to their respective databases (see also Annex H

Table 1

Intersessional E-mail Groups for PH 2018-2019 (for full listing see Annex Y).

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 5.1 PH	ICG	Appendices for photo-ID guidelines	Continue compilation of technical appendices for photo-ID guidelines	Olson (Convenor), Dalla Rosa, Donovan, Double, Galletti, Genov, Mallette, Marcondes, Matsuoka, Minton, Panigada, Reyes Reyes, Stack, Taylor, Torres-Florez, Weinrich
Item 4 PH	SG	Search for missing SOWER photos	Search for and/or reconstruct archive of missing SOWER photos	Matsuoka and Taylor (co-Convenors), Donovan, Olson

Table 2
Work plan for 2019 and 2020 for PH.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Appendices for IWC Guidelines for Photo-identification	Continue compilation	Appendices ready for review	Continue compilation	Appendices ready for review
Upload all available New Zealand blue whale identification photographs to SHBWC (also pertains to Annex H Item 7.1.1)	Cross-reference between separate area catalogue holdings before uploading to SHBWC avoid duplication; intersessional group convened under SH.	Included in SHBWC report	-	-
Development of how-to photo-ID materials for naturalists and citizen scientists (also pertains to Annex H Item 7.1.1.2)	Prepare hard copy and PPT photo-ID guides	Guide completed and available (pending funding)		
Search for missing SOWER photographs, especially fin whale photos from 2006/2007	Search Secretariat archives and contact SOWER researchers for personal copies of photos	Report		

items 7.1.1.2 and 7.1.1.1). Outstanding photographs from New Zealand will be uploaded, after being cross-referenced between collections to avoid duplication of entries. An intersessional email group was established under Annex H item 7.1.1 to address this. An exhaustive search will be conducted for missing photographs from SOWER cruises. A steering group was formed to undertake this work. A simple how-to photo-ID guide will be developed for tourists and naturalists, pending funding (see also Annex H item 7.1.1.2). This has budget implications for the Sub-committee for Other Southern Hemisphere Whale Stocks because the guide has implications for multiple species assessments. The *ad hoc* Working Group **agreed** to continue compiling appendices for the IWC Guidelines for Photo-identification Guidelines. An intersessional correspondence group will continue to work on this item (see Table 1 above).

8.2 Budget requests for 2019-2020

There are no budget implications for this work plan.

9. ADOPTION OF THE REPORT

This report was adopted at 14:43 on 2 May 2018.

REFERENCES

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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. 57pp. [Available at: *http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-report-May08.pdf*].

IWC, 2018. Report of the Scientific Committee. Annex S. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. Appendix 2. IWC guidelines for Photo-identification catalogues. *J. Cetacean Res. Manage. (Suppl.)* 19:408-12.

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 the IWC].

Stevick, P.T., Carlson, C., Crowe, L., Kellett, M., Fernald, T. and Allen, J.M. 2017. Interim report: IWC Research Contract 16, Antarctic Humpback Whale Catalogue. Paper SC/67a/PH03 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 8pp. [Paper available from the Office of the IWC].

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
   2.1 Flukebook
3. Blue whale catalogues
   3.1 Photo-identification of Antarctic blue whales
   3.2 Southern Hemisphere Blue Whale Catalogue
4. Fin whale and other whale photo-ID catalogues
   4.1 Photo-identification of Antarctic fin whales
   4.2 Photo-identification studies of gray whales, NE Sakhalin Island, Russia
5. Guidelines for IWC catalogues and photo-ID databases
   5.1 Draft appendices
6. Intersessional Working Groups
7. Conclusions and recommendations
8. Work plan and budget requests for 2019-20
   8.1 Work plan
   8.2 Budget requests for 2019-20
9. Adoption of the Report

Annex T

Report of the *Ad hoc* Intersessional Working Group on IWC Global Data Repositories and National Reports

Members: Double (Convenor), Allison, Bjørge, Brownell, de Almeida, De la Mare, Diallo, Donovan, Ferris, Fonseca, Gallego, Haug, Hielshcher, Iñíguez, Jaramillo-Legorreta, Kitakado, Lauriano, Lundquist, Palka, Reeves, S., Ridoux, Ritter, Santos, Smith, S., Stachowich, Víkingsson, Witting, Zharikov.

1. INTRODUCTORY ITEMS

The *Ad hoc* Intersessional Working Group on IWC Global Data Repositories and National Reports met in person on 4 May 2018 during the SC/67b meeting. Double thanked members for attending the meeting and reminded the Working Group of its Terms of Reference (see Item 2).

2. TERMS OF REFERENCE

This *Ad hoc* working group continued intersessional work undertaken to conduct an assessment of the utility and support requirements of all IWC databases relevant to the work of the Scientific Committee. Specifically, its Terms of Reference were to:

(1) Collate summary information on all IWC databases relevant to the SC.
(2) Summarise data use by the SC for each database.
(3) Provide recommendations to improve integration, content and workflows.
(4) Review technical progress on existing databases or databases under development.
(5) Consider needs and specifications for potential new databases, including developing simple technical guidelines on new proposals.
(6) 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

The Working Group reviewed a summary of the IWC's 22 existing databases and web applications relevant to the work of the Committee and the Blue Whale song library was added (Tables 1 and 2).

3.2 IWC Databases: Use, development, data entry and priorities

The Working Group reviewed existing IWC databases requiring further development or data entry. The Working Group prioritised further developments to several existing databases (presented in **bold** text in Table 3).

The Working Group **agreed** that the development of the Individual Catch and the Catch Summary databases was now the highest priority. This decision was based on the need for greater accessibility and that these data are frequently requested from the Secretariat (Table 3).

4. IWC NATIONAL PROGRESS REPORTS

4.1 Implementation of last years recommended changes to the Progress Report schema

Miller reported that nearly all the recommendations identified by the Committee in 2017 (IWC, 2018) had now been implemented. However he requested further guidance from the Working Group on the appropriate level of aggregation for some records (e.g. strandings) to simplify and accelerate data entry without losing valuable resolution. The Working Group **agreed** to support Miller intersessionally to progress this task.

4.2 Feedback on data entry from National coordinators, other contributors and SC members

Miller informed the Working Group that data entry this year was hampered due to excessive load on the IWC servers. This issue was generic to the whole IWC portal and has already been addressed and resolved by the IWC Secretariat.

Several members requested that all fields should require positive data entry rather than default values. They noted that many entries were recorded against the first species on the taxonomic list even though this is a rarely observed species. The Working Group **agreed** to remove default values to improve confidence in the data reported.

Miller explained that personal details collected through National Progress Reports cannot be disseminated without permission. The Working Group **agreed** it was adequate to only report the name and contact details of the institution providing the data. However, a function will be developed so individuals who submit data can to have their names associated with their National Report.

4.3 Feedback on data structure from National coordinators, other contributors and SC members

The number of Progress Reports submitted to SC/67b (19) was an improvement on SC/67a (12) but nevertheless represents a small proportion of IWC member nations.

The PDF summaries of Progress Reports presented to the meeting (SC/67a/ProgRep01-19) included records of reported bycatch and ship strikes. Some members questioned the value of these reports given the small proportion of member nations reporting and uncertainties about the reliability of the reports in some cases. It was noted that reports of bycatch covered the range of situations from countries that had well developed reporting systems to countries where any bycatch was unlikely to be reported. Thus for all countries, reports will represent minimum estimates and in most cases cannot be used for estimating total numbers. The Progress Reports do not attempt to provide estimates of total bycatch from observer programmes which require additional data such as fishing effort and careful analysis, even when all reported bycatch is included.

The Working Group **agreed** that the data collected in these reports are not intended to replace in-depth studies. However, the Working Group also **agreed** the reports have value because much of these data would not otherwise be available and the reporting process can assist in supporting national compilation of cetacean data.

To address in part several of the issues and challenges described above the Working Group **agreed** to:

(1) Develop a strategy with the SC Chair and Secretariat to raise awareness of National Progress Reports and promote reporting by member nations.

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 (~6780 records)	Live	Scientific Committee/ Greg Donovan	MySQL	PHP	HTML, JavaScript	IWC Web Servers	Brendan Miller		
Ship Strikes (>1000 reports, >190 cases)	Live	Ship strike Data Review Group	MySQL	PHP	HTML, JavaScript	IWC Web Servers	Brendan Miller	Creation of bulk uploader	
Research Requests	Live	Greg Donovan	MySQL	PHP	HTML, JavaScript	IWC Web Servers	Brendan Miller		
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	
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		
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	Conversion to online database	
Catch Summary Database (~3 million catches)	Live	Cherry Allison	Excel			IWC Storage	Cherry Allison	Conversion to online database	
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-ID	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 & Direct)	Retired	Cherry Allison	MS Word			IWC Storage	Cherry Allison		

Table 1 (Cont.)
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
Compendium of Whale Watching Regulations	Outdated		Text					New data manager	
IWC Database of Recommendations	In development	Sarah Smith/ Sarah Ferriss				IWC Web Servers	Brendan Miller		
Entanglement Response	In planning	David Mattila				IWC Web Servers	Brendan Miller		
Blue Whale Song Library	Awaiting development	Ana Širović				IWC Web Servers	Brendan Miller	Development	

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	
WW Handbook	In Development	Sarah Ferriss	MySQL	PHP	HTML, JavaScript	IWC Web Servers	Brendan Miller	Content completion Database development Application Development	
JCRM Submission Site	Live	Jessica Peers	MySQL	PHP	HTML, JavaScript	IWC Web Servers	Brendan Miller		

Table 3

Database usage by the Scientific Committee, any database development and data entry required, and the priority to complete that work.

Database	Status	How it is used by Scientific Committee	Work Required	Priority to Complete Work
Progress Reports	**Live**	**Time series data on bycatch and entanglements and other anthropogenic impacts on large and small cetaceans**	**Review and implement appropriate level of aggregation for individual records (e.g. strandings)** **Review for and structure of PDF reports for SC**	**High** **Approx. 1 week of 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/Head of Science
Research Requests	Live	This is the 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/Head of Science
IWC biopsy sampling database	Under development	Facilitate stock structure analyses	Updates only	In progress by Secretariat/Head of Science
SH blue whale catalogue	**Awaiting deployment**	**MR abundance estimation for population assessments, population structure**	**Server setup and deployment – SC budget allocated**	**High – approximately 2 weeks of developer time required**
WNP gray whale catalogue	Under consideration	MR abundance estimation for population assessments, population structure	Possible migration to new system	Job yet to be specified
Document Web Archive	Live	For everything	Updates only	In progress by Secretariat/Head of Science
Bibliographic reference database	Live	SC reports, communication	Updates only	In progress by Secretariat/Head of Science
Individual Catch Database	**Live**	**Population assessments, catch limits, distribution and movement**	**Online portal. Document idiosyncrasies within data. Creation of a database of records for which there are no individual data and which conforms to all available summary data on the area, sex and month of these catches, to enable easy creation of catch series. Requires full documentation.**	**Highest**
Catch Summary Database	**Live**	**Population assessments, catch limits, distribution and movement**	**Online portal**	**Highest**
Discovery Marking Data	Live	Populations structure and movement, catch allocation	None required	N/A
Sightings Data (IWC-DESS)	Retired	Population assessments, abundance estimation	Data will be integrated into the new integrated sightings, photo-ID, database	N/A
New integrated sightings, photo-ID	Under development, SC Steering Group	Population assessments, abundance estimation	Updates only	In progress by Secretariat/Head of Science/SC. Funding available.
Small Cetaceans Catches (Bycatch & 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	**Near completion**	**Communication with Commission, assessment of progress and response**	**Transfer from developer to IWC servers**	**High**

Table 3 (Cont.)

Database usage by the Scientific Committee, any database development and data entry required, and the priority to complete that work.

Entanglement Response	**Postponed**	**Develop best practice, information sharing and capacity development**	**Develop database; funding already available**	**Subject to decision by forthcoming meeting of the Global Entanglement Response Network**
Cetacean Diseases of Concern Intranet	In Development		Finalise website	Part of document archive; in progress by Secretariat/Head of Science
WW Handbook	In Development		Finalise website, develop database	Part of document archive; in progress by Secretariat/Head of Science
JCRM Submission Site	Live	JCRM Journal management system (submission to publication)	Customise some features	Medium; current system functional
Blue Whale Song Library	**Awaiting Development**		**Develop database – SC budget allocated**	**High**

(2) Produce a short summary explaining the utility of National Progress Reports and suggest including this text in the circular to member nations calling for data submission.
(3) Request the Secretariat to issue the first call for data submission in February and repeat the call a few weeks prior to the start of the SC annual meeting.
(4) Develop text acknowledging the likely limitations of the reported data. Subsequently this text will be included in all reports and data downloads.

4.4 Future work to progress previous development recommendations

Double presented a simple example of National Progress Report data displayed in PDF format generated using the R markdown (Rstudio). This approach is code-based and can rapidly and repeatedly generate data-rich PDF reports using data files produced from the IWC portal. Importantly the code can be adapted easily by member nations if they wish to provide additional information or bespoke figures and tables.

The Working Group welcomed this information and encouraged further exploration of this approach to produce PDF-formatted National Progress Reports submitted to SC meetings. The availability of the information in this format can help with communicating the depth of available data, cross checking and identifying errors or missing data during the annual meeting.

5. POTENTIAL FUTURE IWC DATABASES

No proposals were received for new databases or major alterations to existing databases.

REFERENCE

International Whaling Commission. 2018. Report of the Scientific Committee. Annex S. Report of the *Ad hoc* Working Group on Photo-Identification. *J. Cetacean Res. Manage. (Suppl.)* 19:405-12.

Annex U

Statements Related to Item 19, Special Permits

ANNEX U1. SUMMARIES OF REPORTS ON ONGOING RESEARCH UNDER NEWREP-A

SC/67b/SP08. Results of the third biological field survey of NEWREP-A during the 2017/18 austral summer season
SC/67b/SP08 presented the results of the biological sampling of Antarctic minke whales during the third NEWREP-A survey conducted in Area VI (170°W-120°W, south of 60°S) during the 2017/18 austral summer season. Two sighting and sampling vessels (SSVs) and one research base vessel engaged in the survey for 83 days. A total of 392 sightings (involving 925 individuals) of Antarctic minke whale were made during 4,164 n.miles of searching distance. A total of 333 Antarctic minke whales (152 males and 181 females) were sampled, and a number of biological samples and data required for the two main objectives of NEWREP-A were obtained from each whale taken. In Area VI-East, the survey was conducted early in the season (December to January) for the first time since the start of JARPA survey in 1987/88. A total of 44 Antarctic minke whales (26 males and 18 females) were sampled in Area VI-East. The obtained samples will contribute to elucidation of the stock structure of Antarctic minke whales, especially to elucidation of the eastern boundary of P-stock. A total of two blue, four humpback and one killer whale were photo-identified and one biopsy sample was collected from a blue whale in the research area. The samples and data collected in this survey are available for interested national and international scientists under the guidelines for research collaboration posted at the home page of the Institute of Cetacean Research (ICR): *http://www.icrwhale.org/NEWREP-AProtocol.html*.

SC/67b/SP04. Results of the feasibility study on biopsy sampling and satellite tagging of Antarctic minke whales under NEWREP-A
SC/67b/SP04 presented the results of the feasibility study on biopsy sampling and satellite tagging of Antarctic minke whales following the recommendations of the NEWREP-A review workshop. The feasibility study was conducted during the first three NEWREP-A surveys between the 2015/16-2017/18 austral summer seasons. The feasibility study was aimed in comparing the efficiency of biopsy sampling in comparison to lethal sampling. First, the Success Proportions of biopsy and lethal sampling was estimated, next the efficiency between the two approaches was assessed using a Generalized Linear Model (GLM) considering the following response variables: sampling methods (biopsy and lethal sampling), Beaufort scale, visibility and sampling area. The explanatory variable in the best fitted model included only 'sampling method'. This result suggested that environmental variables did not have a significant effect. The estimated Success Proportions for biopsy sampling (0.434± 0.050) were much lower than that for lethal sampling (0.967 ±0.006). Furthermore, the time spent on the experiment on biopsy sampling was approximately three times longer than that spent on lethal sampling. This result showed that the efficiency of biopsy sampling for Antarctic minke whales targeted under a random sampling procedure in NEWREP-A is much lower than that of lethal sampling. Given these results, no additional experiments on biopsy sampling will be conducted in future NEWREP-A surveys. However additional biopsy samples could be collected opportunistically to increase the sample size and then consider other variables in the statistical analysis in the future. Given the results on satellite tagging additional tagging trials will be conducted in the future to respond specific research questions. A final evaluation of these techniques will be carried during the mid-term review of the NEWREP-A following an established protocol (Mogoe *et al.*, 2016).

SC/67b/SCSP05. Determining sexual maturity in female Antarctic minke whales during the feeding season based on concentrations of progesterone in blubber
SC/67b/SP05 reported the results of a study on the relationship between concentration of progesterone in blubber and reproductive status in the Antarctic minke whale. The study was based on 230 female Antarctic minke whales sampled during the 2015/16 austral summer survey of the NEWREP-A. The study was conducted in response to a recommendation from the NEWREP-A review workshop to 'Examine use of hormones in blubber to detect sexual maturity'. Progesterone concentrations in blubber of the sampled whales were related to their reproductive status determined by the traditional method of examining reproductive organs (56 immature, 11 resting, 6 ovulating and 157 pregnant females). Significant differences were found in median progesterone concentration between all reproductive categories except in the case between ovulating and pregnant females. However, the ranges of progesterone concentration overlapped between each reproductive status with the exception of the cases immature/ovulating and immature/pregnant. The results of the present study indicate that the progesterone concentration in blubber samples, which potentially can be obtained by biopsy sampling, cannot be used as an accurate diagnostic index to discriminate between immature and mature female Antarctic minke whales. A final evaluation of this technique will be carried during the mid-term review of the NEWREP-A following an established protocol (Mogoe *et al.*, 2016).

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ANNEX U2. STATEMENTS ON THE NEWREP-A REPORTED RESULTS

The feasibility of biopsy sampling: A response to Yasunaga *et al.*

P. Clapham, W. De La Mare, M. Double, R. Hoelzel, Y. Ivashchenko, J. McKinlay and P. Wade

Yasunaga *et al.* (SC/67b/SCSP04) reported the results of a feasibility study on biopsy sampling of Antarctic minke whales, and concluded that such sampling 'is not a feasible technique that could contribute to the NEWREP-A research objectives'. In support of this, the authors indicated that biopsy sampling took longer than lethal sampling, and also stated that the quantity of tissue obtained in a biopsy was insufficient to permit multiple analyses to be conducted (e.g. genetics, stable isotopes, fatty acids and hormone analysis).

There are several factors which render the paper's overall conclusion invalid. First, the overall premise of the paper is fallacious: that one technique takes longer than another should not lead to the conclusion that the more time-consuming technique is infeasible. However, the contention that biopsying a whale takes longer than lethal sampling is itself derived from a spurious comparison of the two processes. The way in which the time involved in obtaining a sample in the two techniques was not explicitly defined, but apparently employed a misleading comparison that involved only the time involved between inception of a chase and the striking of the whale (with either a biopsy dart or a harpoon). This does not take into account processing time, which is considerably longer and far more labour-intensive for lethal sampling (up to an hour with numerous individuals working on deck, versus a few minutes by a single individual to process a biopsy sample); even ignoring the carcass processing time, a catcher still has to deliver the whale to the factory ship before resuming the hunt for another animal. If one instead adopts a more reasonable definition of experimental time as the period between inception of the chase and the point at which the sample is secured and the sampling vessel is free to move on to target another animal, biopsy sampling would emerge as the faster technique.

Second, the authors' statement that the quantity of tissue yielded by a typical biopsy is insufficient for multiple analyses is demonstrably false; other researchers routinely obtain enough material for a variety of experiments of different types, with results providing acceptable levels of precision. For example, a typical minke whale whole biopsy sample yields approximately 60-100 μg of DNA and sometimes much more; the quantity of tissue required for hundreds of genetic experiments is far less (e.g. 20-200 nanograms for 20 microsatellite loci, and 300 nanograms/sample for 5,000-15,000 loci using RAD sequencing). Therefore, even for a low yield from ½ of the biopsy sample (30μg) and a high-coverage method (RAD sequencing) there would be 100 times more DNA than required. Stable isotopes can be analysed from a small portion of the biopsy (as little as 1mg). After identification of the appropriate markers (typically done by methylome sequencing of animals of known age and identifying highly informative loci), as little as 10-100 ng of DNA (depending on the number of loci) would be sufficient for age determination. Note that following the careful selection of loci, this can show a very close correlation to age (e.g. $r2 = 0.84$ in Hannum *et al.* 2013; and see also Jarman *et al.* 2015). The age determination technique is continually being improved and will likely result in consistently precise results in the near future.

Third, the decline in the time to obtain a biopsy sample, as shown in the authors' Table 2, suggests continued use of insufficiently experienced shooters; the ability to accurately hit a target is one of the most important factors involved in this process.

The definition of feasible is 'capable of being done, effected, or accomplished'; consequently, it is inaccurate to state that biopsy sampling is not a 'feasible' technique, and one that 'cannot contribute' to NEWREP-A's research objectives. Biopsy sampling has been widely, routinely and extensively used on the great majority of cetacean species for more than three decades. Furthermore, even if one accepts the statement that lethal sampling is faster, it is worth noting that, using SCSP04's stated average time of 26 minutes to obtain a single biopsy, it would require only 144 hours to sample 333 minke whales (and this does not take into account the option of simultaneously employing multiple shooters and/or sampling vessels). Given that NEWREP-A cruises typically last for up to three months, this is certainly not an undue time burden with which to obtain a statistically robust sample size. Given the much shorter processing time of a biopsy relative to a whole whale, it is conceivable that much larger sample sizes could be obtained during the course of a typical NEWREP-A cruise.

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Progesterone can be used to estimate the percent mature in a sample of Antarctic minke whales

P. Wade, J. McKinlay, B. De La Mare, M. Double, E. Archer, P. Clapham

In paper SC/67b/SCSP05 (Inoue *et al.*, Determining sexual maturity in female Antarctic minke whales during the feeding season based on concentrations of progesterone in blubber), the authors have conducted a study examining progesterone levels for different maturity and reproductive states (as determined by examination of ovaries): immature, pregnant, ovulating, resting. We consider this a useful investigation into the potential for non-lethal methods to accurately determine reproductive status.

However, we disagree with their main conclusion, which was that progesterone value cannot be used to categorize whales as immature or mature. The authors apparently reach this conclusion based upon a small amount of overlap in the distribution of progesterone values between the immature and resting categories. However, the great majority of the mature whales are in the pregnant or ovulating categories (162 whales), whereas only 11 whales were categorized as mature but resting (not pregnant or ovulating). Therefore, it is worthwhile to examine how much difference a small amount of misclassification would make to the estimation of the % mature in the sample.

If one examines Fig. 1, it can be seen there is no overlap in the inter-quartile ranges (25-75% percentiles, the 'boxes') between the immature and resting categories; there is only overlap in the extreme values. It is not possible to tell from the figure how much overlap in distribution there is between immature and resting categories. A histogram with different colours representing immature, pregnant, ovulating, and resting would be useful to show how much overlap there is in the categories. We request that the authors of SC/67b/SCSP05 make such a plot for the consideration of the SC at this meeting. From such a histogram it would also be simple to directly test how well progesterone levels would serve to categorize whales into immature or mature classes.

Since we know the sample size in each reproductive class (Table 1 in SC/67b/SCSP05), as well as that each 'whisker' can contain no more than 25% of the data in the distribution of each category, we can approximate what the likely misclassification rate would be. From Figure 1 we can guess (for illustration purposes) the amount of overlap between immature and resting stages. For example, if one proposed using a value of 1.0 ng/g to define immature vs. mature, it looks like (assuming an approximately uniform distribution between the box and whisker) roughly 25% of the 11 resting whales would be misclassified, which would be 2.75 whales (rounding to 3).

Similarly, roughly one-third of the upper 25% quartile, or 8.3% of the 56 immature whales would be misclassified as resting, which would be 4.6 whales (rounding to 5). Therefore, with 3 whales moving from resting to immature, and 5 whales moving from immature to resting, there is a net gain of 2 whales being misclassified, resulting in an estimated 54 immature and 13 resting. Adding in the pregnant and ovulating states, the estimated percent mature whales would be 76.4% ((156+6+13/229) based on progesterone, versus 75.5% ((154+6+11/229) based on examination of ovaries, for a difference of 0.9%, less than 1%.

In reality the values are unlikely to be uniformly distributed between the 75 percentile (for immature) and the extreme high value, or similarly between the 25th percentile (for resting) and the extreme low value. Therefore, the true amount of misclassification would likely be less than what we calculate here, so the difference is likely even less than 0.9%. We conclude that the amount of misclassification in immature vs. mature using progesterone values would be very small, and could be corrected by using the data and results from this study. Therefore, in contrast to the authors of SC/67b/SCSP05, we conclude that progesterone could be used very effectively to classify Antarctic minke whales as to their maturity state.

Clarifications and responses regarding NEWREP-A studies on biopsy sampling (SC/67b/SCSP04) and blubber progesterone (SC/67b/SCSP05) on Antarctic minke whales

G. Yasunaga, S. Inoue, T. Tamura and L.A. Pastene

Background

First, these two studies were carried out in direct response to recommendations from the NEWREP-A review workshop. Experiments in both studies were designed based on specific suggestions from the NEWREP-A review workshop (IWC, 2016, pp.515-16 for biopsy sampling and pp.519-20 for blubber progesterone).

The suggested deadline for completing these analyses was after the completing the third NEWREP-A survey. Consequently, results of both studies were submitted to the 2018 IWC SC meeting after the 2017/18 NEWREP-A survey had been completed.

While encouraging the studies conducted, some members disagreed with our preliminary conclusions on the biopsy sampling study (see Clapham *et al.*) and blubber progesterone study (see Wade *et al.*). Responses to these WPs are provided in the third and fourth sections below.

Final evaluation of non-lethal techniques in the context of NEWREP-A objectives, using a protocol

As noted above, at this stage preliminary conclusions were provided by the proponents and a final conclusion will be provided by the mid-term review workshop; this will be based on (i) some additional field data taken opportunistically; (ii) additional analysis and (iii) the protocol to evaluate non-lethal techniques presented to the IWC SC at the 2016 annual meeting by Mogoe *et al.* (2016).

The protocol above was developed following a recommendation from the JARPNII review workshop (IWC, 2017, p.86), and it was presented and discussed at the 2016 IWC SC meeting (IWC, 2017, p.82-83). Systematic application of such a protocol to evaluate non-lethal techniques is an efficient and constructive approach because, even though the feasibility and practicability of non-lethal means have been repeatedly discussed, conclusions were often difficult to reach due to a lack of an objective evaluation scheme.

In the protocol above, four questions were established to evaluate the feasibility and practicability of non-lethal methods. The primary questions are whether tissue and other samples can be obtained by a non-lethal method (Question 1); whether enough samples for statistical analysis can be obtained by that non-lethal method (Question 2); whether the sample obtained by the non-lethal method can produce as much scientific information as that produced by a lethal sampling method (Question 3); and whether the cost for obtaining the sample/producing scientific information is reasonable (Question 4). Unless all of these four questions are satisfied together for a particular non-lethal method, such a method is not considered satisfactory to replace lethal methods, and therefore a lethal method is necessary (see details in Mogoe *et al.*, 2016).

While final responses and conclusions on these two studies will be provided at the mid-term review of NEWREP-A following the protocol above, we respond preliminarily below some of the technical questions/criticism in Clapham *et al.,* and Wade *et al.*

Responses to Clapham *et al.* (biopsy sampling)

Clapham *et al.* argued that:

(a) The way in which the time involved in obtaining a sample in the two techniques was not explicitly defined, but apparently employed a misleading comparison that involved only the time involved between inception of a chase and the striking of the whale (with either a biopsy dart or a harpoon).
(b) The contention that quantity of tissue yielded by a typical biopsy is insufficient for multiple analyses is demonstrably false; other researchers routinely obtain enough material for a variety of experiments of different types, with results providing acceptable levels of precision.
(c) The decline in the success proportion of a biopsy sample, as shown in the authors' Table 2 in SC/67b/SCSP04, suggests continued use of insufficiently experienced shooters; the ability to accurately hit a target is one of the most important factors involved in this process.

Our responses to those points are:

Response to (a)

First of all, it should be noted that 'the efficiency' of sampling techniques was defined as 'Success Proportion' rather than 'Time of experiment' in SC/67b/SCSP04 because 'Success Proportion' can represent a better indicator of the efficiency. In light of the purposes of NEWREP-A, random sampling is required in which generally only one animal from a school is sampled. Thus, the most important question is the certainty that a particular method can take a sample from the targeted animal, and time necessary to take the sample is less important. For this reason, 'Success Proportion' was used as the response variable in the GLM analysis in SC/67b/SCSP04.

Therefore, the allegation in Clapham *et al.* that 'the overall premise of the paper is fallacious: that one technique takes longer than another should not lead to the conclusion that the more time-consuming technique is infeasible' ignores the statistical analysis already conducted by the proponents.

Notwithstanding this, we provide details of 'time of experiment' in our study in order to clarify further. First, 'Time of experiment (min.)' in Table 2 in SC/67b/SCSP04 was defined as following:

> Biopsy sampling: a time period from the time of the starting a chase of whale to the time of having retrieved a biopsy sample on a deck.
>
> Whale (lethal) sampling: a time period from the time of the starting the chase of a whale to the time of having kept a whale body on a side deck.

The time spent in transporting the whale to the base vessel was not considered in the analysis because the catcher vessel does not necessarily return to the base vessel after catching a whale, but can immediately start the search for a further whale to capture or biopsy.

Further analyses will be carried out and evaluated under the protocol for evaluation of non-lethal techniques indicated above, by the mid-term review.

Response to (b)
We agree that the amount of epidermal tissue collected by biopsy sampling is enough for the requirement of genetic, epigenetic and stable isotope analyses. However, we have pointed out that the amount (median of weight: 0.8g) of an adipose tissue collected by biopsy sampling is not large enough to measure progesterone (Objective I-(II)), lipid content (Objective II-(III)) and fatty acid (Objective II-(III)) of NEWREP-A.

Response to (c)
We disagree that success proportion of biopsy sampling is declining allegedly because the use of insufficiently experienced shooters. One of our reasons, is that median of time of experiment (min) did not change substantially. In order to examine this factor further, the differences in success proportion in biopsy sampling experiment only were assessed by a GLM for the response variables of outcome of sampling (failure; success). Explanatory variables were considered with research seasons as an ordered variable (2015/16; 2016/17; 2017/18). Table 1 shows results of a GLM analysis based on the binomial distribution assumption. The coefficients for each year were not significant, suggesting that the differences of success proportions between of 2015/16 and 2016/17, and 2017/18 are not statistically significant and consequently provide no evidence that shooters' experience has decreased over the three research seasons.

Table 1

Results of generalized linear model analyses in the best fitted model involved only research season as explanatory variables of biopsy sampling for Antarctic minke whales in the NEWREP-A (2015/16–2017/18).

	Estimate Std.	Error	z value	Pr (>|z|)
2015/16	0.3567	0.4928	0.724	0.4692
2016/17	-0.1054	0.4595	-0.229	0.8186
2017/18	-0.4855	0.2594	-1.871	0.0613

Null deviance: 137.24 on 99 degrees of freedom;
Residual deviance: 133.05 on 96 degrees of freedom.

Responses to Wade *et al.* (blubber progesterone)
Wade *et al.* argued/suggested that:

(a) 'A histogram with different colours representing immature, pregnant, ovulating, and resting would be useful to show how much overlap there is in the categories.'
(b) Based on assumptions which are a 'value of 1.0 ng/g to define immature vs. mature', 'one-third of the upper 25% quartile' and '8.3% of the 56 immature whales would be misclassified as resting', the difference of true amount of misclassification would likely be less than 0.9%.

Our responses to those points are:

Response to (a)
A histogram with different colours representing immature, resting, ovulating and pregnant is shown in Fig.1.

Response to (b)
Based on the assumption of cut off values (1.0 ng/g) of progesterone set in Wade *et al.*, six of 56 immature whales and three of 11 resting whales were misclassified. Misclassification ratios are 10.7% and 27.2%, respectively, and they are not negligible.

As mentioned earlier, final evaluation of this technique will be made at the mid-term review workshop based on the protocol developed for evaluating non-lethal techniques.

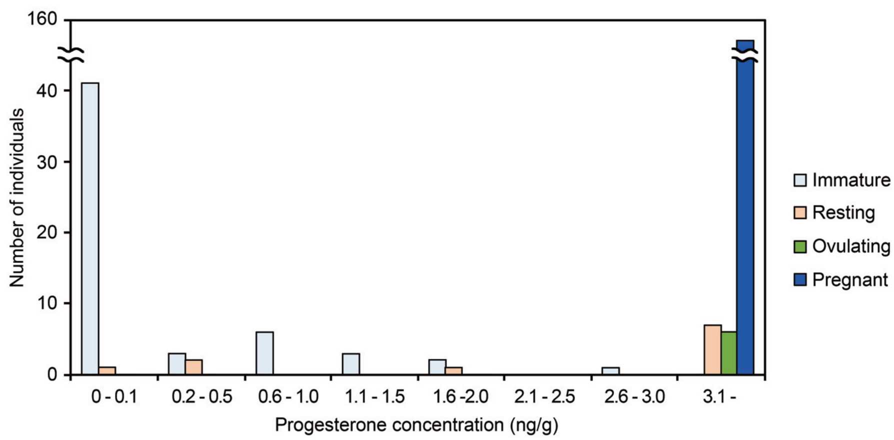

Fig. 1. A histogram with different colours representing immature, resting, ovulating and pregnant of female Antarctic minke whales sampled in 2015/16 NEWREP-A.]

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Assessing the efficiency of biopsy versus lethal sampling

P. Clapham, R. Leaper and P. Wade

The paper on the feasibility of biopsy sampling by Yasunaga *et al.* (SC/67b/SCSP04) generated considerable discussion, much of which was centered on the comparative speed with which biopsy sampling and lethal sampling are achieved, and the method used to assess this. Here, we propose a standard metric for measuring the efficiency of biopsy sampling, and to compare this to the process of lethal sampling.

Metrics for biopsy sampling

Obtaining a biopsy sample from a whale involves several stages:

(1) selecting a target whale (or group of whales) and initiating a chase;
(2) attempting to successfully take the biopsy with either a crossbow or gun; and
(3) retrieving and processing the sample.

We suggest that a fair way to measure the time taken to obtain a biopsy is to use the time from initiation of the chase to the time the sample (i.e. the biopsy dart) is retrieved.

One could also add the time taken to process the sample, but this is typically very short and in fact usually does not need to be accomplished on the sampling vessel. A biopsy tip can be removed from the arrow and placed with the intact sample into a plastic bag that is tagged with a unique number of some kind, linked by the data collector to other information on the whale recorded at the time of sampling (e.g. sample number, date and time, group number, whale number et cetera). The sample can be removed from the biopsy tip and processed, with others, later.

If a sample is processed immediately after retrieval – i.e. it is removed from the tip and placed into a pre-labeled vial with preservative – this typically adds a few minutes. In such a case, this time should be recorded as the end point of the process, but only if that process prevents the vessel crew from resuming another biopsy attempt. Note that if multiple clean tips are taken into the field, there is no need to clean tips that have already been used until the end of the day.

In cases where a biopsy is not obtained, the time between initiation of the chase and suspension of attempts on the whale/group concerned should also be recorded.

In many cases, a sampling vessel encountering an associated group of whales can obtain multiple biopsy samples from the same group. In these cases, the efficiency of subsequent samples should be measured from the time when the previous sample has been secured to the time when the next biopsy is taken, until all members of the group have been sampled or the vessel suspends operations and searches for another whale/group.

Metrics for lethal sampling

Obtaining a lethal sample from a whale also involves several stages:

(1) selecting a target whale (or group of whales) and initiating a chase;
(2) attempting to kill the whale with a harpoon;
(3) towing the dead whale back to the factory ship;
(4) winching the carcass onto the flensing deck; and,
(5) taking and processing the sample.

Presumably a catcher is free to resume targeting another whale only after it has delivered the first carcass to the factory ship. Consequently, a reasonable way to measure the time taken to obtain a lethal sample is to use the time from initiation of the chase to the time the carcass is delivered to the factory ship, thus freeing the catcher to attempt further lethal sampling. It is not necessary to include the processing time of the carcass, since that is independent of the chase, which presumably can resume immediately after delivery of the dead whale.

In cases in which the catcher does not succeed in killing the whale, the time between initiation of the chase and suspension of attempts on the whale/group concerned should also be recorded.

Other notes

For both methods, meteorological variables (notably wind and sea state) should be recorded so that the efficiency of each method can be assessed relative to environmental conditions.

If the sampling design requires whales observed from pre-determined track lines to be sampled, then the time to return to the track line and resume searching after either recovering the biopsy dart or leaving the factory ship, should also be recorded.

Scientists conducting biopsy sampling of any cetacean are encouraged to record the metrics described above so that a robust sample size can be gathered with which to assess the efficiency of biopsy on different species.

ANNEX U3. SUMMARIES OF REPORTS ON ONGOING RESEARCH UNDER NEWREP-NP

SC/67b/SCSP06. Results of the first cruise of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in the 2017 summer season – offshore component

SC/67b/SCSP06 presented the results of the first biological survey of sei and common minke whales under the offshore component of NEWREP-NP. The survey was conducted in part of sub-Areas 7(7WR and 7E), 8 and 9 (-170°E), north of 35°N from June to September 2017. Two sighting sampling vessels (SSVs) and one research base vessel were engaged in the survey for 100 days. A total of 56 sightings (involving 61 individuals) of common minke whale and 320 sightings (involving 407 individuals) of sei whales were made during 5,307 n.miles of searching distance. A total of 43 common minke and 134 sei whales were sampled as originally planned. Biological samples and data required for the two primary objectives of NEWREP-NP were obtained from each whale sampled. In particular earplugs for age determination and reproductive organs for sexual maturity determination were collected for all individuals. SP06 also presented the preliminary results of biological analyses of the whales sampled. Eight blue and one humpback were photo-identified, and biopsy samples were collected from five blue, one humpback and 17 sei whales. Satellite tags were deployed on 15 sei whales and tracking was possible for eight individuals. The samples and data collected in this survey will be available for interested national and international scientists under the guidelines for research collaboration in NEWREP-NP.

SC/67b/SCSP02. Cruise Report of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in 2017- Pacific coastal component off Hachinohe and Kushiro

SC/67b/SCSP02 presented the results of the first survey of the coastal component of NEWREP-NP conducted in sub-areas 7CS off Sanriku (Hachinohe) and 7CN off Kushiro, in the Pacific side of Japan. The survey in Hachinohe was conducted from 18 July to 20 August 2017, using two small-type whaling catcher boats as sighting/sampling vessels and six small fisheries boats supporting sighting activities. The survey in Kushiro was conducted from 1 September to 31 October 2017, using four small-type whaling catcher boats as sighting/sampling vessels. Searching for common minke whales and sampling took place in coastal waters about 50n. miles from Hachinohe and Kushiro Ports. All common minke whales sampled were landed at the NEWREP-NP research stations established in Hachinohe and Kushiro, where biological examination was conducted. During the survey in Hachinohe, a total of six primary sightings (six individuals) and two secondary sightings (two individuals) of common minke whale were made during 4,297.1 n.miles of searching distance (456.2 hours). Three common minke whales (one immature and two mature males) were sampled. During the survey in Kushiro, a total of 43 primary sightings (45 individuals) and two secondary sightings (two individuals) of common minke whale were made during 7,038.5 n.miles of searching distance (724.0 hours). A total of 35 common minke whales were sampled (22 males and 13 females). Biological samples and data required for Primary Objective I and Ancillary Objectives I and II of NEWREP-NP were obtained from all animals sampled. The target sample size of 80 common minke whales however could not be attained, because both surveys were greatly affected by bad weather and sea conditions.

SC/67b/SCSP07. Cruise report of the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) in 2017 – coastal component off Abashiri in the southern Okhotsk Sea

SC/67b/SCSP07 presented the results of the first coastal NEWREP-NP survey in the southern Okhotsk Sea (sub-area 11), which was conducted from 11 June to 6 July 2017. The survey was carried out using five small-type whaling catcher boats as sampling vessels, in coastal waters mainly within about 40 n. miles from Abashiri port. Common minke whales collected were landed at the NEWREP-NP research station for biological examination. During the survey, a total of 2,449.9 n. miles (243.4 hours) was searched and 128 schools (132 individuals) of common minke whales were sighted. Sightings of 39 schools (55 animals) of fin, four schools (10 individuals) of humpback, two schools (two animals) of blue, and one of sperm whales were also made. Of the 132 common minke whales encountered, 47 animals were sampled. Earplugs and eye lenses for age determination and reproductive organs for determination of sexual maturity were collected from all the whales. Sex of animals caught was biased towards the female (9 males and 38 females). Average body length was 6.92m (SD=0.55, range=5.62-7.55m) and 7.35m (SD=0.85, Range=4.96-8.18m) for males and females, respectively. Of nine males, eight were sexually mature (88.9%) and 30 of 38 females were mature (78.9%). A total of 25 females were pregnant. Stock assignment was conducted from nuclear microsatellite data. Of 47 animals collected, 28 were assigned to J stock and 17 were identified as O stock. The remaining two animals could not be assigned. Proportion of J stock animals increased from June (53.6%) to July (76.5%). Sex ratio of males was higher in the J stock animals (28.6%) than in the O stock animals (5.9%). In females, the proportion of mature animals was higher in the O stock (93.8%) than in the J stock (65.0%). Conception date was estimated using a growth formula and fetus body length data. Animals migrating into the Okhotsk Sea have two breeding seasons: autumn breeding season and winter breeding season prolonged to spring. Pregnant females with autumn conception date were genetically assigned to the J stock. All females genetically assigned to the O stock conceived in a period from winter to spring. Dominant prey species was krill (89.4%), followed by Copepoda (4.3%) and walleye pollock (2.1%). Animals feeding on copepods were genetically assigned to the O stock. An individual that fed on walleye pollock was genetically assigned to the J stock.

SC/67b/SCSP03. Results of satellite monitored tagging experiments on North Pacific sei whales conducted during the 2017 NEWREP-NP offshore survey

SC/67b/SCSP03 reported the results of the satellite tagging on North Pacific sei whales conducted during the 2017 NEWREP-NP survey. A total of 44 tagging trials were conducted using SPOT6 type tags with LKArts system for attachments from *Yushin-Maru*-type sighting/sampling vessels. A total of 15 tags were deployed on sei whales, and eight whales were tracked. Two sei whales were tracked for more than 35 days, and these two whales showed a longitudinal movement. In general the tagging experiment of penetrate-type tags from sighting/sampling vessels seems to be practical. However some technical improvements are identified, which could increase the tracking period.

Annex U4
SUMMARY OBJECTIVES TABLES FOR NEWREP-A AND NEWREP-NP

Table 1 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.

N.	Summary	Purpose	Suggested Timeframe	Needs new samples/ data? Effort type	Proponents comments on progress (see SC/67a/SP12)	Committee's comments
(1)	Evaluate the level of improvement that might be expected either in the SCAA or in RMP performance by improved precision in biological parameters using simulation studies including updated *Implementation Simulation Trials*.	A, C, D	By August 2015	No, analytical	**Completed to a reasonable level** (see details in GOJ, 2016 – SC/66b/SP10). 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. As stated in previous meetings, the proponents consider that the steps specified by the Advisory Group go beyond the original scope of Recommendation 1. Nevertheless, some new information in the context of the TOR's of the Advisory Group was provided in SC/67b/RMP03. Their intention is to continue contributing to this work subject to logistical constraint and the availability of specialist analysts.	**2015**: The work follows the intent of the Panel recommendation. It addresses the ability to estimate recruitments by the SCAA, though does not yet evaluate the extent to which the precision of estimates of other parameters such as M and MSYR might be improved given further data. From a management perspective there remains the need for quantification of the extent to which the precision achievable for recruitment estimation will improve management performance. Specifically, it remains to be determined whether a reduction in uncertainty in year-class strength has any appreciable effect on performance statistics for *Implementation Simulation Trials*. The current SCAA does not of itself constitute a full specification of the various operating models/I*mplementation Simulation Trials* needed for management procedure testing. In any case, the current SCAA is not suitable as an operating model as currently formulated. In particular, SC/66a/SP08 includes no specifications for how the modelled population is to be used to project and the uncertainties that are to be represented in trials, both historically and in projections. Furthermore, the Committee had concluded that the SCAA estimates of MSYR are not robust. **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 link 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 (IWC 2017, pp. 441-445). The Committee recognised a range of opinions as to the extent to which this recommendation has been addressed. **2017**: No new information (see IWC/67A/SCSP12). The 2016 evaluation is still valid. See also Recommendation 26 and Item 17.1 (IWC 2018, pp. 71-78) **2018**: Some information presented in the SC/67b/RMP03 (IWC 2019, Item 19.1.2.1).
(2)	Analyses to distinguish between two stocks with mixing versus isolation by distance.	A, D	By May 2015	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 was originally planned for the 2018 SC meeting but due to other priorities this work was postponed for the mid-term review 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. Analyses related to this recommendation are still ongoing and will be presented to the mid-term review. As noted above, preliminary results suggest that the scenario of two stocks that mix in the transition area is the most plausible hypothesis.	**2016**: The Committee notes that the work will be presented at the 2017 meeting. **2017**: No new information (see IWC/67A/SCSP12). The 2016 evaluation is still valid. **2018**: **No progress**. Self-declared deadline (i.e. 2018 SC meeting) not met.

N.	Summary	Purpose	Suggested Timeframe	Needs new samples/ data? Effort type	Proponents comments on progress (see SC/67a/SP12)	Committee's comments
(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	By May 2015	No, analytical	**To be completed by the mid-term review.** 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. Analyses related to this recommendation are still ongoing and will be presented to the mid-term review.	**2016**: No progress reported although the Committee notes that the work will be presented at the 2018 meeting. **2017**: No new information (see IWC/67A/SCSP12). The 2016 evaluation is still valid. **2018**: **No progress**.
(4)	Comprehensive biopsy sampling feasibility study.	B, C, D, E	field season 2015-2016 or 2016-2017	Yes, field effort	**Completed.** Explanation of the design of the biopsy sampling feasibility studies were included in the research plans for the dedicated sighting surveys presented annually to, and endorsed by the IWC SC. The design considered all elements in the recommendation. Feasibility studies were conducted in the three first NEWREP-A surveys, and results were presented by Isoda *et al*. (2016), Isoda *et al*. (2017) and Mogoe *et al*. (2018) (SC/67b/ASI07). A Generalized Linear Model (GLM) used to compare the efficiency between biopsy and lethal sampling was conducted using data collected in the three feasibility studies. Results confirmed that the efficiency of biopsy sampling was significantly lower than the lethal sampling (Yasunaga *et al*., 2018; SC/67b/SCSP04). No further biopsy studies on Antarctic minke whales are planned under the NEWREP-A. However additional biopsy samples will be attempted opportunistically.	**2015:** The work follows the intent of the Panel's recommendations, though more details are needed. For example, will there be people on board that have expertise in successful minke whale biopsying? The biopsy sampling design that will be used in the future to achieve representative coverage of the entire study area (not first field year which is just a feasibility study) needs to be specified, perhaps by the 2016 SC meeting. **2016**: SC/66b/IA04 summarised the research plan for the 2016/17 survey, including the biopsy feasibility study. SC/66b/IA05 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. **2018**: Partially completed, further refined analysis is needed (see this report, Item 19.1.2.2). A WG was formed to review and improve methods.
(5)	Comprehensive telemetry feasibility study.	B, E	field season 2016-2017 or 2017-2018	Yes, field effort	**Completed.** Explanation of the design of the telemetry feasibility studies were included in the research plans for the dedicated sighting surveys presented annually to, and endorsed by the IWC SC. The design considered all elements in the recommendation. Feasibility studies were conducted in the three first NEWREP-A surveys, and results were presented by Isoda *et al*. (2016), Isoda *et al*. (2017) and Mogoe *et al*. (2018) (SC/67b/ASI07). A summary and conclusion of the feasibility studies were made by Yasunaga et al. (2018) (SC/67b/SCSP04). It was concluded that satellite tagging is feasible for Antarctic minke whales to respond specific qualitative question e.g. location of breeding grounds, and will continue on an opportunistic basis.	**2015:** The work follows the intent of the Panel's recommendation, though more details are needed. For example, with which research groups/individuals will there be collaboration to determine which attachment system will be used and which experts will be on board? The future sampling design of when and where telemetry tags will be applied to address the various questions, assuming it is feasible to attach telemetry tags, will need to be specified, perhaps by the 2016 meeting. **2016**: SC/66b/IA04 summarised the research plan for the 2016/17 survey, including the telemetry feasibility study. SC/66b/IA05 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. **2018**: **Completed**. New information was presented (SC/67b/SCSP04). Feasibility study was conducted.
(6)	Estimate *g*(0)for all species.	E	Throughout	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), in Area V in 2016/17 (Isoda *et al*., 2017) and Areas V and VI in 2017/18 (Mogoe *et al*., 2018; SC/67b/ASI07). The analysis of data collected will allow the estimation of g(0) for large whales.	**2015:** The work follows the intent of the Panel's recommendation, and the survey design allows for pertinent data to be collected. **2016**: **Completed annually**. SC/66b/IA04 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**: **Completed annually**. SC/67a/ASI4 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. **2018**: **Completed annually**. SC/67b/ASI07 summarised the research plan for the 2018/19 survey. The Committee endorsed the cetacean abundance estimation component of this proposal.

N.	Summary	Purpose	Suggested Timeframe	Needs new samples/ data? Effort type	Proponents comments on progress (see SC/67a/SP12)	Committee's comments
(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 focussed 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 track lines.	E	By August 2015 then throughout	Yes, analytical then field effort then analytical	**Addressed and Ongoing** Research plans including the elements in the recommendations above have been presented annually to the IWC SC: GOJ (2015a) for the survey in 2016/17; Hakamada *et al*. (2016) for the survey in 2016/17; Hakamada *et al*. (2017) for the survey in 2017/18; and Hakamada *et al*. (2018) (SC/67b/ASI11) for the survey in 2018/19. All the plans have been endorsed by the IWC SC.	**2015:** (1) (a) It is not clear if any considerations have been made to modify the data collection methods or track line placement to make future analyses easier. (b) It is not clear which covariates will be considered in the SDM and hence need to be collected during the survey. (c) It is not clear how the CTD and net tows will be used. This type of information would make it possible to evaluate whether the proposed sampling while on the ship is appropriate. See Annex for more detailed comments on this. (d) This item been addressed. (e)-(g) These aspects are not addressed in SC/66a/SP08, but should be addressed within the next year or so. (2) and (3): The work follows the intent of the Panel's recommendation. Papers describing the future survey are being reviewed under IA. **2016**: **Completed annually**. The Committee approved the proposal in SC/66b/04IA04. **2017**: **Completed annually**. See recommendation 6. **2018**: **Completed annually**. See recommendation 6.
(8)	Examine feasibility of using DNA methylation ageing technique with Antarctic minke whales using good quality earplugs, testing against geographical areas and different time periods and using several laboratories.	B, C, D	By March 2016	No, laboratory then analytical	**Completed.** 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 (seven sites) were scored successfully. Results of the analyses conducted in response to this recommendation were presented in Goto *et al*. (2018) (SC/67b/SDDNA04). A total of 100 Antarctic minke whale samples, for which earplug readings were considered excellent or good, were selected for the DNA-M feasibility study. Seven CpG sites in three genes (TET2, CDKN2A and GRIA2) were selected for this study because they showed significant correspondence between CpG methylation levels and age in a previous study on humpback whales. In addition, changes in the DNA-M rate among different positions of the whale's body, were investigated. Some positions involved dorsal side (expose to sunlight) and others the ventral side. DNA-M rate of the seven CpG sites were scored successfully and regressions of each CpG methylation against age determined by earplug were conducted. Coefficient of determination (R^2) of all CpG sites were lower than that of the previous humpback whale study. The assay predicts age from skin samples with a standard deviation of 8.865 years. DNA-M rate fluctuated among 8-10 positions of the whale body. It is concluded that age determination of Antarctic minke whale based on the seven DNA-M sites (from three loci) used in this study is not feasible particularly for use in population dynamics models such as SCAA.	**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 IWC/67a/SCSP12. **2018**: SC/67b/SDDNA04 presents a feasibility study on epigenetic aging. The method can be used, but the SD & DNA Working Group made suggestion as to how to improve resolution (in particular, evaluate more loci and restrict to those with a high age correlation). While resolution can be improved, SD & DNA Working Group has discussed the limit of resolution of the method for individual age estimation in the light of information provided to this group (see this report, items 11.4.4, 19.1.2.3 and Annex I). While further refinement is encouraged, the feasibility study was conducted, thus this recommendation is **partially completed**.

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(9)	Examine use of hormones in blubber to detect sexual maturity	B, C, D	By March 2017	No, laboratory	**Completed.** Results of the analyses conducted in response to this recommendation are presented in Inoue *et al*. (2018) (SC/67b/SCSP05). The relationship between concentration of progesterone in blubber and reproductive status in the Antarctic minke whale was investigated by examining 230 female Antarctic minke whales sampled during the 2015/16 austral summer survey of the NEWREP-A. Progesterone concentrations in blubber of the sampled whales were related to their reproductive status determined by the traditional method of examining reproductive organs (56 immature, 11 resting, 6 ovulating and 157 pregnant females). Significant differences were found in median progesterone concentration between all reproductive categories except in the case between ovulating and pregnant females. However, the ranges of progesterone concentration overlapped between each reproductive status with the exception of the cases immature/ovulating and immature/pregnant. The results of the present study indicate that the progesterone concentration in blubber samples, which potentially can be obtained by biopsy sampling, cannot be used as an accurate diagnostic index to discriminate between immature and mature female Antarctic minke whales. Discrimination between immature and mature females is fundamental information for population dynamics models such as the SCAA. Therefore, at this stage, lethal sampling is required to obtain information on sexual maturity of female Antarctic minke whales for use in population dynamic models.	**2016**: The Committee was informed that this work has started in collaboration with other research institutions. Results will be presented in 2018. **2017**: Some information is available (see IWC/67a/SCSP12). **2018**: **Completed**, but there are disagreements on the interpretation of results and its conclusions. SC/67b/SCSP05 presents results of the study focused on determining sexual maturity in female Antarctic minke whales, during the feeding season, based on concentrations of progesterone in blubber. On accuracy see Item 19.1.2.3 (this report).
(10)	Evaluate the effect on SCAA of assuming 'resting' females are immature females.	A, C, D	By August 2015	No, analytical	**To be completed by the mid-term review.** 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*	**2015:** No methods nor results presented. **No progress**. **2016**: No methods or results presented at this meeting but see discussion under Recommendation 1. **2017**: No new information (see IWC/67A/SCSP12). The 2016 comments remain valid. **2018**: New information presented (SC/67b/SCSP05).
(11)	Update SCAA with respect to density-dependence following Punt *et al.* (2014), and stock mixing based on existing data.	A, C, D	By May 2015	No, analytical	**Completed** (see GOJ, 2015b – SC/66a/SP8). 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*	**2015: Partially completed.** The SCAA has been updated using the density-dependence function suggested by the Panel – task complete. Results are shown for a different fixed boundary. However, extensions to address the potential utility of genetic data in particular to inform time-dependent mixing and hence improve estimation performance have yet to be addressed. **2016**: **Partially completed**. 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 IWC/67a\/SCSP12). The 2016 comments remain valid. **2018**: No new information.
(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	By August 2015	No, analytical	**To be completed by the mid-term review.** 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. *	**2015**: No methods nor results presented. **No progress**. **2016**: No results nor methods presented but see discussion under Recommendation 1. The Siler model in SC/66b/IA8 is one way to account for time-varying natural mortality. **2017**: No new information (see IWC/67a/SCSP2). The 2016 comments remain valid. **2018**: **No progress**. The 2016 comments remain valid.

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(13)	Develop metrics to evaluate the benefits of including time varying ASM data in the SCAA.	A, C, D	By May 2015	No, analytical	**To be completed by the mid-term review.** The proponents have shown the impact of time varying ASM on the results of the SCAA (IWC 2015c). 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. *	**2015:** The simulation results suggest (as expected given the formulation of the model) that allowing for time-varying age-at-50%-sexual maturityASM50 has little impact on the majority of the results from the SCAA. The calculated values of mature population and recruitment rate are rescaled by changing the definition of the proportion mature over time. In principle, integrating time-varying ASM50 into the Implementation Simulation Trials might suggest that this is an important factor to understand, but this has yet to be demonstrated. **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 IWC/67a/SCSP12). The 2016 comments remain valid. **2018**: **No progress**. The 2016 comments remain valid.
(14)	Consider the adoption of this multibeam sonar in krill surveys.	E	By August 2015	No, logistical	**Already in progress.** Careful consideration is given before the first dedicated krill survey (CCAMLR-type survey) scheduled for the 2018/19 austral summer season. Survey plan being developed in consultation with CCAMLR.	**2016**: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists. **2017**: No information was presented (see IWC/67a/SCSP12). **2018**: No information was presented.
(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	By 2016 for annual surveys	Yes, logistical, field effort, analytical	**Completed.** Calibration of the echosounder system (EK80) was conducted in Japan before the start of the 2016/17 and 2017/18 NEWREP-A surveys. Details of this work are provided in Wada *et al*. (2017; 2018) (SC/67a/EM09 and SC/67b/EM05).	**2015:** No plan has been presented, but a plan needs to be developed before the survey is conducted. There needs to be documentation on how the EK60 will be calibrated and that someone trained to conduct on such calibration will participate in the surveys. **2016**: **Completed**. This work was completed before the start of the second whale sighting-based krill survey and results were presented in Wada et al. (2017) (SC/67a/EM09). 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 IWC/67a/EM9. **2018**: New information presented (SC/67b/EM05).
(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 programme	No, logistical	**Already in progress.** Careful consideration is given before the first dedicated krill survey (CCAMLR-type survey) scheduled for the 2018/19 austral summer season. Survey plan being developed in consultation with CCAMLR.	**2016**: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists. **2017**: No new information was presented (see IWC/67a/SCSP12). **2018**: No new information was presented.
(17)	Conduct full analysis of statistical power to detect changes in krill abundance from proposed techniques.	A, E	By August 2015	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 IWC/67a/SCSP12). **2018**: No new analysis was presented
(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	By May 2015	No, logistical	**To be addressed.** This has been deferred until the 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 IWC/67a/SCSP12). **2018**: No new information was presented.
(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 programme	No, logistical, analytical	**Already in progress.** Careful consideration is given before the first dedicated krill survey (CCAMLR-type survey) scheduled for the 2018/19 austral summer season. Survey plan being developed in consultation with CCAMLR.	**2016**: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists. **2017**: No new analysis was presented (see IWC/67a/SCSP12). **2018**: No new information was presented.

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(20)	Give careful consideration to scale and design of oceanographic sampling, taking into account BROKE/BROKE West data.	E	Within programme	No, logistical, analytical	**Already in progress.** Careful consideration is given before the first dedicated krill survey (CCAMLR-type survey) scheduled for the 2018/19 austral summer season. Survey plan being developed in consultation with CCAMLR	**2016**: The Committee was informed that this recommendation will be addressed in consultation with CCAMLR specialists. **2017**: No new analysis was presented (see IWC/67a/SCSP12). **2018**: No new information was presented
(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	Throughout programme	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 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.	**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**: Limited new information was presented (see IWC/67a/SCSP12). **2018**: No new information was presented.
(22)	Develop a more powerful approach to estimating energy intake (requirements) using a bio-energetics model; evaluate non-lethal methods for obtaining a time series of tuning data for such models.	A, B, D	By August 2015	No, analytical	**To be addressed.** Need clarification from the IWC SC on the kind of bioenergetics model suggested.	**2016**: The Committee was informed that this work will be completed in 1-2 years. **2017**: No new information was presented (see IWC/67a/SCSP12). **No progress**. **2018**: No new information was presented. **No progress**.
(23)	Investigate stable isotopes along edge of baleen plates to see if this provides insights into duration of time on feeding grounds.	B	By August 2015	No (if existing samples), laboratory	**Completed.** Results of the analyses conducted in response to this recommend-ation are presented in Uchida et al. (2018) (SC/67b/SCSP09). The stable isotope analysis was based on 16 Antarctic minke whales sampled in the NEWREP-A surveys in 2016 and 2017. The stable carbon (δ13C) and nitrogen isotope ratios (δ15N) were determined along the edge of baleen plates of 10 pregnant sampled in the Ross Sea and 6 other immature females. Each baleen plate was examined at an interval of 5mm to investigate if there were records of feeding in the δ15N and δ13C derived from the long-term feeding profile. In the pregnant females, about 4 cycles of nitrogen were seen at each baleen plate and the mean length of cycle was 7.7±2.0cm (mean±SD, range: 6.0-10.0cm), while two individuals had nitrogen cycles more than 12cm. No constant cycle was observed in δ13C. The trophic enrichment factor of the Antarctic minke whale was calculated as 3.48‰, assuming the mean δ15N value at base of baleens derived from feeding on the Antarctic krill. From the analyses in immature animals, the δ15N kept high value before birth to the end of lactation followed by a rapid down, suggesting feeding on krill causes lower δ15N. The cycles of stable isotope values in immature animal were longer than those in pregnant females, suggesting the baleen plates in younger animals have higher growth rate. It is difficult the interpretation of the changes of values of δ13C compared to δ15N. The fluctuation range of δ15N in the pregnant females was 0.97 ±0.21 ‰, suggesting that they highly depend on the Antarctic krill only. The duration of time on feeding grounds of the Antarctic minke whales remains unknown. Analysis of baleen samples obtained at lower latitude during austral winter, which possibly show the change of δ15N during fasting, could facilitate the estimate the timing of leaving Antarctic waters. The growing ratio of baleen plates can facilitate the estimate the seasonal changes of δ15N, and subsequently the duration of time on feeding ground.	**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 IWC/67a/SCSP12. **2018**: **Completed**.

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(24)	Use 'non-lethal' techniques on all animals; develop 'condition indices'; work to develop non-lethal techniques for total consumption.	E	Within programme	To be determined after relevant analyses related to purposes A-D are completed	**To be addressed.** This needs careful consideration. Clarification from the IWC SC is required on the 'condition indices' suggested.	**2016**: No new information was presented. **2017**: No new information was presented (see IWC/67a/SCSP12). **2018**: **No progress**.
(25)	Provide an improved outline of the proposed ecosystem and multispecies model structures and provide a data gap analysis.	E	By May 2015	No, analytical	**To be completed by the mid-term review** An update of the Mori- Butterworth Antarctic ecosystem model, taking JARPA and JARPA II data into account was presented in SC/67a/EM14.	**2016**: The Committee notes that the further 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 IWC/67a/SCSP12). **2018**: **No Progress**.
(26)	Provide a thorough power analysis of sample sizes required to detect change in ASM and follow the other recommendations in this Item.	D	By May 2015	No, analytical	**Completed to a reasonable level** (see details in GOJ, 2015c; 2016 – SC/66b/SP10). 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. The IWC SC has already concluded that the approach being taken to address the recommendation is appropriate As stated in previous meetings, the proponent's opinion is that the additional refinements specified in 2016 go beyond the original scope of Recommendation 26. Nevertheless the proponents intention is to continue contributing to this work subject to logistical constraint and the availability of specialist analysts.	**2015:** The simulations conducted generally follow the approach suggested by the Panel. However, future recruitment was not stochastic, no allowance was made for cohort-specific deviations in ASM, and overdispersion associated with the annual proportion mature by age was not modelled. As expected, more additional variation leads to lower power as does lower effect size. Consequently, sample sizes are likely to be too small. Ideally, there should be a management-related (or biologically-based) justification for the effect sizes. **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**. • **SC/66b/SP10 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 SC/66b/SP10 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 uncertainty of these variances and develop probability distributions for them. Adjunct X provide an example of a likelihood for the overdispersion parameter, 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 arisng from this sort of heterogeneity was considered to some extent in SC/66b/SP10 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 SC/66b/SP10.** **2017**: No new analysis was presented (see IWC/67a/SCSP12) and Item 19.2.1. The 2016 comments remain valid. **No progress**. **2018**: **No progress**. The 2016 comments remain valid.
(27)	Provide additional analyses on effect of catches upon the stocks for comparison with those presented.	E	By May 2015	No, analytical	**Completed** 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 IWC/67a/SCSP12). The 2016 comments remain valid. **2018**: **No Progress**.

N.	Summary	Purpose	Suggested Timeframe	Needs new samples/ data? Effort type	Proponents comments on progress (see SC/67a/SP12)	Committee's comments
(28)	Improve mechanisms for co-operative research.	E	By May 2015	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 IWC/67a/SCSP12. **2018**: **No Progress**.
(29)	Provide information on programme management, personnel and logistic resources.	E	Throughout programme	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 (GOJ, 2017), which is also valid for NEWREP-A. In particular refer to section 5 and Annex 21 of the research proposal.	**2016**: SC/66b/SP09 Appendix 1 contains a progress report on management, personnel and logistic resources. **2017**: See comments in IWC/67a/SCSP12. **2018**: **No Progress**.

*As described in the sub-section 4.4 of SC/66b/SP10, the proponents believe that the response required for recommendation 1 has been provided. Building upon this, the proponents are aware that, for the purpose of 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.

Table 2. Summary of recommendations relevant to NEWREP-NP.

No.	Panel recommendations	Proponent response/comments	*Scientific Committee Comment*
HIGHEST PRIORITY RECOMMENDATIONS			
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;	Completed. Already responded for Antarctic minke whale (GOJ, 2016). See SC/67a/SC SP01. p.6, 10-14; SC/67a/SC SP13 pp. 2-5.	**2017**: Different opinions, need for more discussion (IWC 2018, Annex D Item 2.4, pp. 116-117). **2018**: **No progress**.
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.	Completed. 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 was included in the final research plan (P.90, P.151).	**2017**: **Completed**: historical samples of minke whale (SC/67a/SCS/10, pp. 86-87) and of sei whale (see SC/67a/SCS/10 p. 111) have been included.
13	The Panel **recommends** conducting analyses in which the historical age-composition data are downweighted by various levels.	Disagree with Panel (see SC/67a/SC SP01, p. 15).	**2017**: No progress as proponents disagree with Panel. **2018**: **No progress**.
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);** (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.	Disagree with Panel (see SC/67a/SC SP01, p. 3). See also Yasunaga *et al*. (2017a; b). 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).	**2017**: No progress as proponents disagree with Panel. Advisory Group established regarding biopsy sampling. See discussion under Item 19.3.1 (IWC 2018, p. 78). **2018**: **No progress**.
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.	To be considered by the mid-term review. 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/SC SP01, p. 16. See "Possible modification of lethal sample sizes" section in SC/67a/SC SP10 (p.39) and the final research plan (p.37).	**2017**: The possibility for further work has been considered (SC/67a/SCSP10 p.39). **2018**: **No progress**.
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.	Not relevant. 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/SC SP01, p. 17). Also see SC/67a/SCSP/13 p. 5 for split samples into coastal and offshore.	**2017**: The proponents made available additional microsatellite data (10 loci) for small subset of data. The proponents also presented additional analysis (i.e. kin ship, 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 in IWC 2018). **2018**: **No progress**.

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, 2014).	Disagree with Panel (see SC/67a/SC SP01, p. 18). Notwithstanding the disagreement, analyses were presented to the 2017 SC meeting (SC/67a/SCSP13). Refined analyses were presented this year in SC/67b/RMP/02.	**2017**: Major concerns by the Panel were addressed by the proponents. See Item 19.4.2.2 (IWC 2018). **2018**: **Completed**. Refined analyses were presented. It could be reconsidered in the next *Implementation Review*.
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.	Disagree with Panel (see SC/67a/SC SP01, p. 18). Notwithstanding the disagreement, analyses were presented to the 2017 SC meeting (SC/67a/SCSP13). Refined analyses were presented this year in SC/67b/RMP/02.	**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, pp. 10-11; IWC 2018). **2018**: **Completed**. Refined analyses were presented. It could be reconsidered in the next *Implementation Review*.
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, 2014).	Completed. Addressed in SC/67a/SCSP/13 Section 4.	**2017**: **Completed** (see Annex D, Item 4.2, pp. 11-12; IWC 2018).
HIGH PRIORITY RECOMMENDATIONS			
No.	**Panel recommendations**	**Proponent response/comments**	***Scientific Committee Comment/timeline***
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.	Completed. See "Sexual maturity" section in SC/67a/SC SP10, 3.1.1 (p.25) and the final research plan (p.23). Results of a study for Antarctic minke whales were presented in SC/67b/SCSP/05, demonstrating that the progesterone level in blubber cannot be used as an accurate index for determining sexual maturity.	**2017**: The Proponents demonstrated intention to include analysis of blubber for progesterone, but there are few details of how. **2018**: **Completed for blubber**, but there are disagreements on the interpretation of results and its conclusions. SC/67b/SCSP05 presents results of the study focused on determining sexual maturity in female Antarctic minke whales, during the feeding season, based on concentrations of progesterone in blubber. On accuracy see Item 19.1.2.3 (this report).
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.**	Ongoing. See SC/67a/ASI06, SC/67b/ASI10	**2017**: **Completed**: new survey plan was presented to the SC by the proponents (SC/67b/ASI6, appendix 1). The plan was endorsed. Matsuoka IWC oversight. **2018**: **Completed**: new survey plan was presented to the SC by the proponents (SC/67b/ASI10). The plan was endorsed.
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.	Completed. See "Stomach contents/tissue sampling" section in SC/67a/SC SP10, Annex 17 (p.126-127) and the final research plan Annex 17 (p.169-175).	**2017**: **Completed**. This recommendation referred to the former secondary objective that has been transformed into an ancillary objective. The information provided is sufficient.

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.	Completed. See "Laboratory and analytical works" section in SC/67a/SC SP10, Annex 18 (p.135) and the final research plan Annex 18 (p.176-178).	**2017**: **Completed**.
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.	Completed. See "Laboratory and analytical works" section in SC/67a/SC SP10, Annex 18 (p.135) and the final research plan Annex 18 (p.176-178).	**2017**: **Completed**.
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.	Ongoing. See "Photo-identification and biopsy sampling" in SC/67a/SCSP10, 3.1.1 (p.126) and the final research plan Annex 19 (p.179-180). See SC/67b/ASI/06 Appendix 1 p.11-12.	**2017**: **Completed annually**: presentation of sightings surveys plans and results. **2018**: **Completed annually**: presentation of sightings surveys plans and results (SC/67b/ASI06).
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. (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.**	Disagree with Panel (see SC/67a/SC SP01, p. 8).	**2017**: No progress as proponents disagree with Panel. **2018**: **No progress**.
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.	Ongoing. See SC/67a/SC SP10, (p. 105 for minke whale; p. 120 for sei whale) and the final research plan (p. 108 for minke whale; p. 162 for sei whale). Result of feasibility study for sei whales presented in SC/67b/SCSP/06.	**2017**: **Partially addressed**. **2018**: New information presented (SC/67b/SCSP/06).
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.	Ongoing. See section on "Description of overall project management including personnel and logistic resources" in SC/67a/SC SP10, 5.2 (p.43) and the final research plan (p.47).	**2017**: It is not clear that additional qualified personnel have been hired. **2018**: **No progress**.
28	Additional information on sample and data archiving, relational database(s) as noted by previous expert panels would be welcome.	Ongoing. See section on "Description of overall project management including personnel and logistic resources" in SC/67a/SC SP10, 5.1 (p.43) and the final research plan (p.47-48). See also relational data set presented to the JARPNII review meeting.	**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. **2018**: No new information presented.
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.	Ongoing. See section on "Adjustments of research protocols at the scene and in the year of disruption" in SC/67a/SC SP10, 5.3 (p.44) and the final research plan (p.48-49).	**2017**: This recommendation has been **partially addressed**. **2018**: No new information presented.

FUTURE PRIORITIES (OPTIONAL)

No.	Panel recommendations	Proponent response/comments	*Scientific Committee Comment/timeline*
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.	Not Applicable.	**2017**: Not considered in the new proposal. **2018**: **No progress**.
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.	Completed. See section on "Laboratory and analytical work" in SC/67a/SCSP10, Annex 18 (p.133) and the final research plan Annex 18 (p.176-178).	**2017**: This recommendation has been **partially addressed** as partially reflected in SC/67a/SCSP10; additional details are needed. **2018**: **No progress**.
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.	Disagree with Panel. See SC/67a/SCSP10, Fig 2 "Use and evaluation of new non-lethal techniques (field and analytical) on common minke whales in NEWREP-NP" (p.27).	**2017**: No progress. **2018**: **No progress**.
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.	Completed. See section on "satellite tagging" in SC/67a/SC SP10, Annex 9 (p.105-106).	**2017**: **Completed** (SC/67a/SCSP10). **2018**: A Japanese scientist (Dr. Minamikawa) participated in the 2017 Workshop.
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.	Ongoing. See SC/67a/SCSP10, (p. 105 for minke whale) and the final research plan (p.108).	**2017**: The proponents provided a few details in SC/67a/SCSP10. **2018**: No new information presented.
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.	Ongoing. Agree partially with Panel (see SC/67a/SC SP01, p. 16). Will be considered when the feasibility study on Antarctic minke whale is completed. Results of the feasibility study for Antarctic minke whales was presented in SC/67b/SDDNA04 and authors concluded precision insufficient for use in SCAA.	**2017**: No new information has been presented, but this recommendation is highly relevant in the context of age determination by non-lethal methods. **2018**: **Partially addressed**. SC/67b/SDDNA04 applied the epigenetic aging technique to the Antarctic minke whales, closely related to common minke whales. Issues of general feasibility can be derived from this paper. Further loci need to be evaluated to improve resolution.
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.	Completed. SC/67a/SCSP10, Fig 2 "Use and evaluation of new non-lethal techniques (field and analytical) on common minke and sei whales in NEWREPNP" (p.27) and the final research plan (p. 25).	**2017**: This recommendation has been **partially addressed**. Reflected in SC/67a/SCSP10.
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.	Completed. See section on "Expected outcomes and future plan" in SC/67a/SCSP10, Annex 18 (p.133) and the final research plan Annex 18 (p.176-178).	**2017**: Collaboration with specialists has begun and thus this recommendation has been **partially addressed (ongoing)**, as reflected in SC/67a/SCSP10. **2018**: No new information presented.

Annex V

Report of the IWC-SORP Scientific Steering Committee

Members: Double (Chair), Bell (ex-officio remote participant), Brownell, Burkhardt, Bjørge, Dalla Rosa, Fortuna, Fruet, Galletti, Hielscher, Iñíguez, Jackson (SH Chair), Langerock, Luna, Lundquist, Lauriano, Reyes Reyes, Ridoux, Vermeulen, Zerbini

1. INTRODUCTORY ITEMS

Double welcomed members of the IWC-SORP Scientific Steering Committee.

Double recalled the IWC's Southern Ocean Research Partnership (IWC-SORP) was proposed to the International Whaling Commission (IWC) in 2008 with the aim of developing a multi-lateral, non-lethal scientific research programme that would improve the coordinated and cooperative delivery of science to the IWC. Currently, there are 13 member countries in the Partnership: Argentina, Australia, Belgium, Brazil, Chile, France, Germany, Italy, Luxembourg, New Zealand, Norway, South Africa and the United States. IWC-SORP is an open Partnership that welcomes new members. Its ethos is one of open collaboration, communication and data sharing.

There are currently five endorsed and ongoing IWC-SORP themes: (1) 'The Antarctic Blue Whale Project'; (2) A project aimed at describing the 'Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean'; (3) The 'Foraging ecology and predatorprey interactions between baleen whales and krill' project; (4) A project to investigate the 'Distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica?' focused initially on east Australia and Oceania; and (5) the project 'Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean'.

Apologies

Apologies were received from Herr and Charrassin.

1.2 Documents available

Documents available were SC/67b/SH18, SC/67b/01.

2. IWC-SORP THEMES AND PROGRESS OF PROJECTS FUNDED IN 2016

The Steering Committee welcomed all the recent activities that have contributed to IWC-SORP's research themes (SC/67b/SH21) and the projects funded in 2016 (SC/67b/SH18)

The Steering Committee noted that overall the IWC-SORP has contributed to 126 peer-reviewed publications to date and 124 IWC-SORP related papers have been submitted to the Scientific Committee, 21 of which were considered by the IWC Scientific Committee this year.

3. FINANCIAL UPDATE OF STATUS OF THE IWC-SORP RESEARCH FUND AS OF JANUARY 2018

In 2009, the IWC Secretariat established an IWC Southern Ocean Research Partnership Research Fund (IWC-SORP Research Fund).

To date this fund has received voluntary contributions from Australia, the Netherlands, the United States, the International Fund for Animal Welfare, and WWF-Australia. IWC-SORP has also received support from the French and Chilean Governments for meetings and symposia. A detailed report on the current financial status of the IWC-SORP Research Fund is presented in SC/67b/01. £641,828 GBP remains unallocated and unspent in the IWC-SORP Research Fund.

The Steering Committee welcomed this report.

4. 2017/18 IWC-SORP FUNDING ROUND

4.1 Background to Call and Assessment Process

The background to the current Call is provided in Appendix 1.

4.2 Proposed allocation of funds

Fortuna, as Convenor of the Assessment Panel, presented the outcome of the assessment process. The outcome is summarised in Appendix 1, Table 1.

Bell noted that Proposals 6 and 10 will directly contribute to understanding the relationship between baleen whales and their prey (Antarctic krill), contributing to (but assessment outcome not influenced by) the request of the Australian Government that around £280,000 of their 2016 voluntary contribution be assigned to whale/krill research across any Calls for Proposals that disburse their contribution. A brief summary of each project proposal and assessment can be found in Appendix 1, Table 2.

The Steering Committee welcomed the outcome of the Assessment Group and **agreed** with the allocation of a total of £493,544 GBP from the IWC-SORP Fund to 15 projects (Appendix 1 Tables 1 and 2).

The Steering Committee noted this recommendation for the allocation of IWC-SORP funds would next be considered by the Scientific Committee.

If agreed by the Scientific Committee, these allocations will be presented to the Finance and Administration Committee during IWC67 (September 2018) for Commission endorsement. The proponents of successful proposals will be informed of the Commission's decision following IWC67. Contractual matters will subsequently be handled by the Secretariats of the IWC and IWC-SORP.

The Steering Committee thanked Fortuna for convening the Assessment Panel and expressed its gratitude to the Panel members who all provided valuable and thoughtful input into the assessment process.

4.3 Timing of future call

The Steering Committee discussed the timing of the next IWC-SORP Call for Proposals (Call) and **agreed** that the next Call should open prior to SC/68b (i.e. late 2019/early 2020) in readiness for IWC/68 (2020).

This timing would allow strategic prioritisation of the research toward which the Call is directed in order to meet IWC-SORP and IWC/SC priorities; allow knowledge gaps to be identified; and allow the IWC-SORP SSC to seek additional funding to augment the funds available in the IWC-SORP Research Fund.

5. PROPOSALS FOR NEW IWC-SORP THEME

The Steering Committee received a proposal for a new IWC-SORP research theme: *The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale*.

The specific objectives of the Theme would be to:

(1) increase our understanding of southern right whale foraging habitats and ecology;
(2) update our knowledge on southern right whale population dynamics in a comparative framework;
(3) pursue integration of health assessment indicators with long-term monitoring data; and
(4) investigate the impact of climate variation at foraging grounds on population recovery.

The Steering Committee noted that the proposed work is highly collaborative, has the capacity to support long-term research and scientific excellence, has clearly identifiable avenues for medium- to long-term funding and is likely to be highly productive.

It was proposed that the theme will be led by Drs Emma Carroll and Els Vermeulen, in close collaboration with colleagues from Argentina, Australia, Brazil, New Zealand and South Africa. The new theme will adhere to IWC-SORP's ethos of open collaboration, communication and data sharing.

The Scientific Steering Committee welcomed and supported this proposal and **agreed** to seek endorsement of this new theme from the Scientific Committee and to develop criteria to assess any new theme proposals.

6. NOMINATION OF VICE-CHAIR

The current Chair of the IWC-SORP SSC, Dr Michael Double, will come to the end of his three-year term as Chair at the next Commission meeting.

Dr Helena Herr is currently vice-Chair and it is proposed that she adopt the role of Chair.

The IWC-SORP SSC **agreed** to seek nominations for the role of vice-Chair from IWC-SORP member nations, intersessionally.

Appendix 1

IWC-SORP CALL FOR PROPOSALS (2017/18)

Background

The process for the allocation of funds from the IWC-SORP Research Fund was originally adopted by the Commission following Annex R of the SC/62 Scientific Committee Report (IWC, 2011).

At SC/66b (June 2016), this Annex was revised and endorsed by the Scientific Committee (see Annex W in IWC, 2017a). The IWC Finance and Administration Committee considered this revised procedure in September 2016 and advised the Commission of its endorsement at IWC/66 in October 2016 (IWC, 2017b).

Subsequently, two open, competitive, Calls for Proposals have taken place. The first in 2016, allocated £144,058 GBP to 10 research projects (details can be found in SC/67b/SH18).

In making their contribution of £758,325 GBP to the IWC-SORP voluntary fund in 2016, the Government of Australia requested that up to 20% of the contribution be allocated to IWC-SORP related projects before the start of the 2016/17 austral field season; this was achieved by holding a Call for Proposals in 2016 and disbursing funds after IWC/66 (2016). The Australian Government also requested that about £280,000 GBP of their total voluntary contribution be assigned to whale/krill research across any Calls for Proposals held.

An IWC-SORP Call for Proposals was opened in September 2017 and closed on 5 January 2018.

Applications and Assessment

Nineteen proposals were received by the IWC-SORP Secretariat and assessed for eligibility in accordance with criteria clearly stated in the guidelines associated with the Call (Appendix 2). All 19 proposals were deemed eligible and were distributed to an IWC-SORP Assessment Panel established by Chair of the IWC Scientific Committee (IWC, 2018).

The Chair of the IWC Scientific Committee established an IWC-SORP Assessment Panel that included 15 members of the IWC Scientific Committee. The composition of this Panel was agreed by the Scientific Committee at SC/67a (IWC, 2018).

- Chair of the Scientific Committee.
- Vice Chair of the Scientific Committee.
- IWC Head of Science.
- Current Convenor of the SH sub-committee.
- Two to three ex-Convenors of the SH sub-committee.
- A representative from the IWC-SORP Secretariat.
- Chair and Vice-chair of the IWC-SORP Scientific Steering Committee.
- Additional members deemed necessary by the Chair to facilitate the assessment of proposals. These assessors will be drawn from the Scientific Committee.

All 19 eligible proposals were distributed to the IWC-SORP Assessment Panel. Proposals were assessed against seven criteria tabulated in the guidelines associated with the Call (IWC, 2018). The assessment included a determination of how well the proposals aligned with IWC-SORP and IWC/SC objectives and priorities. In addition, the Panel considered any conditions associated with voluntary contributions as specified by donors.

Assessors reviewed between three and eight proposals each. Each proposal was reviewed by a minimum of four independent Assessors.

This process aimed to provide robust scientific oversight and probity whilst meeting the request of the Contracting Parties making voluntary contributions. The assessment process was coordinated by the IWC/SC Chair.

Measures taken to ensure probity and handle Conflicts of Interest

As part of their proposal application proponents were required to declare Conflicts of Interest that would impact on or prevent the applicant from proceeding with the project or any Contract it may enter into with the IWC. Where a

Table 1

List of the funding allocations by project recommended by the IWC-SORP Steering Committee.

Proposal number	Chief Investigator	Co-Investigators	Title	Requested amount (£)	Recommended amount (£)	Level of funding
1	Baker, C. Scott; Steel, Debbie	Ari Friedlaender, Renee Albertson, Michael Poole, Susana Caballero, Logan Pallin, Jooke Robbins, Ana Lucia Cypriano-Souze, Rochelle Constantine	Is migratory connectivity of humpback whales in the Central and Eastern South Pacific changing? A decadal comparison by DNA profiling	27,598	**26,375** (deducted in house instrument expenses)	Partial
2	Charrassin, Jean-Benoit	Laurene Trudelle, Virginia Andrews-Goff	Application of satellite telemetry data to better understand the breeding strategies of humpback whales in the Southern Hemisphere	21,200	**21,200**	Full
3	Branch, Trevor	-	Modelling somatic growth and sex ratios to predict population-level impacts of whaling on Antarctic blue whales	32,594	**32,594**	Full
4	Friedlaender, Ari; Constant-ine, Rochelle	Jooke Robbins, Scott Baker, Claire Garrigue, Logan Pallin	Pregnancy rates in Southern Ocean humpback whales: implications for population recovery and health across multiple populations	29,334	**19,984** (equipment deducted and some analytical costs)	Partial
5	Herr, Helena	Sacha Viquerat, Simone Panigada, Bettina Meyer, Anna Panasiuk, Natalie Kelly, Jennifer Jackson, Paula Olson, Ursula Siebert	Recovery status and ecology of Southern Hemisphere fin whales (*Balaenoptera physalus*)	82,300	**81,900** (equipment deducted)	Partial
6	Friedlaender, Ari; Constant-ine, Rochelle	Alex Zerbini, Ben Weinstein	A circumpolar analysis of foraging behaviour of baleen whales in Antarctica: Using state-space models to quantify the influence of oceanographic regimes on behaviour and movement patterns	34,711	**34,711**	Full
7	Buchan, Susannah; Miller, Brian	Flore Samaran, Danielle Harris, Kate Stafford, Ken Findlay, Ana Širović	A standardized analytical framework for robustly detecting trends in passive acoustic data: A long-term, circumpolar comparison of call-densities of Antarctic blue and fin whales	43,369	**41,369** (publication costs)	Partial
8	Lang, Aimee; Archer, Frederik	Robert L Brownell, Kelly Robertson, Michael R McGowan	Inferring the demographic history of blue and fin whales in the Antarctic using mitogenomic sequences generated from historical baleen	22,710	**22,710**	Full
9	Zerbini, Alex; Clapham, Phillip	Yulia Ivashchenko, Mike Double, John Bannister, Els Vermuelen, Ken Findlay	Assessing blubber thickness to inform satellite tag development and deployment on Southern Ocean whales	22,646	**22,426** (supply costs deducted)	Partial
10	Širović Ana, Stafford Kate,	-	Acoustic ecology of foraging Antarctic blue whales in the vicinity of Antarctic krill studied during AAD interdisciplinary voyage aboard the *RV Investigator*	34,183	**30,107** (airfares deducted)	Partial
12	Kelly, Natalie; Maire, Frederic	Amanda Hodgson, David Peel, Helena Herr, Phil Trathan, Jennifer Jackson; Guy Williams	Development of statistical and technical methods to support the use of long-range UAVs to assess and monitor cetacean populations in the Southern Ocean	30,576	**30,576**	Full
13	Reisinger, Ryan; de Bruyn, Nico	A. Rus Hoelzel, Christophe Guinet, Simon Elwen	An integrative assessment of the ecology and connectivity of killer whale populations in the southern Atlantic and Indian Oceans	33,650	**33,650**	Full
14	Bengston Nash, Susan	Ari Friedlaender, Frederik Christiansen, Juliana Castrillon, David Johnston	Implementation of humpback whales for Antarctic sea-ice ecosystem monitoring; Inter-program methodology transfer for effective circumpolar surveillance	91,202	**51,555** (equipment costs deducted)	Partial
17	Carroll, Emma; Torres, Leigh; Graham, Brittany	Luciano O Valenzuela, Darren Gröcke, Scott Baker, Rochelle Constantine, Ken Findlay, Robert Har-court, Pavel Hulva, Petra Neveceralova, Larissa Rosa de Oliveira, Paulo Henrique Ott, Per Palsbøll, Vicky Rowntree, Jon Seger	Circumpolar foraging ecology of southern right whales: past and present	21,290	**21,290**	Full
18	Iñíguez Bessega, Miguel	Simone Baumann-Pickering, Marta Hevia, John Hildebrand, Alexander Marino, Mariana Melcóón, Maria Venesa Reyes Reyes, Ana Širović, Juan Pablo Torres Florez	Habitat use, seasonality and population structure of baleen and toothed whales in the Scotia sea and the western Antarctic Peninsula using visual and passive acoustic methods and genetics	26,579	**23,097** (equipment costs reduced and communication/ network costs deducted)	Partial
			TOTAL	693,195	**493,544**	

Table 2

A brief summary of each project recommended for funding.

PROPOSAL 1 BAKER, STEEL *ET AL.:* IS MIGRATORY CONNECTIVITY OF HUMPBACK WHALES IN THE CENTRAL AND EASTERN SOUTH PACIFIC CHANGING? A DECADAL COMPARISON BY DNA PROFILING
This proposal will investigate decadal changes in connectivity between Breeding Stock G and the 'adjacent stocks' of Oceania humpback whales using DNA profiling, including sex and 10 microsatellites for individual identification and sequencing of the mtDNA haplotype for maternal lineages. For this continue previous collaborative efforts to assemble a 'DNA register' of profiles representing 2,104 individual humpback whales sampled on wintering grounds and in the Antarctic from 1991 to 2005. The proposal is scientifically interesting, highly collaborative, uses existing samples, and is applicable to a wider geographic area. The proponents are very capable and demonstrably productive. The project will contribute to the IWC-SORP Humpback Whale Connectivity Theme.
PROPOSAL 2 CHARRASSIN *ET AL.:* APPLICATION OF SATELLITE TELEMETRY DATA TO BETTER UNDERSTAND THE BREEDING STRATEGIES OF HUMPBACK WHALES IN THE SOUTHERN HEMISPHERE
This highly collaborative proposal will analyse satellite tracking data collected in Madagascar, Australia, Central America, Brazil, Gabon, and New Caledonia in order to compare the whale coastal movements and habitat use of five Southern Hemisphere breeding grounds, to increase our knowledge of humpback whale distribution patterns and habitat preferences. This proposal is closely aligned with the priorities and objectives of two IWC-SORP Themes: the Humpback Connectivity and Baleen Whale Foraging Ecology Themes.
PROPOSAL 3 BRANCH: MODELLING SOMATIC GROWTH AND SEX RATIOS TO PREDICT POPULATION-LEVEL IMPACTS OF WHALING ON ANTARCTIC BLUE WHALES
This proposal aims to build a sex-specific age-structured model to predict changes in mean Antarctic blue whale population length as a result of whaling, and compare the predictions to catch length distributions to estimate how much mean population length declined during whaling. In addition to more precise estimates of growth, the proposed project will have immediate utility in converting recent non-lethal measurements of blue whale lengths from the air into ages; and will be able to predict whether trends in mean lengths from aerial methods have sufficient precision to track population recovery of Antarctic blue whales. This is a well-defined proposal addressing an important topic of relevance to the IWC/SC. It will explore existing data that has received little attention in recent decades. The proposal will contribute directly to the IWC-SORP Antarctic Blue Whale Project.
PROPOSAL 4 FRIEDLAENDER, CONSTANTINE *ET AL.:* PREGNANCY RATES IN SOUTHERN OCEAN HUMPBACK WHALES: IMPLICATIONS FOR POPULATION RECOVERY AND HEALTH ACROSS MULTIPLE POPULATIONS
This highly collaborative proposal will use existing biopsy samples collected by IWC-SORP researchers to perform the largest and most extensive non-lethal analysis of pregnancy rates in Southern Hemisphere humpback whales using newly established and validated biochemical techniques. The project will produce a current reference point for the rates of pregnancy in humpback whales within the Southern Hemisphere, providing an opportunity to assess the impact of future climatic trends on the recovery of these populations. The proposed work will make very important contributions to both the IWC-SORP Baleen Whale Foraging Ecology and Humpback Connectivity Themes.
PROPOSAL 5 HERR *ET AL.:* RECOVERY STATUS AND ECOLOGY OF SOUTHERN HEMISPHERE FIN WHALES (*BALAENOPTERA PHYSALUS*)
This project aims to investigate the recovery status, population structure, ecology and migratory patterns of Southern Hemisphere fin whales (SHFW) around the Western Antarctic Peninsula (WAP), where increasing SHFW numbers have been reported, and the Scotia Sea. Targeted research will be conducted during research cruises in 2019 and 2020. Dedicated vessel-based visual surveys will collect sightings information for abundance estimation; feeding ecology will be investigated through concurrent krill surveys; genetic samples will be collected for the assessment of population structure; and habitat use, movements and migratory pathways analysed using satellite telemetry. Data on SHFW that have been collected opportunistically by various research groups during past decades will be combined and analysed together to assess recent changes of SHFW abundance and distribution around the WAP. This excellent proposal closely aligns with IWC-SORP and IWC/SC priorities.
PROPOSAL 6 FRIEDLAENDER, CONSTANTINE *ET AL.:* A CIRCUMPOLAR ANALYSIS OF FORAGING BEHAVIOUR OF BALEEN WHALES IN ANTARCTICA: USING STATE-SPACE MODELS TO QUANTIFY THE INFLUENCE OF OCEANOGRAPHIC REGIMES ON BEHAVIOUR AND MOVEMENT PATTERNS
The proposed project will bring together senior and early career researchers and a large, multi-national satellite telemetry dataset, to develop state-space models that will allow the comparison of humpback whale foraging behaviour around the Antarctic continent, and contrast how regional differences in sea ice and other critical oceanographic parameters influence whale foraging behaviour and distribution. This excellent proposal aligns well with IWC-SORP priorities and will make important contributions to both the IWC-SORP Baleen Whale Foraging Ecology and Humpback Connectivity Themes. It was ranked the highest of all proposals received by the IWC-SORP Assessment Panel.
PROPOSAL 7 BUCHAN, MILLER *ET AL.:* A STANDARDIZED ANALYTICAL FRAMEWORK FOR ROBUSTLY DETECTING TRENDS IN PASSIVE ACOUSTIC DATA: A LONG-TERM, CIRCUMPOLAR COMPARISON OF CALL-DENSITIES OF ANTARCTIC BLUE AND FIN WHALES
This highly collaborative proposal seeks to implement a standardized analytical framework for estimating calibrated call densities of Antarctic blue whales and fin whales, with a long-term view of using call densities to determine animal densities and examine population trends of Antarctic blue and fin whales in the Southern Ocean, based on existing IWC-SORP Acoustic Trend Working Group passive acoustic datasets. The aims of this study are extremely relevant to IWC-SORP priorities and will help to ensure that acoustic data across the Antarctic can be analysed in a comparable fashion in order for accurate estimates of trends in abundance to be obtained.
PROPOSAL 8 LANG, ARCHER *ET AL.:* INFERRING THE DEMOGRAPHIC HISTORY OF BLUE AND FIN WHALES IN THE ANTARCTIC USING MITOGENOMIC SEQUENCES GENERATED FROM HISTORICAL BALEEN
This proposal aims to use a combined dataset consisting of both contemporary and historical mitogenome sequences to examine the demographic histories of Antarctic blue and fin whales in the Antarctic using techniques such as Bayesian skyline plots and Approximate Bayesian Computation. The proposed work is important because there is currently no means of assessing trends in abundance for fin whales, the species with the highest catch by modern whaling in the Southern Oceans, and it will provide much needed information on fin and blue whale population structure, aligning with IWC/SC and IWC-SORP priorities.
PROPOSAL 9 ZERBINI, CLAPHAM *ET AL.:* ASSESSING BLUBBER THICKNESS TO INFORM SATELLITE TAG DEVELOPMENT AND DEPLOYMENT ON SOUTHERN OCEAN WHALES
This interesting proposal seeks to review whaling and stranding records in order to evaluate the variation of blubber thickness in whales, taking into consideration species, sex, age/length, season and life history information. Statistical models will be developed to predict blubber thickness for five species of large whales commonly tracked with implantable satellite tags and results will be used to propose species-specific parameters that will guide development and future deployments of implantable satellite tags. The proposed work will provide results and guidance highly relevant to all IWC-SORP Themes and to the wider IWC Scientific Committee. The proponents are recognised experts in the area of tag development and deployment.

PROPOSAL 10 ŠIROVIĆ, STAFFORD *ET AL.:* ACOUSTIC ECOLOGY OF FORAGING ANTARCTIC BLUE WHALES IN THE VICINITY OF ANTARCTIC KRILL STUDIED DURING AAD INTERDISCIPLINARY VOYAGE ABOARD THE RV INVESTIGATOR
This well founded proposal seeks to deploy a fixed acoustic mooring during a ship-based survey focusing on Antarctic blue whale behaviour and krill dynamics (the 2019 IWC-SORP RV Investigator voyage). Coupling moored data collection with ship-based, real-time passive and active acoustics will better enable the interpretation and quantification of the presence of Antarctic blue whales and their prey. This project will make substantial contributions to both the IWC-SORP Antarctic Blue Whale Project and Acoustic Trends Theme.
PROPOSAL 12 KELLY, MAIRE *ET AL.:* DEVELOPMENT OF STATISTICAL AND TECHNICAL METHODS TO SUPPORT THE USE OF LONG-RANGE UAVS TO ASSESS AND MONITOR CETACEAN POPULATIONS IN THE SOUTHERN OCEAN
The proposed project will involve synthesis of existing work to produce a toolbox of statistical methods for the use of aerial digital imagery (particularly that derived from long-range UAVs), to generate unbiased and precise estimates of abundance and the distribution of whales. Subsequently, the proponents will employ machine learning methods, such as deep neural networks, to test their utility for automated detection of animals in extensive collections of digital images. The proposed work is highly relevant to all IWC-SORP Themes and to the wider IWC Scientific Committee and beyond.
PROPOSAL 13 REISINGER, DE BRUYN *ET AL.:* AN INTEGRATIVE ASSESSMENT OF THE ECOLOGY AND CONNECTIVITY OF KILLER WHALE POPULATIONS IN THE SOUTHERN ATLANTIC AND INDIAN OCEANS
The proponents propose to integrate data on killer whale habitat use, feeding ecology (though stable isotope, photo-identification and telemetry data), population history and connectivity (through genetic analyses), historical population dynamics and regional patterns of diversity, from three locations in the southern Atlantic and Indian Oceans using state-of-the-art methodologies. This work builds on long-term studies of killer whales in waters around the Prince Edwards and Crozet Islands, by providing new data to help address key questions about essential prey and habitat resources, and the evolutionary implications of killer whale movement patterns and insularity. This project will address key conservation and management questions directly relevant to IWC-SORP killer whale thematic priorities through a better understanding of range extent and overlap, population structure and environmental dependencies.
PROPOSAL 14 BENGSTON NASH *ET AL.:* IMPLEMENTATION OF HUMPBACK WHALES FOR ANTARCTIC SEA-ICE ECOSYSTEM MONITORING; INTER-PROGRAM METHODOLOGY TRANSFER FOR EFFECTIVE CIRCUMPOLAR SURVEILLANCE
The proponents seek to integrate the findings and ongoing efforts of Southern Hemisphere humpback whale programs that have been investigating humpback whale foraging ecology in relation to the dynamics of their principal prey item, Antarctic krill. They will use existing biopsy samples and UAV morphometry measures, as well as initiating the collection of new samples/images, to compare and validate analytical methods and conduct same-year feeding vs. breeding ground population comparisons (diet and energetic reserves). The project will make valuable contributions to both the IWC-SORP Baleen Whale Foraging Ecology and Humpback Connectivity Themes. Good support was received for this proposal but the requested budget was substantially higher than all but one of the other proposals received. The IWC-SORP Assessment Panel considered the equipment costs unsupportable and proposed that analytical costs be reduced.
PROPOSAL 17 CARROLL, TORRES, GRAHAM *ET AL.:* CIRCUMPOLAR FORAGING ECOLOGY OF SOUTHERN RIGHT WHALES: PAST AND PRESENT
This proposal aims to compile a large stable isotope dataset comprising existing stable carbon and nitrogen isotope data from all major extant southern right whale wintering grounds. These data will be combined with spatial models of isotope distributions (isoscapes) of the Southern Ocean in order to identify and describe major southern right whale foraging areas. The proponents will then compare contemporary foraging habitat with historical foraging habitat identified using historical whaling data, to examine how habitat use has changed through time. Additional data will be generated by analysing historical bone samples to augment our understanding of historical foraging ecology. The proponents also plan to undertake a pilot study to investigate heterogeneity in foraging ecology linked to demographic class. This excellent proposal is closely aligned to IWC/SC priorities and prompted the recommendation of a new IWC-SORP Theme (See Section 6).
PROPOSAL 18 INIGUEZ *ET AL.:* HABITAT USE, SEASONALITY AND POPULATION STRUCTURE OF BALEEN AND TOOTHED WHALES IN THE SCOTIA SEA AND THE WESTERN ANTARCTIC PENINSULA USING VISUAL AND PASSIVE ACOUSTIC METHODS AND GENETICS
The proponents propose to develop ecological models for cetaceans in the western Antarctic Peninsula region by integrating passive acoustic data with remotely sensed environmental parameters, such as sea ice concentration, sea surface temperature, and chlorophyll a concentration. Comparisons with acoustic data collected in 2001-2003 will be made to examine changes in baleen whale patterns within this ecosystem over the past decade. In order to complement the information obtained, acoustic recordings, genetic, acoustic and photo identification studies will be carried out to investigate density, population structure and the behaviour of baleen and toothed whales in these waters. The substantial co-investment documented in the proposal budget was deemed worthy of note. The proposed work will make valuable contributions to both the IWC-SORP Antarctic Blue Whale Project and Acoustic Trends Theme.

proponent subsequently identified that an actual, apparent, or potential conflict of interest existed, or might arise, in relation to their application for funding, the applicant was required to inform the IWC-SORP Secretariat and IWC/SC Chair in writing immediately.

IWC-SORP Assessment Panel members that were involved in the assessment process were also required to declare any Conflicts of Interest to the IWC-SORP Secretariat and IWC/SC Chair prior to assessment of applications. The IWC/SC Chair decided on a case-by-case basis if the Panel member(s) should be excluded from the assessment of individual project(s).

In total, 22 Conflicts of Interest were declared by six Assessors. These Assessors did not assess the proposals for which a Conflict of Interest had been declared and abstained from subsequent Panel discussions regarding these proposals.

Outcome

Projects recommended for funding by the Assessment Panel are presented in Table 1 and the associated project summaries are provided in Table 2.

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Annex W

Draft Amendments to Scientific Committee Rules of Procedure

CURRENT RULES OF PROCEDURE AND PROPOSED CHANGES

[Key changes: (1) ***added text***; (2) ~~deleted text~~.]

This document contains a number of proposed changes to the Scientific Committee Rules of Procedure for its consideration and endorsement. Changes are meant to clarify some procedure, to align RoPs with the most current Scientific Committee practices and to cross-reference relevant Commission RoPs and Financial Regulations, which apply to the Scientific Committee as well. Some of these changes were discussed last year and agreed upon in principle.

1. Scientific Committee Rule A on 'Membership and Observers': National Delegates

There are a few Commission's and Financial Regulations rules that are relevant to Rule A.1 of the Scientific Committee Rules of Procedure. Here we propose: (a) an addition to cross-reference them aligns our RoPs to the latest version of Financial Rules of the Commission; (b) a factual correction to Rule A.3; and (c) a clarification on the type of existing members, also in relation to the election of the Committee vice-chair.

A. Membership and Observers***: full members, ex-officio members, Observers and Invited Participants***

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. ***These are the only voting members (full members). Representatives from Contracting Governments that received a grant from the Voluntary Assistance Fund, shall be considered national delegates. See also Commission's RoP A.1, A.2, D.1(a) and Financial Regulations' rule C1(f)***. [This text could be added as a Footnote to keep the rule easy to read and easy to amend if anything factual changes]. The Secretary of the Commission and relevant members of the Secretariat shall be *ex-officio* non-voting members of the Scientific Committee.

2. The Scientific Committee recognises that representatives of Inter-Governmental Organisations ***- Observers -*** 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~~ ***International Union for*** Conservation ***of Nature*** ~~Union~~ (IUCN) shall have similar status in 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.

2. Scientific Committee Rule A on 'Membership and Observers': Invited Participants

Some amendments are proposed to Rule A.6 to clarify the process of selection of Invited Participants. as follow:

A.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 the Committee's 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.

(a) Convenors[footnote: ***In practice, Convenors and Co-convenors are selected by the Chair and Vice-Chair of the Scientific Committee in consultation with the Head of Science***] 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~~ ***Head of Science***) not less than four months before the meeting in question. The 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) 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 ***fill a template on key aspects of their travel and return it*** ~~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~~.

(c) At the same time as (b), ***all Contracting governments will be advised of all invitations.*** ~~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~~***d***) 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 based on the~~ ***estimated*** actual cost of the hotel deemed most suitable by the Secretary and Chair. [The following text has been lifted from the footnote]Invited participants who choose to stay at cheaper ~~hotel~~ ***accommodation*** will receive the actual rate for their ***accommodation*** ~~hotel plus the same daily allowance~~"], plus ***(4)*** an appropriate daily ***subsistence*** allowance ***set by the Secretariat***.

~~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. ***Any invitee who subsequently attends the same meeting as an Invited Participant who has obtained financial support from elsewhere, or as a delegate nominated by a Contracting Government under rule A1, will not be eligible for financial support from the Scientific Committee budget.***

(~~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 language:***

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 Scientific Committee members nominated by Contracting 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 ***all*** ~~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.~~

3. Scientific Committee Rule A on 'Membership and Observers': Local Scientists

This amendment to SC Rule A.7 is proposed to align the finalisation of the Local Scientists list with that of the Invited Participants, helping logistics.

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 logistic reasons, requests should be sent at least two months before the annual meeting.***

4. Scientific Committee Rule B.1 on 'Agenda'

This amendment to SC Rule B.1 is proposed to align it with the current practice, which reflects the biennial cycle of the Commission.

B. Agenda ***and workplan***

1. ***In years when the Commission meets,*** ~~T~~*t*he initial agenda ***and workplan*** for the Committee meeting of the following ***biennium*** ~~year~~ shall be developed by the Committee prior to adjournment~~ each year~~***, for the Commission's approval***. The agenda should identify, as far as possible, key issues to be discussed ***in the next biennium*** ~~at the next meeting~~ and specific papers on issues should be requested by the Committee as appropriate. ***In years when the Commission does not meet, the Committee shall develop its initial agenda and workplan for the following year based on the progress made.***

5. Scientific Committee Rule C.1, C.4 and C.5 on 'Organisation'

This amendment to SC Rule C.1 is proposed to align it with the current practice and SC Rule C.4 and tidy up the text. In fact, there were three so-called 'standing' sub-groups (i.e. AWMP, E, SM). The distinction between a working group and a sub-committee should be clarified at some point, possibly at the Commission level. At present, the Chair is entitled to create only sub-committees (C.4). This year, in fact we have "promoted" two working groups to sub-committees (HIM, E).

C. Organisation

1. The Scientific Committee shall include standing sub-committees and working groups by area or species, or other subject, and ~~a~~ standing-sub-***groups***~~committee~~ on small cetaceans***, aboriginal whaling management procedure and environmental concerns***. The ***Chair of the*** Committee***, assisted by the Convenors group,*** ~~shall~~ ***may create*** ~~decide~~ ~~at each meeting on~~ sub-***groups***~~committees~~ ***as appropriate*** ~~for the coming year based~~ ***on the biennial workplan***.

[…]

4. ~~The Chair may appoint other sub-committees as appropriate.~~

5. The Committee shall elect from among its ***voting*** members ***(Full members)*** a Chair and Vice-Chair who will normally serve for a period of three years. They shall take office at the conclusion of the annual meeting at which they are elected. The Vice-Chair shall act for the Chair in his/her absence. ~~The election process shall be undertaken by the heads of national delegations who shall consult widely before nominating candidates[3][Footnote: [3]The Commission's Rule of Procedure on voting rights (rule E.2) also applies to the Scientific Committee].~~ The Vice-Chair will become Chair at the end of his/her term (unless he/she declines), and a new Vice-Chair will then be elected. If the Vice-Chair declines to become Chair, then a new Chair must also be elected. ~~If the election of the Chair or Vice-Chair is not by consensus, a vote shall be conducted by the Secretary and verified by the current Chair. A simple majority shall be decisive. In cases where a vote is tied, the Chair shall have the~~

~~casting vote. If requested by a head of delegation, the vote shall proceed by secret ballot. In these circumstances, the results shall only be reported in terms of which nominee received the most votes, and the vote counts shall not be reported or retained.~~

6. The election process shall be undertaken by the heads of national delegations who shall consult widely before nominating candidates[3][Footnote: [3]The Commission's Rule of Procedure on voting rights (rule E.2) also applies to the Scientific Committee]. The Chair shall facilitate the process. If the election of the Chair or Vice-Chair is not by consensus, a vote shall be conducted by the Secretary and verified by the current Chair. A simple majority shall be decisive. In cases where a vote is tied, the Chair shall have the casting vote. If requested by a head of delegation or the Chair, the vote shall proceed by secret ballot. In these circumstances, the results shall only be reported in terms of which nominee received the most votes, and the vote counts shall not be reported or retained.

6. Commission's Rule I on the Chair of the Scientific Committee

This amendment to Commission's Rule I is proposed to align it with current practices.

1. The Chair of the Scientific Committee ~~may~~***usually*** attend***s*** meetings of the Commission and Technical Committee in an *ex officio* capacity without vote, at the invitation of the Chair of the Commission or Technical Committee respectively in order to represent the views of the Scientific Committee.

7. Commission's Rule M.5 on Report of the Scientific Committee

This amendment to Commission's Rule M.5 is proposed to set a more realistic deadline for the SC report.

5. The report of the Scientific Committee should be completed and made available to all Commissioners and posted on the Commission's public web site ~~by the opening date of the Biennial Commission Meeting or~~ within ~~14~~***21*** days of the conclusion of the Scientific Committee meeting~~, whichever is the sooner~~.

8. Financial Regulations on Research Fund and other voluntary research funds (i.e. Voluntary Fund for Small Cetaceans Research and Conservation and Voluntary Research Fund on Southern Ocean Research Partnership)

The following are totally new proposed amendments to align the Commission and Committees Rules of Procedure to relatively recent developments (i.e. procedures on the Voluntary Fund for Small Cetaceans Research and Conservation and Voluntary Research Fund on Southern Ocean Research Partnership, which were already agreed working practices, endorsed by the Commission). It also looks at gaining some throughout the Committee's approaches on how to handle contingency funds. Finally, an amendment proposes to lose the option of unsolicited research proposal.

8.1 Amendments to Financial Regulations Rule C on General Financial Arrangements and Scientific Committee Rule G

In relation to the Research Fund, we propose some amendments to the Financial Regulations of the Commission, including an amended version of Appendix 1 (Small Cetaceans voluntary fund) and a new Appendix for the SORP fund. For consistency, the option of a discretionary contingency fund is added to the Small Cetaceans voluntary fund and the Research Fund. The General Financial Arrangements of the Committee are also amended: additions to Rule G and one new Rules (I) to inscribe the Scientific Committee Handbook into our RoP. Finally, we propose to delete the Rule G.2 General Financial Arrangements of the Committee on unsolicited proposals.

C. General Financial Arrangements [of Financial Regulations]
1. There shall be established a Research Fund, a General Fund, a Voluntary Fund for Small Cetaceans ***Research and Conservation***, a Voluntary Fund for Aboriginal Subsistence Whaling, ~~and~~ a Voluntary Conservation Fund, ***a Voluntary Research Fund on Southern Ocean Research Partnership***, ~~and~~ a Voluntary Assistance Fund to facilitate Contracting Governments in Capacity to Pay Groups 1 and 2 that are not EU Member States or members of the Organisation for Economic Cooperation and Development, (hereinafter eligible Groups 1 and 2 Governments), to Participate fully in the Work of the Commission (the Voluntary Assistance Fund)***.***

(a) The Research Fund shall be credited with voluntary contributions and any such monies as the Commission may allocate for research and scientific investigation and charged with specific expenditure of this nature. The Research Fund shall have a balanced distribution among activities, defined according to conservation priorities and the work of the Commission, including small cetaceans. ***The details of the Research Fund are given under Scientific Committee Rules of Procedure G and in the Handbook of the Scientific Committee.***
(b) The General Fund shall, subject to the establishment of any other funds that the Commission may determine, be credited or charged with all other income and expenditure.
(c) The details of the Voluntary Fund for Small Cetaceans ***Research and Conservation*** are given in Appendix 1.
The General Fund shall be credited or debited with the balance on the Commission's Income and Expenditure Account at the end of each financial year.
(d) The details of ***the administration of funding from*** the Voluntary Fund for Aboriginal Subsistence Whaling are given in Appendix 2.
(e) The details of the Voluntary Conservation Fund are given in Appendix 3.
(f) The details of the administration of funding from the Voluntary Research Fund on Southern Ocean Research Partnership in Appendix 4.
(~~f~~g) The details of the administration of funding from the Voluntary Assistance Fund to facilitate eligible Groups 1 and 2 Governments to Participate fully in the Work of the Commission are given in Appendix 4***5***.

[…]

G. Financial Support for Research Proposals [of the Scientific Committee Rules of Procedure]
1. The Scientific Committee shall identify research needs.
~~2. It shall consider unsolicited research proposals seeking financial support from the Commission to address these needs. A sub-committee shall be established to review and rank research proposals received 4 months in advance of the Annual Meeting and shall make recommendations to the full Committee.~~
3. The Scientific Committee shall recommend priority research proposals for Commission financial support as it judges best meet Commission priorities as communicated in the Scientific Committee's workplan. ***Details of the procedure agreed to identify priorities is given in the Handbook of the Scientific Committee***[footnote: ***See Rule I***].

In years when the Commission meets, the Committee shall develop and include in its report an overall budget summary with a short summary of the objectives of each proposed item for funding. In the alternate years, in light of progress made, the Chair, Vice- Chair, Head of Science and Secretary shall present the actual situation of all completed activities and provide to the Scientific Committee a plan to include all identified priorities of the second year.
5. The Scientific Committee Chair, Vice-Chair, and the Head of Science, in consultation with the Secretary shall be able to allocate a discretionary amount of not more than 10% of the total budget of the Research Fund, per budget period, in order to ensure the smooth running of approved projects. All discretionary allocations shall be consistent with the priorities of the IWC as proposed by the Scientific Committee and endorsed by the Commission. All allocations shall be reported in written by the Scientific Committee Chair to the Committee at its next meeting.

I. Working practices of the Scientific Committee
1. The Scientific Committee shall regularly consider its working practices, known as the Handbook of the Scientific Committee, and revise them as necessary.
2. In years when the Commission meets, a revised version of the Scientific Committee Handbook shall be submitted to the Commission for its consideration at the same time as the report of the Scientific Committee.

Appendix 1

VOLUNTARY FUND FOR SMALL CETACEANS ~~S~~ *RESEARCH AND CONSERVATION*

Purpose
The Commission decided at its 46th Annual Meeting in 1994 to establish an IWC voluntary fund to allow for the participation from developing countries in future small cetacean work and requested the Secretary to make arrangements for the creation of such a fund whereby contributions in cash and in kind can be registered and utilised by the Commission. ***In 2009, the purpose of this fund was extended to support high priority research that improves conservation outcomes for populations of small cetaceans, particularly those that are threatened or especially vulnerable to human activities.***

Contributions
The Commission has called on Contracting Governments and non-contracting Governments, intergovernmental organisations and other entities as appropriate, in particular those most interested in scientific research on small cetaceans, to contribute to the IWC voluntary fund for small cetacean~~s~~ ***research and conservation***.
Acceptance of contributions from entities other than Governments will be subject to the Commission's procedures for voluntary contributions. Where funds or support in kind are to be made available through the Voluntary Fund, the donation will ***be*** registered and administered by the Secretariat in accordance with Commission procedures.
The Secretariat will notify all members of the Commission on receipt of such voluntary contributions.
Where expenditure is incurred using these voluntary funds the Secretariat will inform the donors of their utilisation.

Distribution of Funds
1. Recognising that there are differences of view on the legal competence of the Commission in relation to small cetaceans, but aware of the need to promote the development of increased participation by developing countries, the following primary forms of disbursement will be supported in accordance with the purpose of the Voluntary Fund:
(a) provision of support for attendance of invited participants at meetings of the Scientific Committee;
(b) provision of support for research in areas, species or populations or research methodology in small cetacean work identified as of direct interest or priority in the advice provided by the Scientific Committee to the Commission; ***particularly, to support high priority research that improves conservation outcomes for populations of small cetaceans, particularly those that are threatened or especially vulnerable to human activities;***
(c) other small cetacean work in developing countries that may be identified from time to time by the Commission and in consultation with intergovernmental agencies as requiring, or likely to benefit from support through the Fund.

2. Where expenditure is proposed in support of invited participants, the following will apply:
(a) invited participants will be selected through consultation between the Chair of the Scientific Committee, the Convenor of the appropriate sub-committee and the ~~Secretary~~ ***Head of Science at the IWC Secretariat***.
~~(b) the government of the country where the scientists work will be advised of the invitation and asked if it can provide financial support~~.

3. Where expenditure involves research activity, the following will apply:
~~(a) the normal procedures for review of proposals and recommendations by the Scientific Committee will be followed;~~
~~(b) appropriate procedures for reporting of progress and outcomes will be applied and the work reviewed;~~
~~(c) the Secretariat shall solicit the involvement, as appropriate, of governments in the regions where the research activity is undertaken.~~

(a) an Assessment Panel shall be established by the Chair and vice-Chair of the Scientific Committee, in consultation with the Head of Science, at the beginning of his/her term.
(b) the Assessment Panel shall consist of the Chair and vice-Chair of the Scientific Committee, the Convenor of the Sub-committee on Small Cetaceans, the Head of Science at the IWC Secretariat, and a number of competent members of the Scientific Committee who provide a wide geographical scope and relevant expertise.
(c) in years where sufficient funds are gathered the following process shall be followed:
- ***(i) the Secretariat shall advertise a call for proposals on the official website and through a Circular Communication, which shall include detailed information on deadlines, review process (including criteria), administrative process;***
- ***(ii) all full proposals meeting the minimum administrative requirements shall be sent by the Secretariat to the Assessment Panel, which produce a report with its recommendations for funding, with the rationale behind each recommendation;***
- ***(iii) all projects recommended by the Assessment Panel shall be considered by the Sub-committee on Small Cetaceans at the Annual meeting of the Scientific Committee and then by the full Scientific Committee when discussing its budget;***
- ***(iv) recommended proposals shall be included in the Scientific Committee's budget, as given in its report to the Commission under the heading of a specific request to the Voluntary Research Fund for Small Cetaceans;***
- ***(v) these recommendations shall be presented to the Budgetary sub-committee and endorsed when the Commission approves the overall budget;***
- ***(vi) after final approval by the Commission, the Secretariat develops grant contracts specifying deliverables and timelines for the project leaders; funds shall be provided in accordance with the agreed schedule.***

(d) an Assessment Panel shall be able to allocate a discretionary amount of not more than £10,000, per budget period, in order to ensure the smooth running of approved projects. Any such requests will be discussed and agreed by the Assessment Panel in advance of an allocation being made. All discretionary allocations shall be consistent with the priorities of the sub-committees on Small Cetaceans and the IWC as endorsed by the Scientific Committee and Commission. All allocations shall be reported in written by the Assessment Panel chair to the Scientific Committee at its next meeting.

Appendix 4

VOLUNTARY RESEARCH FUND ON SOUTHERN OCEAN RESEARCH PARTNERSHIP

Purpose

The Southern Ocean Research Partnership (IWC-SORP) is an integrated, collaborative consortium for non-lethal whale research, which aims to maximise conservation outcomes for Southern Ocean whales through an understanding of the post-exploitation status, health, dynamics and environmental linkages of their populations, and the threats they face. The partnership maintains an integrated and responsive relationship with the Scientific Committee and its priorities. IWC-SORP was endorsed by the Scientific Committee of the IWC at its Annual Meeting in June 2009. The SORP Research Fund was established in 2010 (Annex R; IWC/SC/62).

Contributions

The Commission has called on Contracting Governments and non-contracting Governments, intergovernmental organisations and other entities as appropriate, in particular those most interested in this partnership, to contribute to this voluntary fund.

Acceptance of contributions from entities other than Governments will be subject to the Commission's procedures for voluntary contributions. Where funds or support in kind are to be made available through the Voluntary Fund, the donation will be registered and administered by the Secretariat in accordance with Commission procedures.

The Secretariat will notify all members of the Commission on receipt of such voluntary contributions.

Where expenditure is incurred using these voluntary funds the Secretariat will inform the donors of their utilisation.

Distribution of Funds

Where expenditure involves research activity, the following will apply:

(a) an IWC-SORP Scientific Steering Committee (IWC-SORP SSC) is established as advisory body for all processes and activities related to SORP [NOTE: this is a different task compare to the one that this group has now]***;***

(b) the SORP SSC is composed of a representative, with technical expertise, nominated by each member nation of the Partnership, as well as the Convenor of the Southern Hemisphere sub-committee, the Chair of the Scientific Committee, the IWC Head of Science, the IWC-SORP Secretariat and the CCAMLR observer to IWC Scientific Committee. At the discretion of the IWC-SORP SSC, additional representatives from Partnership members, as well as interested parties are welcome to attend and participate in meetings of this Committee;

(c) in years when sufficient funds are gathered the following process will be followed [NOTE: This following section contains agreed adjustments to the existing evaluation procedure to select for fund IWC-SORP project proposals (see Annex W; IWC 2017) which aim to help avoiding conflict of interest]***:***

> ***(i) IWC-SORP Assessment Panel shall comprise 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; (h) Additional members deemed necessary by the SC Chair to facilitate the assessment of proposals. These assessors will be drawn from the Scientific Committee.***
>
> ***(ii) the IWC and SORP Secretariats shall advertise a call for proposals on their official websites and through a Circular Communication, which shall include detailed information on deadlines, review process (including criteria) and administrative requirements;***
>
> ***(iii) all full proposals meeting the minimum administrative requirements (i.e. prepared in accordance with the IWC Scientific Committee pro forma) shall be sent by the Secretariat to the IWC-SORP Assessment Panel;***
>
> ***(iv) the IWC-SORP Assessment Panel shall carry out an evaluation of all proposals, which shall include a determination of how well the proposals align with IWC-SORP objectives, any other criteria specified in the Call for Proposals and shall consider any conditions associated with voluntary contributions as specified by donors. The IWC-SORP Assessment Panel may suggest improvements to proposals where they believe this is appropriate.***
>
> ***(v) upon receipt of a final proposal(s) (revised if necessary), the IWC-SORP Assessment Panel shall provide its written report to the Scientific Committee for consideration at its next annual meeting. For each proposal, this shall include: (a) a short summary of the proposal and its associated budget; (b) a summary of the final evaluations made by the IWC-SORP Assessment Panel, including comments on how well it aligns with IWC-SORP objectives and recommendations as to whether funding should be fully, partially or not supported;***
>
> ***(vi) the Scientific Committee shall consider these funding recommendations when discussing its budget; following consideration (and potential revision) by the Committee, approved requests shall be added to the Scientific Committee budget as a specific request to the IWC-SORP Research Fund and included in its Report;***
>
> ***(vii) the Scientific Committee recommendations shall be presented to the Budgetary sub-committee and endorsed when the Commission approves the overall budget;***
>
> ***(viii) after final approval by the Commission, the IWC Secretariat, with the assistance of the SORP Secretariat, shall develops grant contracts specifying deliverables and timelines for the project leaders; funds shall be provided in accordance with the agreed schedule.***

(d) the IWC-SORP SSC shall be able to allocate a discretionary amount of not more than £15,000, per budget period, in order to ensure the smooth running of approved projects. Any such requests shall be discussed and agreed by the IWC-SORP SSC in advance of an allocation being made. All discretionary allocations shall be consistent with the objectives of IWC-SORP and the IWC as endorsed by the Scientific Committee and Commission. All allocations shall be reported in written by the SORP SSC chair to the Scientific Committee at its next meeting.

Annex X

Preliminary Feedback Provided by the Scientific Committee on the 'IWC Review – Final Report'

1. INTRODUCTION

The final report from the Governance Review was released on the 16 April 2018 (see IWC Review report downloadable here: *https://archive.iwc.int/?r=6890*). The Independent Review Panel report represents the view of the three panellists and is the first step of the Governance Review process. The Chair of the Operational Effectiveness Working Group of the Finance and Administration Committee asked the Scientific Committee to review the Review report and provide feedback to the Commission on those recommendations related to the Committee.

The Scientific Committee (hereafter the 'Committee') formed an *ad hoc* Working Group (WG) to develop an initial response, which was then discussed in Plenary. The initial WG membership was the following: Scientific Committee Chair and Vice Chair, Heads of Delegations, sub-groups Convenors and former Scientific Committee Chair present at the meeting. The presumption was made that this subset represented the view of Committee's members, given their different roles, had a strong knowledge on the current and past structure and procedures of the Committee. All members of the WG concurred with the recommendations and comments reported herein. For membership see Appendix 1.

The WG established its *modus operandi*. The WG's feedback on relevant portions of the report should either provide support for a given recommendation or offer practical alternative solutions to recommendations, where appropriate. In addition, the WG should also identify recommendations and comments based on misinterpretations or misunderstandings of the Review Panel, providing a more accurate reflection of current Committee's practices and arrangements.

The WG organised its discussion and feedback on Review Panel's recommendations and comments around five mutually exclusive subject areas (see section 2 below). Within each subject area, those recommendations of perceived importance to the Committee were identified. Where feasible, a timeline for developing a response was proposed.

Any text from the 'IWC Review Final Report' is quoted here in *italic*.

2. FEEDBACK ON THE 'IWC REVIEW – FINAL REPORT'

The Working Group (WG) identified five mutually exclusive subject areas of interest related to its mission and function in the 'IWC Review Final Report'. These are:

(i) pre-eminence of the Scientific Committee;
(ii) the overarching issue of IWC strategic planning;
(iii) ways to facilitate communication within the IWC;
(iv) Scientific Committee function in relation to the Commission and other subsidiary bodies, including the use of budget; and
(v) IWC Secretariat function in relation to the Scientific Committee.

2.1 Feedback from the Scientific Committee on recommendations and comments

In this section we summarise the WG view on all recommendations and comments, made by the Review panel, which seem directly or indirectly relevant to the current Scientific Committee arrangements. The WG, in addition to commenting on misunderstandings and errors in the Review report, and providing a more accurate reflection of current Committee's practices and arrangements, has attempted to offer practical solutions to recommendations which were deemed neither applicable nor efficient.

2.1.1 Pre-eminence of the Scientific Committee

One of the strongest recommendations (no.18) from the Review panel was to maintain the recognized pre-eminence in global cetacean research of the Committee. Herein, we have treated this as a separate subject in the review.

'***Recommendation 18****: The Scientific Committee should remain a key strength of the IWC and every effort should be maintained to ensure its focus on meeting the needs of the Commission, while maintaining its global preeminence on cetacean research*'.

> *Panel basis for Recommendation 18*
> *(45) There seems to be universal agreement among IWC stakeholders that the IWC Scientific Committee (SC) is the premier body worldwide regarding cetacean science, comprising some of the greatest experts on cetacean biology in the World. The unique and enormous expertise on cetaceans in the SC provides IWC with the stature and credibility to remain as the main global body for cetacean management and conservation. The Review Team notes the Scientific Committee is a key strength of the IWC and every effort should be maintained to ensure its focus on meeting the needs of the Commission, while maintaining its global preeminence on cetacean research.*

WG CONSIDERATIONS

The Committee is certainly the main global scientific body for cetacean research, as it applies to management and conservation. This year the Committee was composed by over 200 scientists (this year, 119 National Delegates and 90 Invited Participants) coming from 40 different countries. The combination of experts from national delegations and Invited Participants, helps guaranteeing the presence of a variety of expertise from a wide geographical range.

The Committee widens its pool of expertise offered by National delegations (31 countries represented) and geographical representation by inviting participants (IPs) to contribute to its work (at its 2018 meeting, 50% were funded with Committee funding). This year, the participation of scientist from IWC member countries was increased by 30% through IPs participation.

The geographical distribution of represented countries at this year's Committee meeting is as follows: North America (6), South America (6), Europe (15), Africa (4), Asia including Middle east (7), and Oceania (2). This coverage to some extent parallels the distribution of IWC member countries by region.

The Committee is recognised as a global body that has a number of distinct roles: (from the IWC Rules of Procedure, 2016): The Scientific Committee shall *inter alia*: (1) review the current scientific and statistical information with respect to whales and whaling; (2) shall review current scientific research programmes of Governments, other international organisations or of private organisations; (3) shall review the scientific permits and scientific programmes for which Contracting Governments plan to issue scientific permits; and (4) shall consider such additional matters as may be referred to it by the Commission or by the Chair of the Commission, and shall submit reports and recommendations to the Commission.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **concurs** with Recommendation 18 that '*every effort should be maintained to ensure its effectiveness and global pre-eminence on cetacean research*'.

2.1.2 The overarching issue of IWC strategic planning

The WG noted that at least five recommendations (2, 4, 6, 7, 14 and 20) and paragraph (53), relevant to the Scientific Committee, are concerned with the need for better strategic planning by the Commission.

Recommendations 2 and 6 seem very similar, therefore they are commented on together.

'***Recommendation 2****: IWC should undertake greater scrutiny and assessment of reports from Committees and Working Groups at its biennial meetings and provide clearer directions for the inter-sessional work of all subsidiary bodies.*

> *Panel basis for Recommendation 2*
> *(17) Alongside a streamlined subsidiary body system, the Review Team considers the IWC should undertake greater scrutiny and assessment of reports from subsidiary bodies at their meetings and provide clearer directions for their inter-sessional work.*

'***Recommendation 6****: The IWC should develop and adopt a Strategic Plan and a multi-year work programme setting strategic directions and clear priorities for the work of IWC and its subsidiary bodies in line with best practice of other treaty bodies. Ideally, 'what', 'why', by 'whom' and by 'when' should be clearly defined for each task agreed in the strategic plan'.*

> *Panel basis for Recommendation 6*
> *(21) There was a great convergence of views recognizing the need for the Commission to play a greater role in preparing work programs with strategic and prioritized directions, both for the Commission itself and for its subsidiary bodies. The IWC budget should then be determined according to pre-established priorities. Such an approach would enable better communication and coherence between the Commission and subsidiary bodies not least in the case of the Scientific Committee, which in the view of many stakeholders tends to set its own priorities and requires better guidance from the Commission.*

WG CONSIDERATIONS

The Committee's priorities are set by the Commission. The Scientific Committee's Rules of Procedure and Handbook fully explain how the Committee's Terms of Reference should be interpreted in accordance with the Convention protocol and instructions received from the Commission (e.g., resolutions from the Commission directed to the Committee). The Scientific Committee Handbook also explains how the Committee handles its planning process.

Biennially a draft work plan is developed by the Committee and approved by the Commission. Each year the Committee's Agenda is available for comments and revisions by Contracting Governments 60 days in advance its annual meeting.

Recommended Agenda items, work plans and budgets are available to Contracting Governments at least three months before the Commission's biennial meeting.

In years when the Commission meets, the Scientific Committee provides the Commission with a two-year budget for the Commission to deliberate over and revise, as appropriate. Any budget items either reduced or eliminated from the Committee budget by the Commission would result in a reduction or elimination of Agenda items and sub-items. Items not on the agenda of the Committee are not addressed by the Committee at its annual meeting.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **agrees** that developing a multi-year IWC Strategic Plan is very important for the Commission in providing for an effective, efficient and consistent planning approach and for the fair and efficient implementation of IWC policies.

The WG also **suggests** that a coordinated multi-year Work Plan that includes all subsidiary bodies of the Commission would improve efficiency and coordination. The Work Plan should follow logically from the IWC's Strategic Plan.

The WG also **suggests** that any Work Plan approved by the Commission should identify how Commission funding would be allocated across all of its subsidiary bodies, providing some criteria for their assignment. In this way, funding priorities would be clear.

The WG **agrees** on the concept of streamlining planning protocols for all subsidiary bodies and is ready to provide a more 'user-friendly' work plan and proposed budget immediately after its 2018 meeting. This could be done through a separate document prepared by the Chair of the Committee for the consideration of the F&A Committee. The work plan of the Committee, together with work plans from all subsidiary bodies, would allow the Commission to draft an overall Work Plan for the Commission. This would guarantee consistency in planning protocols throughout its subsidiary bodies. This comprehensive set of work plans for all subsidiary bodies of the Commission would provide detailed information on 'who', 'why', 'when' and 'how' each element of the Commission would work to achieve overall mission goals of the Commission.

Recommendations 7 and 20 touch on very similar issues, therefore, they are considered together.

'***Recommendation 7****: All IWC Commission decisions should be properly reflected in the work programme, in a prioritized manner, with the human and/or financial resources needed to ensure their implementation clearly identified and allocated. They should be taken up by Subsidiary Bodies, including the Scientific Committee, with a clear follow-up mechanism put in place. At the very least, in the report of the SC and other subsidiary bodies to the Commission, a clear and specific response on progress achieved on every recommendation/request presented by the Commission should be given.*

Panel basis for Recommendation 7
(24) At present, when the Commission takes a decision or endorses a recommendation, there is no method to formally adjust the work programmes of the relevant subsidiary bodies, or to allocate the human or financial resources needed to ensure the proper implementation of that decision/ recommendation. Some respondents noted that Commission decisions are not always effectively followed-up by subsidiary bodies, including the Scientific Committee. An example given was the 2016 adopted resolution on the research gap analysis on ecosystem services for cetaceans, which, it appears, was not adequately factored into the workplan and agenda of the Scientific Committee. There is also a perception amongst some stakeholders that key decisions are made by Committees and Working Group Chairs rather than by the Commission, giving the impression sometimes that the 'tail has been wagging the dog' for IWC. The Review Team considers the IWC should develop a clearer system to ensure that all Commission decisions are prioritized and taken up by IWC subsidiary bodies, including the Scientific Committee, with a clear follow-up mechanism in place.

(25) Such a system could be introduced based around the 'Main Outcomes' document, which is adopted by the Commission at the close of each plenary session. This should ensure actions are followed from Commission decisions. It would also help to promote discussion on Commission level strategy. In general, it is very important that decisions by the Commission and subsidiary bodies are better implemented, monitored and followed-up. Systems used by other treaty bodies are outlined in Section 9 of this report, have a number of common features which are also relevant to the IWC, including: (i) ownership and agreement of outcomes and decisions by member States; (ii) assignment of priorities by member States, based on criteria such as those outlined in paragraph 155 of this report; (iii) assignment of lead responsibilities for action; and (iv) clear systems of monitoring, evaluation and follow up.

'***Recommendation 20****: A more effective process should be developed to ensure that resolutions and other decisions by the Commission are included in the IWC Workplan and that these items are afforded high priority by the SC and other subsidiary bodies. A clearer channel of communication and a process should be developed for following-up on IWC Resolutions by the Chair of the SC.*

Panel basis for Recommendation 20
Accountability
(49) According to many stakeholders, the SC tends to set its own agenda and priorities, including ***too much discretion for the chair, vice-chair, IWC Head of Science and conveners, reflecting, in some instances, the personal interests of the scientists involved rather than those of the Commission*** [emphasis added]. *The Review Team finds it important that the Commission provide clear and unambiguous direction to the SC at its biennial meetings as already noted in Recommendation 2, with regard to all subsidiary bodies. The Commission should undertake greater scrutiny and assessment of the SC reports at their biennial meetings and should also provide clearer and more explicit directions for the inter-sessional work of the SC. The SC submits its draft two-year workplan and agenda to the Commission at least 100 days before the Commission meeting for Commission approval or otherwise and this should provide time for adequate preparation for scrutiny and assessment at Commission meetings.*

(50) Also, Commission directions should be followed-up more effectively by the SC and reported on at subsequent Commission Meetings.

WG CONSIDERATIONS

The Committee, as a body and through its leadership, makes every effort to comply with all instructions received from the Commission. The Committee reports regularly to the Commission on its efforts to implement instructions from the Commission via: (1) annual reports, including budget requests; (2) a 2-year summary document; and (3) orally at the Commission's plenary meeting.

In 2017 the Committee discussed the issue of responsiveness to Commission directives. The Committee report from 2017 states:

> 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 to '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 (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.

The Intersessional Correspondence Group (ISG) on 'Work focused on biological hypothesis relevant to IWC Resolution 2016-3' discussed on how to develop proposals for a way forward in SC/67b, and how to best integrate this stream of work into the Scientific Committee. The ISG contacted a gap analysis expert to see if they would be willing to undertake a review in time for SC67b. An initial proposal was received, but was subsequently withdrawn because it was too large a task. In 2018, the Scientific Committee Agenda included a specific sub-item on this matter (*16.4.4 Ecosystem functioning*). The section of the Committee report on this issue follows:

> *16.4.4 Ecosystem functioning*
> Resolution 2016-3 tasked the Committee with investigating the contribution of cetaceans to ecosystem functions.
>
> Last year, the Committee noted that its focus would be on scientific aspects of the issue and established an intersessional correspondence group to progress this work. Progress made by that group, including development of a final terms of reference, can be found in Annex L, item 6.2. The Committee notes that the Conservation Committee will focus on the conservation and social science aspects of this survey.
>
> It was noted that there is broad interest in understanding the role of cetaceans in ecosystem functions, and that the Committee's expertise relates to the scientific aspects of the issue. Given the broad interest, it is suggested that the Committee work in collaboration with interested parties (e.g. CMS, CCAMLR, SCAR and SCOR) to share information and avoid the duplication of work.

Attention: C-A, CC, SC

In responding to Commission Resolution 2016-3, the Committee **advises** the Commission that in its focus on the scientific aspects on the contribution of cetaceans to ecosystem functioning:

(1) it is unlikely that the ultimate goal of properly determining the contribution of cetaceans to ecosystem functioning could be achieved in under a decade, given the complexity of the issue and the data gaps;
(2) a more immediate and achievable goal is the carrying out of a gap analysis to identify knowledge gaps and to develop a plan to address them.

To further this work, the Committee **agrees**:

(1) that it would be beneficial to hold a workshop to (a) define short- and medium-term objectives to be addressed and (b) to identify what further research is required in order to begin initial modelling of the contribution of cetaceans to ecosystem function; and
(2) that the Secretariat in conjunction with the Steering Group (ref) should contact CMS to determine their interest in participating in such a workshop.

These agreements show the Committee's plan on integrating the 'Ecosystem functioning' issue in our workplan with the initial focus on conducting a gap analysis.

Along these same lines, the Committed noted that as part of its formal budget submission to the Commission, it included a budget line regarding implementation costs of directives from the Commission.

Further, as part of recommendation 20, and as found in paragraph (49), there are serious claims from 'many *stakeholders*' regarding potential conflicts of interest affecting the actions of the Committee Chair, Vice-Chair and Head of Science. The role and powers of these officers are described in RoPs I, Appendix 1 of the Financial Regulations, SC-RoPs A, B, C, D and E.

The role of the Chair and Vice-Chair is to facilitate the work of the Scientific Committee in providing the best scientific advice to the Commission. As is the case for the Chair of the Commission, the Scientific Committee Chair's role is 'to serve the Commission, and as such, shall serve in an individual capacity and not represent the views of their Contracting Government, when acting as Chair' (Commission Rule F.1). To accentuate this, when presenting the results of the Scientific Committee's work at the Commission meeting, the Chair of the Scientific Committee usually sits with the Secretariat's Head of Science and they work together to deliver the report and answer questions. The IWC Secretariat's Head of Science (HoS) is the liaison officer dedicated to support the Scientific Committee activities. The HoS also oversees the production of all IWC scientific meeting reports and publications (see sections 5.2-5.4 of the SC HB). See section 3.2 of the SC Handbook for full details on these roles.

The Convenors' group is established in accordance to SC-RoP D.3. It currently includes 11 National delegates (representing six CGs), and 12 Invited Participants (four of which are former delegates, increasing the representation to 10 out of 31 CGs attending the SC), the Head of Science, and as *ex officio* members the Head of Statistics and the IWC Secretary. This group is now wide, diverse and has expanded in recent years to guarantee inclusion to the maximum extent possible.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **notes** that the Committee is always responsive to the instructions of the Commission. The WG **rejects** the claim that '*the SC tends to set its own agenda and priorities, including too much discretion for the chair, vice-chair, IWC Head of Science and conveners, reflecting, in some instances, the personal interests of the scientists involved rather than those of the Commission'*. Here, it would have been helpful had the Review Panel provided specific examples to support their assertion. Members of the WG, which represent considerable experience at the Committee and considerable experience responding to Commission directives, have simply not found personal interests or personal agendas of Committee leadership to dictate Committee priorities. It is certainly the case that the implementation of actions responsive to some received instructions may, however, require more time than others. Nonetheless, the Committee has always promptly responded to Commission requests to the best of its ability. In addition, it should be recognized that when instructions are unclear or require resources beyond the scope of the Committee, the implementation of an adequate response may prove difficult or impossible.

For example, when the draft Resolution 2016-3 was presented at the 2016 Commission meeting, the Committee's Chair provided the following statement (from IWC/66/17):

> *'The proposed resolution on cetaceans and ecosystem services requests that the Conservation Committee and Scientific Committee incorporate 'ecosystem services provided by live cetaceans to its work, including the review of the aspects previously identified' [legal, ecological, management, environmental, social, economical and financial aspects related to ecosystem services provided by live cetaceans to people and natural systems]. The Scientific Committee* [already] *considers ecological and environmental aspects of the relationship between cetaceans and marine ecosystem and their key role in the ecosystem under this item* [Ecosystem Modelling]. *A wider discussion on legal, social and economic values of cetaceans is outside the current remit of the Scientific Committee and thus may be more appropriate for the Conservation Committee'.*

The draft Resolution was amended, taking into consideration this statement in the amendments.

The WG **agrees** that, in order to improve the Committee's ability to respond to Commission recommendations to the Committee, it is advisable that authors of any new draft resolutions being considered by the Commission that contain instructions or have implications for the Agenda or workload of the Committee consider consulting with the Committee's Chair, Vice-Chair and Head of Science. This would provide an opportunity for a 'feasibility and implications' check. Such a practice would greatly improve efficiency and responsiveness of the Committee regarding Commission resolutions that direct the Committee to undertake a given task.

'***Recommendation 14****: A clearer and more logical structure should be established for the IWC Committee and Working Group system, setting out: (i) the roles of, and the distinction between, committees, sub-committees and Working Groups; (ii) which current groups fit into which category; and (iii) opportunities for reducing duplication and ensuring better reporting arrangements between the different groups. The development of this structure should be led by the Commission and should be included in the strategic plan, referred to in Recommendation 6.*

> *Panel basis for Recommendation 14 and Paragraph (53)*
> *(40) Overall, the structure of the system appears confusing to the Review Team and seems to have evolved organically. For the non-mandatory groups, it is not clear under which RoP rules they have been established, and it is not specified whether they are permanent or ad hoc. Their titles as either 'committee', 'sub-committee' or 'working group' seem random, without distinction and reflection on their variable levels of performance and*

subordination. In this regard, the Scientific Committee is in a category of itself, having resources at its disposal that the other subsidiary bodies lack. Adding to the lack of clarity is the fact that 'sub- committees' and 'working groups' have not only been established directly under the Commission, but also as subsidiary bodies to Committees.

(41) There appears to be some overlaps between the different groups. This needs to be addressed more strategically, including through a review of these overlaps and associated recommendations to reduce duplication and increase effectiveness. Reporting lines also require clarification. In general, the Review Team considers the number of Committees, Sub- Committees and Working Groups excessive. This creates difficulties, particularly for Contracting Governments with limited resources. This situation should be rationalized and streamlined with a clearer structure and hierarchy in the context of the Commission, providing overall policy and strategic direction for the whole IWC. In particular, there is a need to evaluate those bodies that do not meet nor conduct work inter-sessionally, since some may have already finalized their mandates. The broad authority and autonomy of the SC to create subsidiary bodies should also be critically evaluated. In the shorter term, a possible way to minimize the problem of the excessive number of committees, groups and concurrent meetings would be to conduct more inter-sessional work, and to make better use of technological tools. […]

(53) The SC agenda covers too many areas, with an associated excessive amount of information being provided annually to the SC by some sub-committees for evaluation and discussion. Therefore, the annual scope of work and materials need to be reviewed and refined to ensure SC meetings are more manageable. The Review Team also notes there are 14 sub-committees under the Scientific Committee, which is unwieldy and creates a very large volume of information that needs rationalization and streamlining. It should also be noted that not all sub-groups are allocated the same amount of time within the SC agenda. Having so many sub-committees also makes it harder for countries with small delegations to cover all of the issues and the sub-committees. The Review Team notes considerable work is underway to limit the papers and agenda items submitted to the SC in accord with its agenda (as agreed by the Commission).

WG CONSIDERATIONS

The Committee's RoPs C.1 and C.4 state how the Scientific Committee establish its sub-committees and working groups.

While there are subjects of common interest, the Committee's sub-groups deliberately avoid duplicating the work of any other groups or sub-groups within the Commission. Regular exchanges with the chairs of Conservation Committee's sub-groups, which are tasked to look at complementary topics (i.e., Whale Watching, Ship strikes), have been ongoing over the past three years. This was done to help streamline complementary agendas and avoid duplication.

The establishment of sub-committees at the Scientific Committee serves two purposes: (a) to be responsive to requests from the Commission for advice; and (b) to improve the efficiency and consistency of advice provided to the Commission.

Section 9 of the SC Handbook provides details on the current organization of the Committee. In general, the number of Committee sub-groups is directly related to standing and new agenda items requested or approved by the Commission. Splitting the Committee Agenda into workable size units is the main reason why the Committee is able to deliver such a large amount of information and advice at the end of its annual meetings. Discussions at one sub-committee meeting are not duplicated at other sub-committee meetings by design. This is due to a strict focus on sub-committee Terms of Reference and coordination of agenda items by the convenors group. In this way, the Committee is able to achieve consistency in the rigor of its peer-reviewed process throughout the entire Agenda of the Committee.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG again notes the importance of the Commission preparing a Strategic Plan that would address Commission priorities over the next 5-10 years. A work plan could then be developed to implement the objectives of the Strategic Plan. The Committee would then work closely with the Commission in developing a work plan that better reflected the priorities of the Commission.

The Committee over the past five years has undertaken to reduce the number of sub-groups and give specific ToRs to shorten the longevity of some of its sub-groups. This effort perhaps was not recognized by the Review Panel, who only observed the Committee at one meeting. While the mix of sub-committees and working groups can be confusing for non-Committee members, from the perspective of Committee members the system seems to work reasonably well, at least with respect to discussion and provision of scientific advice.

The WG **agrees** that additional consolidation may be possible, but would require guidance from the Commission that a given topic being addressed by a sub-group of the Committee was no longer a priority for the Commission.

The WG also **agrees** that a shorter Agenda would allow for better discussion of the remaining topics and possibly for a better communication of the results to other subsidiary bodies and to the Commission. Efforts to achieve a reduction in the number of Agenda items will be initiated prior to the 2019 annual meeting of the Committee, but will require guidance from the Commission.

2.1.3 Recommendations on ways to facilitate communication within the IWC

The WG identified a number of comments and recommendations that indicate there is a need to improve and facilitate communications within the IWC as a whole. In particular, we considered Recommendations 1, 3, 11, 16, 21 and related paragraphs and additional paragraphs (47) and (58).

Recommendation 1 and 16 seem very similar (at least in some part), therefore, comments and proposals from the Committee are given for both at the same time.

'Recommendation 1*: Biennial Commission meetings should be maintained, but measures should be implemented to strengthen the IWC inter-sessional process, including through having:* ***(i) a strong and effective Bureau****; (ii) a well-structured and effective subsidiary body system;* ***(iii) regular, effective and two way communication within the Commission*** [emphasis added]*; and (iv) effective involvement of States in decision making during the inter-sessional period, particularly in the case of developing States, which should be supported to attend IWC meetings,* *including those of the scientific and conservation committees.'*

Panel basis for Recommendation 1
*Executive Summary (p. 6): '**the Review Team notes the Bureau can play an important role in the governance of IWC, including ensuring inter-sessional work by subsidiary bodies, such as the Scientific Committee, is occurring and is consistent with the proceedings of Commission meetings**'.*

(16) The Review Team believes that the advantages of biennial sessions exceed the disadvantages, provided that the biennial meetings are accompanied by a structured, effective IWC inter-sessional process, to establish and maintain momentum between Commission meetings. A number of measures have been taken by other Multilateral Environmental Agencies (MEAs) and Regional Fisheries Management Organisations (RFMOs) to strengthen the inter-sessional process, including: (i) having a strong and effective Bureau; (ii) a well-structured and effective subsidiary body system operating in line with clear mandates from the Governing Body; (iii) regular, effective and two way communication between the Secretariat, Bureau, and the Governing Body; and (iv) effective involvement of States in decision making during the inter-sessional period, particularly in the case of developing States. These measures are also relevant and applicable to the IWC and should be developed and applied as a priority.

'***Recommendation 16***: *Mechanisms for better communication, collaboration and coordination between the different IWC subsidiary bodies should be established, to enable them to better address instructions from the Commission and to avoid overlapping. Such mechanisms could include, inter alia: (i) joint meetings; (ii) common membership of different bodies; (iii) joint projects; and (iv) regular and effective communication of meeting minutes, key outcomes and products.*

Panel basis for Recommendation 16
(43) The relationship between the subsidiary bodies is considered by the Review Team to be unclear, particularly to people who are not intimately involved in the Commission's work, and should, therefore, be clarified, and also require more collaboration, coordination and communication on issues of mutual interest. In this context, the Joint CC-SC meeting was highlighted by many stakeholders as a positive move in this direction and a possible model that could be replicated to other subsidiary bodies, notwithstanding the limitations related to the availability of financial resources. Mechanisms for better communication and collaboration between the different IWC subsidiary bodies should be established. Given the IWC structure, and noting experience from other treaty bodies, these mechanisms could include: (i) joint meetings, such as those held by the CC and the SC; (ii) common membership of different subsidiary bodies; (iii) joint projects, involving two or more subsidiary bodies; and (iv) regular and effective communication of meeting minutes, key outcomes and products between the different subsidiary bodies.

WG CONSIDERATIONS

At present, the communication between the Scientific Committee and Commission is primarily achieved through the Chair and vice-chair of the Commission. Whenever issues arise, the Committee chair and vice-chair can contact the Commission chair and vice-chair seeking their advice. The Commission Chair has the same opportunity if a matter needs to be discussed with the Committee. The Scientific Committee Chairs do not typically attend Bureau meetings, but they could be invited (see recommendations below).

It is useful to clarify that there is little or no decision-making accomplished during intersessional periods. Chairs, supported by the Secretariat, are simply overseeing agreed activities, making sure that they all go according to the endorsed plan.

According to the IWC Rules of Procedure this role – coordination and oversight of intersessional activities and adherence with the Commission's instructions – is the responsibility of the Commission Chair (see Comn RoP F.2f).

In relation to the SC arrangements, this is ensured by the Scientific Committee Chair and Convenors' group, established under SC-RoP D.3. See 'Committee's consideration and facts checking' section under Recommendation 20 (p.4 of this report) for details on the composition of this group.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **notes** that communication among scientists and lay persons involves communicating highly technical information in a manner that is both understandable and informative. This is a difficult task and it should be recognized as being so. Nonetheless, it is the goal of the Committee to continue to expand its efforts to better communicate scientific advice to the Commission.

The WG **agrees** that a better protocol for communication within subsidiary bodies would result in more efficient work and greater intersessional progress. Under the current organization and communication protocols, the Committee provides the Commission with considerable advice in response to Commission directives, and general advice on the status of cetacean stocks and impacts of anthropogenic activities, including direct and indirect killing of cetaceans. The nature of these communications from the Committee to the Commission is primarily through technical documents, and summaries of technical documents. Oral presentations from the Committee to the Commission are also an important aspect of the Commission communication protocol, and have been used many times in the past. If the Commission's organization or communication protocol changes, the Committee would welcome involvement in discussions regarding different mechanisms of communication. The Committee would also welcome input from the Commission regarding other forms of communication with the Commission, including the expanded use of interactive media.

The WG **suggests** that all Chairs of Commission subsidiary bodies, including the Scientific Committee, be included in the Bureau mailing list, as *ex officio members*, and that they participate (even only if in a remote mode) in Bureau meetings whenever the Bureau agenda includes issues relevant to their subsidiary bodies. This would strengthen the intersessional communication between the Commission and all subsidiary bodies.

Alternatively, an IWC convenors' group could be formed under the Commission Chair, which includes all chairs of subsidiary bodies and all members of the Bureau. In this case, the Committee suggests that Chairs of subsidiary bodies be invited to participate in Bureau meetings.

Recommendation 3 and 21 seem very similar; therefore, they are commented together.

'***Recommendation 3****: IWC Scientific and other committees should provide information to Commission Members in a format and structure that allows effective consideration by the Commission of scientific and policy issues and their implications for Commission decision making.*

Panel basis for Recommendation 3
(18) The agenda of Commission meetings is expanding and it is increasingly challenging to conduct business in the time available. Some stakeholders noted that the 2016 IWC Meeting was 'an improvement' compared to previous meetings, reflecting good chairing and the fact that the Chair tried to 'get all draft decisions out on the first day', with an initial general discussion and a major attempt to reach consensus in small groups on contentious issues, such as Aboriginal Subsistence Whaling. The rule of a 100-day interval between the Scientific Committee and the Commission Meeting is an improvement compared to former back-to- back meetings of the two forums. Nonetheless, reports from the Scientific Committee to Commission are often 'dense and heavy', according to many interviewed for this review, and it is important that information is provided to Commission Members in a format and structure which allows effective consideration of scientific and policy issues and their implications for Commission decision making. This is in line with the role of the Scientific Committee, which is to provide the best scientific advice to the Commission. There is an Executive Summary provided for the main SC report, however it is still important to have shorter, non-technical documents, which objectively set out the advice to the Commission stemming from scientific data in a format more digestible for Commissioners.

'***Recommendation 21****: Recommendations from the SC to the Commission should be clearer. The RoP of the Commission, the SC and other subsidiary bodies should be thoroughly revised and harmonized.*

Panel basis for Recommendation 21
Clarity of recommendations
(51) The inability of the SC to deliver clear recommendations on contested issues was considered to hamper its credibility. At least part of the problem stems from the confusing, and many times conflicting, rules of procedure (RoP) of the organization. SC-RoP E (3), for instance, allows the Scientific Committee to make recommendations on any topics under its consideration, while IWC RoP M (4) suggests that the Scientific Committee may consider only topics referred to it by the IWC or the Commission Chair and that any reports and recommendations must derive only from its prescribed course of work. A thorough revision and consequent harmonization of the rules of procedure of Commission and SC-RoP is, therefore, warranted.

WG CONSIDERATIONS

As noted above, the Committee has been working to improve the way it communicates information and recommendations to the Commission. Examples include the production of a biennial summary of Committee advice and recommendations (since 2014), as well as a reformatting of the Committee's annual report. The effort on the part of the Committee to improve the usefulness of information provided to the Commission received a formal commendation of appreciation by the Commission in 2016. See section 5.3 of the SC Handbook for full details on the current approach regarding how the Committee informs the Commission.

The Committee has also engaged in a thorough reconsideration of the nature and structure of the main body of its annual report. This process will take at least another biennium before it is completed.

Finally, the WG would like to respond to an assertion regarding the '*inability of the SC to deliver clear recommendations on contested issues*'. It would have been very helpful to the Committee had the Review Team provided specific examples of what prompted this comment. In addition, it would be helpful to know what the Review Team meant by a 'contested issue'. From a scientific perspective, the Committee first would like to point out that consensus regarding the interpretation of complex scientific data is not always possible. In fact, such debates are common and enrich the content of the Committee's science. Second, uncertainty is a vitally important aspect of research. Over time, uncertainty can be addressed; but it rarely can be eliminated. Therefore, from the Committee's perspective, it is reasonable to expect a lack of consensus on some or perhaps many of the scientific issues before the Committee. The Review Panel should understand this state of affairs and not necessarily consider a lack of consensus on the part of the Committee a weakness. Finally, a majority position in a working group or committee does not necessarily characterize the best science regarding a decision before the Commission. As scientific discussions are fraught with uncertainty, there is often the need for recommendations to be conditional on future work. This is unavoidable.

WG CONCLUSIONS AND RECOMMENDATIONS

The Committee **is fully engaged** in a continuous effort to improve its ways to communicate with the Commission and all other subsidiary bodies. Any feedback on other potential modifications of current ways to communicate with the Commission, beside the ongoing two initiatives ('new recommendation box' and '2-year summary'), would be greatly appreciated. To this end, the WG **agrees** to explore other forms to further distill documents which summarise the main outcomes and the proposed biannual work plan, and a wider use of PowerPoint presentations or other media protocols at the Commission Plenary and subsidiary meetings.

The WG **reiterates** that scientific recommendations or advice based on a consensus opinion of the Committee are not always possible; this situation should be recognised as unavoidable given the complexity of the issues under discussion and the diversity of the Committee's membership. Further it is recognized that from a lay person's position, it is difficult to understand why a group of scientists cannot agree on scientific advice regarding complex issues. This perception needs to be address in a communication strategy by the Committee.

'***Recommendation 11:*** *IWC should continue with the arrangements for IISD/ENB reporting of Commission Meetings and consider expanding this reporting to other key meetings, such as those of the Scientific Committee, subject to availability of resources. To the extent possible, the service should also be expanded to include detailed daily reports.*

Panel basis for Recommendation 11
(31) The arrangements for reporting on meetings are generally satisfactory, while some stakeholders complained that it takes too much time for meeting

reports to be circulated. It should be noted that most stakeholders welcomed the IISD/ENB reporting at Commission meetings, as IISD has done for many years in other multilateral treaty bodies, such as the COPs and scientific and technical bodies of CBD and CITES, for instance. This reporting service is seen as a positive step towards greater transparency and outreach for IWC Meetings and alignment with good practices of other treaty bodies.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **disagrees** with the Review Panel regarding the merits of IISD/ENB reporting at Committee meetings. Rather, given the nature and arrangements of the Scientific Committee annual meetings and the limited resources available for all IWC activities, the IISD/ENB reporting would not be the best use of funds, nor is it necessary.

2.1.4 Recommendations related to the Scientific Committee function in relation to the Commission and other subsidiary bodies, including the use of the core budget

In this section we discuss all recommendations related to the Scientific Committee functioning in relation to the Commission and other subsidiary bodies, including the use of the core budget. SC structure, Agenda, work plan (including the inter-sessional period) and budget. These are Recommendation 23 and paragraph (104). See also all considerations around Recommendation section 2.2.1.

'***Recommendation 23****: The budget allocation for the SC, as well as for all other subsidiary bodies of the Commission, should be revised in order to allow a more equitable distribution of the resources available and to ensure alignment with IWC priorities. This should be done in conjunction with the revision of the structure and number of subsidiary bodies (Recommendations 14 and 15). Over-expenditure relative to allocated budget should not be allowed to occur. IWC should also look for additional sources of funding for SC meetings, in addition to funds available through the IWC core budget.*

Panel basis for Recommendation 23 (see also 24) and paragraphs (57), (58) and (104)

Finance issues

(55) The cost of the Scientific Committee is a substantial part of the overall budget of the Commission, and it is notable that the Scientific Committee meeting was over budget by 20% in 2017. The Review Team notes SC Research (commonly known as 'the SC Budget') is separate to the budget for SC Meetings. The budget allocation for the Scientific Committee needs to be carefully reviewed relative to other IWC activities and the Chair of this Committee and the Secretariat should ensure that over-expenditure relative to allocated budget is not permitted to occur. The Review Team notes the current IWC budget for the Scientific Committee is 120,000 GBP and that this is considered inadequate by Commission members and Scientific Committee participants. The Review Team draws attention to the fact that other MEAs and RFMOs look for a range of funding sources for statutory and non-statutory meetings, including support from the host country of these meeting. IWC should look to additional sources of funding for SC meetings, in addition to funds available through the IWC core budget. […]

(57) In spite of recent years' momentum, the CC still faces many challenges, including:

- *Imbalance between the work of the SC and CC. First and foremost, the allocation of resources to the SC is from the core budget, while resources to the CC are allocated through voluntary contributions. This is a constraint for the work of the CC. Moreover, the SC holds major annual meetings separate from the biennial Commission meeting, while the Conservation Committee is currently held once every two years, just before the Commission meets. As mentioned above, the Conservation Committee Planning Group meets for a few hours directly after the Scientific Committee. This disparity in resources as well as meeting frequency and duration constrains the effectiveness of the CC.*
- *Role clarity. Some respondents noted the lack of clarity of mandates of the CC and SC, resulting in overlap and confusion of roles. A better coordination and synergy between the CC and the SC, as well as with other subsidiary bodies, in particular with the Working Group on Whale Killing Methods and Welfare Issues, is, therefore, much needed.*
- *Limited budget. The CC lacks an adequate budget to carry out its work, since its activities are funded exclusively through voluntary contributions, limiting its performance and effectiveness. According to some of the respondents, this reflects the much higher priority (and thus more time and financial resources) being placed on whaling related items, such as RMP and special permits, than on conservation related issues.*
- *Recognition of the CC. The Review Team notes a number of member governments do not attend the CC 'on principle' and this poses challenges for the effectiveness and legitimacy of the CC.*

(58) The Review Team believes a greater focus on the work of the Conservation Committee is warranted, although this should not detract in any way from the work of the Scientific Committee on which the work of the Conservation Committee is highly dependent. There is a strong case to increase the number of dedicated staff to support the CC, including a Head of Conservation to mirror the Head of Science, and to enhance the time and funds available, from the core budget, for it to undertake its work. There is considerable expertise on cetacean conservation within Contracting Governments, and the Scientific Committee, and there is potential for better use of this expertise within the work of the Conservation Committee. Consequently, there is also a need to upgrade the contact group between the Scientific and Conservation Committees from its current rather marginal role. […]

(104) The Review Team considers that 'Business as Usual' is not acceptable given the considerable financial challenges the IWC currently faces. For example, as at September, 2017, there was an overspend of 26,000 GBP in the years' budget and also a 20% overspend in the Scientific meeting budget. From the budget papers, it appears that the costs of major meetings, such as the Scientific Committee, are also not sustainable. Once Secretariat costs are taken away from the budget, then the Scientific Committee consumes 80% of the remaining funds. The Review Team notes the IWC Secretariat prepared a table in 2017 outlining costs for the last 5 Scientific Committee meetings: this is a positive trend towards greater transparency and should continue. However, the basic issue of sustainability of financing of these meetings remains.

WG CONSIDERATIONS

The Committee does not manage the budget associated with the cost of hosting the annual meeting of the Committee. Moreover, the assertion regarding a budget overrun contained in paragraph (104) seems to lack knowledge of actual practice within the Commission.

In addition, the recommendation to redistribute the core fund seems in contradiction with Recommendation 18 (‘*the Scientific Committee is a key strength of the IWC and every effort should be maintained to ensure its effectiveness and global pre-eminence on cetacean research*’) and paragraph (58) (‘*The Review Team believes a greater focus on the work of the Conservation Committee is warranted, although this should not detract in any way from the work of the Scientific Committee on which the work of the Conservation Committee is highly dependent*’). It is the view of the WG that the allocation of limited funding by the Commission would best be driven by prioritized objectives developed in a future IWC Strategic Plan. The allocation of a budget among subsidiary bodies should be based on priorities and not preconceived perceptions regarding equity, which may not reflect the agreed views of the Commission.

For example, in relation to the bullet points in paragraph (57), ‘*Imbalance between the work of the SC and CC*‘ and ‘*Limited budget*’, it should be clarified that this reflects the current priorities of the Scientific Committee and the Conservation Committee, which has been adopted by the Commission. It is the priorities of the Commission and the general workload of the Committee that explains the so-called ‘*imbalance*’ referred to by the Review Panel. It should also be recognized that when the Conservation Committee was proposed, the Commission agreed that it ‘*would be on a par and equal with the Scientific and Finance and Administration Committees and should not have major implications for either cost or responsibilities of the Commission*’ (IWC 2003). This agreement was based on the following assertion by the Commission: that the ‘*establishment, by the Commission, of an appropriate trust fund (including the identification of potential contributors), to make available the necessary financial resources to the Commission and, particularly, to the Contracting Governments committed to implementing specific items of the Conservation Agenda related to conservation-oriented research*’ (IWC 2003).

In regard to the ‘*Role clarity*’, the Scientific Committee believes it has a very clear mandate from the Commission, which is codified in its Terms of Reference (see SC-RoPs M.4a; sections 1.2 and 2 of the SC Handbook).

Finally, some Heads of Delegation pointed out that this recommendation or the preambular paragraphs (57 and 58), the Review Panel members have not acknowledged the stated positions of IWC members regarding the establishment and role of the Conservation Committee.

WG CONCLUSIONS AND RECOMMENDATIONS

While the Committee will comply with any decision that the Commission will take regarding the Core Fund, the WG does not believe that determining how the General Fund is assigned to different committees (i.e. the size of the Research Fund) is its responsibility. Rather, it believes that allocation of the General Fund should be based on clearly established priorities. Further, an equitable distribution of resources to Commission subsidiary bodies is unlikely to result in an optimal implementation of Commission objectives. Nevertheless, the WG **agrees,** as noted earlier, that the Commission should develop and approve a Strategic Plan, and the allocation of resources to subsidiary bodies should stem from what is needed to best achieve its objectives.

The WG **concurs** with the Review Panel statement in paragraph (58), that any measure to improve the ability of the Conservation Committee ‘*should not detract in any way from the work of the Scientific Committee on which the work of the Conservation Committee is highly dependent*’.

Recommendation 4 and paragraphs 47 and 48 consider similar issues, therefore, are treated together.

‘***Recommendation 4****: Once the Commission has completed a revision of the structure and number of subsidiary bodies, streamlining them (Recommendations 14 and 15), a joint working group of scientists and managers should be created to improve dialogue between the Commission and the Scientific Committee and to ensure SC proceedings and recommendations are clear, concise and as policy relevant as possible.’*

> *Panel basis for Recommendation 4*
> *(19) The Review Team considers a contact group between the Commission and the Scientific Committee should be established, tasked to make SC proceedings and recommendations are clear, concise and policy relevant so as to establish the most suitable format for decision-making by the Commission. Hard deadlines should be set for the submission of papers in advance of meetings.*
>
> *‘Paragraphs 47 and 48 on the Relationship between the Scientific Committee and Other Committees:*
> *(47) The relationship between the Scientific Committee and other committees and working groups is seen as reasonably satisfactory by IWC stakeholders. The main criticism relates to a lack of communication and cooperation between different groups, particularly during inter-sessional periods. One of the negative consequences of this is the overlapping and duplication of work. The Scientific Committee and other committees and working groups, therefore, should have better coordination and clearer mandates.*
>
> *(48) In the absence of formal Terms of Reference and guidance from the Commission, some subsidiary bodies tend to self-determine their mandates, resulting in duplication of work and waste of valuable resources. The establishment of a Joint Working Group of the CC and the SC is welcomed as a step in the right direction, but is considered to be less effective than it could be, mainly because of the short time available to it and the inappropriate timing. The meeting of the Conservation Committee is currently held once every two years, just before the Commission meets. However, the Conservation Committee Planning Group meets for a few hours directly after the Scientific Committee. This is a small planning meeting, to ensure intersessional progress with work and to plan for the biennial Conservation Committee meeting. The holding of concurrent sessions of the Scientific Committee and Conservation Committee during the normal course of Scientific Committee meetings could be a more effective way to ensure better coordination and joint work. The Review Team notes however, that concurrent sessions pose challenges for delegations with only one or two members. The Review Team notes the Joint Conservation Committee – Scientific Committee Working Group is progressively developing a database of IWC recommendations which will be presented to the Joint*

CC/SC Working Group in May 2018. The Review Team commends this positive initiative.

WG CONSIDERATIONS

Figure 1 of the Scientific Committee Handbook clarifies how the Committee interacts with all other subsidiary bodies and the Commission.

The Joint Conservation Committee and Scientific Committee Working Group has clear Terms of Reference:

- The Joint CC/SC working group (CC/SC WG) is tasked with facilitating the communication, implementation, and follow-up of conservation recommendations. The CC/SC WG shall:
- 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;
- report, as appropriate, to the Commission on progress in delivering conservation recommendations;
- develop clear procedures/strategies for effectively transmitting and facilitating the implementation of conservation recommendations to and from the SC/CC WG to the appropriate Committees and sub-committees/working groups, including for further technical work;
- provide advice to the Conservation Committee on those priority conservation recommendations it could assist in implementing;
- provide feedback to the Scientific Committee on further advice and/or actions to assist in the implementation of conservation recommendations;
- 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.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **suggests** that communication between the Commission and its subsidiary bodies can be improved by using a Commission convenors' group, with all chairs and vice-chairs and the Bureau members.

The WG **notes** that the current ToR do not include joint planning of CC and SC activities and that the coordination is done via direct contact between Chairs and convenors of these Committees. The Joint CC/SC WG focuses on finding ways to improve the communication of SC recommendations relevant to the CC and their implementation.

In case the Commission chooses to implement this recommendation, the WG **respectfully requests** more clarity on how a joint working group of 'scientists' and 'managers' committee would function and its Terms of Reference. In addition, this group could potentially add an unnecessary layer, which seems contrary a streamlining process. This is especially true considering the existence of the CC/SC joint Working Group.

'***Recommendation 17****: IWC should consider making papers available in advance of Committee and Working Group Meetings, except for issues considered sensitive and/or confidential by the IWC Chair. The IWC Chair, in consultation with the Vice Chair and the Bureau, should determine whether documents are confidential and the level of availability.*

Panel basis for Recommendation 17

(44) The Scientific Committee (SC) and other Committees and Working Groups have confidentiality rules until background reports are tabled in plenary sessions. Such rules normally do not exist in other treaties. There was a clear rationale for such confidentiality in IWC when there was an industry advantage in keeping information confidential. However, this is no longer an issue and this should be reviewed. The Review Team suggests the IWC should make papers available in advance of Committee and Working Group Meetings, except for issues considered sensitive and/or confidential.

WG CONSIDERATIONS

Section 5 of the Scientific Committee Handbook give full details on deadlines and confidentiality within the Committee. The Review Panel appears unaware that many of the protocols established by the Scientific Committee and Commission were part of the 'Future of the IWC' process. Protocols were established to 'avoid surprises'. The effort has proven quite helpful in avoiding arguments within the Commission or Scientific Committee due to last minute submissions.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **agrees** that making papers available in advance of Committee and Working Group meetings is generally consistent with the mission goals of the IWC. The WG **notes** that implementation of RoP regarding data sharing and data submission is improving year by year.

2.1.5 Recommendations on the function of the Secretariat in relation to the Scientific Committee

Recommendations 19, 22, 28, 30 and 31 concern the function of the Secretariat in relation to the Scientific Committee. If the current setup and role of the Scientific Committee is to be maintained, any change in the relationship between the Committee and the Secretariat should be carefully planned and introduced gradually. Comments to these recommendations should be read with this prospective.

'***Recommendation 31****: Additional staff should be appointed to allow the Secretariat to meet its increasing demands. The Executive Secretary should determine an organigram and staff priorities once the Commission has agreed its Strategic Plan and multi-year work programme (Recommendation 6). Priority positions should include a deputy Head of Science, a Head of Conservation and additional IT expertise.*

Panel basis for Recommendation 31

(75) The Review Team notes there is a need for additional personnel in the Secretariat, particularly in the finance, human resource and IT areas, including:

- *a Deputy Head of Science. The current IWC Head of Science has outstanding skills and expertise, which contribute significantly to the high quality and global reputation of IWC's work. However, the Head of Science is approaching retirement and a Deputy Head of Science is thus crucial due to the current concentration of knowledge/expertise in one person and the need to ensure an effective transition, with minimal disruption to the work of IWC;*
- *a Head of Conservation, to support the Conservation Committee and associated activities;*
- *an IT personnel to improve electronic archiving and to ensure effective database organization;*
- *a legal expert;*
- *a professional position for the IWC Journal; and*
- *a professional position to liaise with other organizations, to strengthen IWC cooperation and communication with other international and regional institutions*

WG CONSIDERATIONS

The SC Handbook describes the role of the IWC Secretariat's Head of Science (HoS) as 'the liaison officer with the Scientific Committee' and details his tasks in relation to the SC as follows:

> The primary tasks of the HoS (usually carried out in consultation with the Chair and the Vice-Chair) are:
>
> 1. support to the Chair on Annual Meeting-related activities and intersessional activities;
> 2. to coordinate (including acting as Plenary rapporteur) all IWC scientific meeting reports and publications, with the assistance of other Secretariat staff;
> 3. to represent the Committee at scientific meetings of other IGOs when designated;
> 4. to co-chair the Standing Steering Group on Special Permits (this is a shared responsibility with Chair and Vice-Chair);
> 5. to participate in the following intersessional groups as an *ex officio* member:
>   i Data Availability Group;
>   ii. Aboriginal Subsistence Whaling Working Group of the Commission;
>   iii. Strandings Initiative Steering Group;
>   iv. IWC-SORP Standing Steering Committee;
>   v. Conservation Committee Standing Working Group on the Bycatch Mitigation Initiative;
>   vi. Conservation Committee Standing Working Group on Conservation Management Plans;
>   vii. Conservation Committee Whale Watching Working Group on Whale watching;
>   viii. Joint CC/SC Working Group;
>   ix. Review Group of the Voluntary Research Fund for Small Cetaceans;
>   x. Steering Group for the Voluntary Conservation Fund;
>   xi. Other groups that the Scientific Committee or Commission may deem necessary.

In reality, past SC Chairs have probably only invested about 20-25% of their time in Committee-related matters, because they normally hold a full-time position outside the IWC. However, the HoS is a full-time position at the IWC and, therefore has been able to provide overall support and assistance to the SC Chairs over the last 40 years. This support results from his knowledge and expertise, both scientifically and procedurally.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **agrees** that the HoS has outstanding skills and expertise. All of the Convenors that serve on the Committee were unanimous regarding the exceptional role the HoS plays in the accomplishments of the Committee in contributing to the mission of the Commission.

The WG **is also concerned** with the lack of a succession plan for several key members of the Committee. The HoS is one of these. Discussions on potential solutions for a smooth succession plan started within the Committee in 2017. Aware of the current financial situation within the Commission, the WG **suggests** an approach whereby a temporary role be established for a 'Deputy HoS' that would evolve into HoS over a set period of time (e.g. in a five-year window). Similarly, concern regarding succession planning in a number of other key positions on the Committee remains.

Recommendations 22 and 30 seem rather similar and will be commented together.

'***Recommendation 22***: *Options for continuing the current secondment arrangements for the Chair of the Scientific Committee, to the IWC Secretariat, should be explored with member governments and partners, with the aim of continuing this arrangement after the current secondment concludes.*

> *Panel basis for Recommendation 22*
> *Structural and process issues*
> *[...]*
> *(54) Many stakeholders noted the positive benefits of having the Chair of the Scientific Committee seconded to work with the Secretariat, both in terms of enabling the Chair to work effectively with the Secretariat and the Head of Science and also by enhancing the capacity of both the Secretariat and the Scientific Committee. The Review Team considers this arrangement should be continued if possible and suggests options should be explored to ensure it while recognizing financial limitations. IWC members should also be invited to consider secondment arrangements to support the Commission's work in more general as recommended in recommendation 35 below.*

'***Recommendation 30***: *Options should be explored for increasing secretariat resources, including through secondments, internships, and through fundraising linked to implementation of priority programmes, as defined by the Commission.*'

> *Panel basis for Recommendation 30*
> *(74) There are growing pressures and demands on the Secretariat to effectively implement its full mandate (e.g. conservation and management) and there was a clear feeling from the Secretariat, and a number of stakeholders, that staff levels need to be increased to meet these increasing demands. Many IWC staff interviewed noted they are 'overloaded' and 'under stress' due to inadequate staff resources. IWC Secretariat resources are, in fact, far lower than in other comparable multilateral treaty secretariats. There have been some initiatives to increase staff resources, including through the current secondment of the Chair of the Scientific Committee, and joint arrangements with other organisations, such as the involvement of Dr. David Mattila with the Secretariat to deal with entanglement response measures. These arrangements appear to be working well, and the secondment of the SC Chair is a major contributor to the success and effectiveness of the Scientific Committee. However, it is not an open-ended arrangement, and there is no guarantee it will continue after the term of the current Chair expires. The Review Team considers options should be explored for expanding secondment opportunities at the Secretariat from Member Governments, including for the continuation of the current secondment arrangements for future chairs of the Scientific Committee to the IWC Secretariat. IWC members should be invited to consider secondment arrangements to support the Commission's work. The Review Team notes it is essential that any increase in resources must be allocated in line with priority programmes defined by the Commission.*

WG CONSIDERATIONS

Within the IWC secondment has been used only twice. The first example has been the Disentanglement Coordinator (David Mattila) who was seconded by the US Government to the Secretariat for two years. At the request of the US government and with the support of the Commission, this position evolved into a staff position in the Secretariat. The second instance, as reported by the Review Panel, has been the Committee Chair (Caterina Fortuna), seconded by the Italian Government for the entire duration of her service in this role (three years).

WG CONCLUSIONS AND RECOMMENDATIONS

The WG **agrees** that the current arrangement of secondment of the Committee Chair to the Secretariat has been an ideal situation. However, any expectation that this is could be a common practice, for the Chair of the Committee, is ill-advised because it would imply an additional financial obligation for the IWC member governments that nominate candidates for the position. Therefore, this would very much limit the range in Committee members who could agree to serve as Chair.

On the other hand, the WG **agrees** that secondment of member nations' personnel with relevant expertise to the Secretariat should be strongly encouraged for roles within the Secretariat.

'***Recommendation 28****: The workload of the Secretariat should be better distributed among members of the staff. IWC staff should not act as conveners of any IWC group, to ensure impartiality and to not compromise the secretariat function of assisting other subsidiary bodies. In future hiring of personnel, the Secretariat should consider language skills as an attribute in recruiting and hiring additional staff, to improve the Secretariat capacity to engage more efficiently with a wider range of parties.*

Panel basis for Recommendation 28

(70) The Review Team notes a discrepancy of views between long-standing members of the Secretariat and newer members who are 'used to' more modern procedures and working practices (e.g. staff appraisal system, improved financial procedures), resulting in a degree of resistance to change. These differences are not helpful for the overall effectiveness of the Secretariat and need to be openly recognized and addressed in a positive, effective and diplomatic manner.

(71) A relative imbalance in the distribution of work in the Secretariat, with some members of the staff being underutilized and others, like the Head of Science, being overloaded, was also suggested. In this context, the outstanding scientific capacity of the Head of Science in IWC was recognized, but with the caveat that this position should not participate as a convener of any group, not only to ensure impartiality, but also to allow this position to be available for all discussions and subsidiary bodies during key IWC meetings. Finally, the hiring of professionals that do not have English as their native language was recommended in the future to broaden the Secretariat capacity to engage more efficiently with a wider range of parties. The Review Team notes UK law precludes the IWC Secretariat from undertaking 'positive discrimination' in its hiring practices and also notes that current staff do have language skills (French, Spanish, and Italian). However the Review Team suggests the Secretariat should consider language skills as an attribute in recruiting and hiring additional staff in the future.

WG CONSIDERATIONS

Section 4.1.1 of the Scientific Committee Handbook details the role of Committee convenors. Requirements to be appointed as Convenor/Co-convenor include appropriate scientific background and chairing experience, knowledge of Committee procedures and appropriate communication skills. Being perceived as a balanced and fair Scientific Committee member is also necessary. Delegates serving in the role of a convenor must be able to do so, not in their role as a delegate of a member nation of the Commission, but rather in a role so as to be supportive of all viewpoints expressed during Committee meetings.

The role of 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.

The current Head of Science convenes the Aboriginal Whaling Management Procedure Standing Working Group (AWMP SWG). The work of the Standing Working Group is a very high priority for the Commission and is a highly technical sub-group of the Committee. Given the accolades from the Commission to the work of the AWMP, it seems clear that the HoS has done an excellent job convening this sub-group over the 25 years. It should also be noted that the Aboriginal Whaling Procedure Standing Working Group is now considered to have completed the task for which it was established, so will not continue in its current form.

WG CONCLUSIONS AND RECOMMENDATIONS

The WG is not able to comment on the issue of workload within the Secretariat; however, the role of Head of Science in relation to the SC is highly specialised and cannot be necessarily spread amongst present members of the Secretariat.

The WG **agrees** that the Head of Science has been a very efficient convener and should not be precluded from acting in that capacity. The WG **reiterates** that it is implicit that all convenors are meant to be impartial in the deliberations of their sub-group. Therefore, the Committee supports staff from the Secretariat serving as Convenors, given appropriate experience and given there is sufficient capacity in the Secretariat to provide for this assignment. The basis of the notion that impartiality of staff of the Secretariat would somehow be compromised by acting as convenors is unclear, and is a position the WG **disagrees** with.

'***Recommendation 19****: The Secretariat should continue with improvements to scientific data archiving and access, to assist effective Commission decision making, and adequate resources should be made available to that aim. With this purpose, the Secretariat should prepare a comprehensive data management strategy/plan for data archiving and access, to deliver a modern and cost-effective solution, with priorities and budget clearly indicated.*

Panel basis for Recommendation 19

(46) The procedures for scientific data archiving and access were highly praised by stakeholders and considered to be well-thought out, time-tested, transparent and credible, despite being a bit burdensome, slow and with uncertain outcomes. Notwithstanding a significant improvement in recent years, the system could perform much better if the resources requested by the Secretariat had been provided.

WG CONSIDERATIONS

In 2017, the Scientific Committee Chair formed an ad hoc Working Group on IWC Global Data Repositories and National Reports (GDR) (IWC 2018, JCRM 19(supplement):399-404; see also the SC Handbook). The initial Terms of Reference for this group were to conduct an assessment of the utility and support requirements of all IWC databases relevant to the work of the Committee. Particularly the group: (1) collated summary information on all IWC databases relevant to the Scientific Committee (including data availability considerations); (2) summarised data use by the Committee for each database; (3) provided recommendations to improve integration, content and workflows; (4) review technical progress on existing databases; (5) considered needs and specifications for potential new databases, including developing simple technical guidelines on new proposals; and (6) produced a budget and work plan for the implementation and development of existing and new databases.

The group completed its main tasks in May 2017, except for producing a budget and thoroughly assessing the human resource and needs to accomplish the stated objectives. For this reason, the Working Group was transformed into a Standing Intersessional Steering Group, which will work in conjunction with the Secretariat to further clarify these points.

WG CONCLUSIONS AND RECOMMENDATIONS

Based on the recent experience gained by the GDR working group, the Committee agrees that it is apparent that improvements '*to scientific data archiving and access*' or activities requiring structural fixes/arrangements can only be achieved if there is a strong coordination and dialogue between the Scientific Committee members and key/relevant members of the Secretariat.

3. METHODS USED BY THE REVIEW PANEL AND ITS TOR

3.1 Methods used by the Panel to assess the IWC performance

Methods used by the Review Panel for the survey and the in-person interviews can be found in the Introduction (pp.12-13 of the IWC Review report) and Annex B.

3.1.1 Considerations on the methods used by the Panel

The WG noted that much of the information used by the Review Panel in this review was based on interviews with a relatively small group of people. However, the Review Panel report seems to indicate that their conclusions are based on a broad consensus of IWC constituents and stakeholders. The WG believes that a more representative characterization of how the Commission and its subsidiary bodies perform would have been achieved with a much larger survey sample.

There are basic weaknesses in the survey methods applied by the Review Panel to evaluate the efficiency of the IWC. Major points highlighted by WG members include the following.

- Unclear definition of what an 'IWC stakeholder' is.
- Unbalanced stratification within the interviewees' pool and in the 'in-person interviews' (CGs *vs* 'NGOs and other IGOs', gender, different view on whaling, age, years of IWC participation).
- Extremely low rate of responses to the survey (38 respondents out of 600 'stakeholders').
- Potential duplication or accounting of interviewees' opinions (i.e. with same people responding to both the survey and in-person interviews).
- Inability to discriminate what was the opinion of the Review Panel and what was the opinion of the respondents.

While the WG did not have adequate time to fully evaluate the merits of the methodology employed by the Review Panel, it is recognized that the limits of the methods used might have had a significant effect on the ability of the Review Panel to adequately characterize the full range of positions or opinions held by 'stakeholders' or of the full membership, with a likely consequence on the outputs (recommendations) and conclusions.

3.1.2 Other considerations on factual mistakes or unsolicited comments

The Review Panel reported that the '*IWC issues permits for scientific research*', which is a rather serious error of fact. Permits for scientific research are issued by member nations of the IWC, as outlined in the Convention (Article VIII).

The Review Panel had very specific Terms of Reference, and the WG believes that some comments provided in the report in relation to the Scientific Committee were unnecessary, if not inopportune, because they were outside the remit of this Review Panel. For example:

- 'Politicization of the SC': *(52) Some respondents noted an inherent political bias in some of the activities performed by the Scientific Committee. For example, pro-whaling governments considered it is spending less and less time and resources on management matters, and more and more time on the conservation agenda. On the other hand, pro-conservation governments considered that too much time and resources are being spent on whaling-related issues. Although the Review Team does recognize the problem, its mandate does not allow it to make any recommendation on the subject.*

4. CONCLUDING REMARKS BY THE WORKING GROUP

The IWC Scientific Committee members appreciates the opportunity to comment on the recommendations and advice received by the Commission from the Review Panel.

The WG understands the importance of periodic independent reviews to improve the performance of the IWC regarding its mission. The WG further understands that the report of the Review Panel represents the judgement of its members and the perceptions of those that responded during the review process.

The WG reviewed the recommendations of the Review Panel, which were most relevant to the Scientific Committee, by assigning each of these recommendations to one of five categories: (1) maintain pre-eminence of the Committee regarding cetacean research and management advice; (2) advice regarding strategic planning; (3) advice regarding communication within the IWC; (4) advice regarding the function of the Scientific Committee in relation to the Commission; and (5) advice regarding the function of the Secretariat in relation to the Scientific Committee.

The WG intent in preparing this preliminary document was:

(1) where agreement on recommendations existed, to provide additional support, justification or clarification of the actual context;
(2) where agreement on recommendations did not exist, to

provide a rationale for the disagreement and provide alternative approaches or solutions to address the specific issue raised by the Review Panel; and

(3) to provide additional information or context for sections of the report where the Committee believes the Review Panel either misinterpreted information provided to them or where the Review Panel was likely unaware of important additional information.

Table 1 provides a summary of recommendations from the 'IWC Review – Final Report' that are commented on in this document.

Table 1

Summary of recommendations from IWC Review – Final Report with comments.

No.	Priority assigned by the Panel	Short Title	Comments
1	A	Strengthen inter-sessional process related to Commission directives	Agree
2	A	The Commission to provide greater scrutiny/clear directives	Agree
3	A	SC to provide reformatted information to facilitate communication with Commission	Agree, but concern that Panel appears unaware of SC efforts over last 5 years to improve communication with Commission
4	B	Form joint group of scientists and managers to advise Commission	SC unclear as to how such a group would operate and what the TOR would be. Seems a duplication of the CC/SC joint WG
6	A	The Commission to develop and adopt a Strategic Plan	Agree
7	A	SC to report on progress re Commission directives, workplan required	Agree with recommendations, but concern regarding text
11	C	Arrange for IISD/ENB	Disagree
14	A	IWC to reorganize to achieve more logical structure; SC agenda too long	Agree first part of recommendation; concern regarding second part
16	B	Improve communication among Commission and its subsidiary bodies	Agree
17	B	Make papers available prior to Committee and Working Group meetings	Agree (SC usual practice adopted well prior to review)
18	B	Maintain pre-eminence of IWC SC	Agree, but note some other recommendations inconsistent with this recommendation
20	A	Develop process to track SC progress on recommendations from Commission	Agree with recommendation, but concern regarding text
21	B	SC to provide recommendations to Commission more clearly; SC to revise RoP as appropriate	Disagree with premise; agree with objective of improved communications between SC and Commission
22	B	Support for secondment to SC Chair	Disagree in general; experience of past Chair was excellent
23	B	More equitable allocation of funding among Commission subsidiary bodies	Disagree, concern over factual errors in text (eg, management of SC meeting budget, context and reported figures). Budget should be based on Commission priorities
28	B	Distribute workload better within Secretariat	Without more information on current distribution of workload, SC has no opinion Disagree on Secretariat staff not convening groups as default rule.
30	B	Increase resources of Secretariat	Agree, especially on secondment for Secretariat roles
31	B	Add staff to Secretariat	Agrees in principle on deputy HoS, but the process needs appropriate planning

Appendix 1

LIST OF PARTICIPANTS

ARGENTINA
Miguel Iñíguez (*SC Head of Delegation*)

AUSTRALIA
William de la Mare (*SC Head of Delegation*)
Mike Double
Elanor Bell (*SH Co-convenor,* remote participation)

AUSTRIA
Michael Stachowitsch (*SC Head of Delegation*)

BELGIUM
Fabian Ritter (*SC Head of Delegation*)

BRAZIL
Rodrigo Mendes Carlos de Almeida (*SC Head of Delegation*)
Artur Andriolo
Alex Zerbini (*ASI Convenor*)

COLOMBIA
Ana Maria Gonzalez Delgadillo (*SC Head of Delegation*)

COTE D'IVOIRE
N'da Konan (*SC Head of Delegation*)

CROATIA
Katja Jelic (*SC Head of Delegation*)

DENMARK
Lars Witting (*SC Head of Delegation*)

FRANCE
Vincent Ridoux (*SC Head of Delegation*)

GERMANY
Nicole Hielscher (*SC Head of Delegation*)

GUINEA, Rep. of
Samba Diallo (*SC Head of Delegation*)

ICELAND
Gisli Vikingsson (*SC Head of Delegation*)
Thorvaldur Gunnlaugsson

INDIA
Manmohan Singh Negi

ITALY
Giancarlo Lauriano (*SC Head of Delegation*)
Caterina Fortuna (*SC Chair*)
Simone Panigada

JAPAN
Luis Pastene (*SC Head of Delegation*)
Hideki Moronuki

KENYA
Othniel Mwabili (*SC Head of Delegation*)

KOREA, REPUBLIC OF
Jung Youn Park (*SC Head of Delegation*)

LUXEMBOURG
Pierre Gallego (*SC Head of Delegation*)

MEXICO
Armando Jaramillo-Legorreta (*SC Head of Delegation*)

NETHERLANDS
Anne-Marie Svoboda (*SC Head of Delegation*)
Meike Scheidat (*SM Convenor*)

NEW ZEALAND
David Lundquist (*SC Head of Delegation*)

NORWAY
Tøre Haug (*SC Head of Delegation*)
Arne Bjørge (*former SC Chair*)

PANAMA
Lissette Trejos (*SC Head of Delegation*)

PORTUGAL
Marina Sequeira (*SC Head of Delegation*)
Luis Freitas

RUSSIAN FEDERATION
Kirill Zharikov (*SC Head of Delegation*)

SLOVENIA
Andrej Bibic (*SC Head of Delegation*)

SPAIN
Begoña Santos (*SC Head of Delegation*)
Graham Pierce

ST. LUCIA
Horace Walters (*SC Head of Delegation*)
Thomas Nelson

SWITZERLAND
Patricia Holm (*SC Head of Delegation*)

UNITED KINGDOM
Stuart Reeves (*SC Head of Delegation*)
Ailsa Hall (*E Convenor*)
Russell Leaper (*HIM Convenor*)

UNITED STATES OF AMERICA
Debra Palka (*SC Head of Delegation, former SC Chair*)
Robert Brownell (*former SC Chair*, *NH Convenor*)
Doug DeMaster (*former SC Chair*)
Geof Givens (*ASI Co-convenor*)
Aimee Lang (*SD&DNA Convenor*)
Robert Suydam (*SC Vice Chair*, *WW Convenor*)

Convenors (Invited Participants)
Ralph Tiedemann (*SD&DNA Co-convenor, Germany*)

Former Scientific Committee Chairs
John Bannister (remote participation) (*RMP Convenor*, Invited Participant)
Toshihide Kitakado (*EM Convenor*, *Invited Participant*)

Annex Y

Intersessional E-mail Groups

This list contains the intersessional groups identified at SC/67b. This listing was revised after the meeting. 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/68a. 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/68a.

(3) Advisory Groups (AG): 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
Items 3.2 and 23 SC	ICG-1	IWC Global Data Repositories and National Reports (GDR)	This Intersessional Steering Group will: (a) collate summary information on all IWC databases relevant to the SC; (b) summarise data use by the SC for each database; (c) provide recommendations to improve integration, content and workflows; (d) review technical progress on existing databases or databases under development; (e) consider needs and specifications for potential new databases, including developing simple technical guidelines on new proposals; (f) produce a budget and workplan for the implementation and development of existing and new databases; (g) review the information collected by IWC Databases and National Progress Reports and make recommendations to the Scientific Committee to amend structure, content and workflows; and (h) 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.	*Email: iwcglobaldata@groups.iwc.int* Double (Convenor), Allison *(as Head of Statistic Department, Secretariat)*, Bjørge, Brownell, de Almeida, de la Mare, Diallo, Donovan *(as Head of Science)*, Ferriss *(Secretariat)*, Fonseca, Gallego, Haug, Helmens, Hielscher, Hrabovsky, Iñíguez, Jaramillo-Legorreta, Kitakado, Lauriano, Lundquist, Miller B. *(as IT Secretariat)*, Palka, R. Reeves, S. Reeves, Ridoux, Ritter, Santos, Sohn, S. Smith *(Secretariat)*, Stachowitsch, Suydam *(as SC Chair)*, Ulloa, Víkingsson, Witting, Zerbini *(as SC Vice Chair)*, Zharikov.
Item 5.1 GA-RMP	ICG-2	Energetics-based model (the relationship between $MSYR_{1+}$ and $MSYR_{mat}$)	Main tasks are: (a) continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model; (b) compare the yield curves from the IBEM with those from the emulator model; and (c) 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.	*Email: ebmmsyr@groups.iwc.int* De la Mare (Convenor), Allison, Butterworth, Cooke, Donovan, Kitakado, Punt.
Item 5.2 GA-RMP	ICG-3	Status and *IST*s-programming	Modify the control programs used for *Implementation Simulation Trials* to report the three measures of status.	*Email: statistsprog@groups.iwc.int* Allison (Convenor), Butterworth, Cooke, Donovan, Givens, Punt, Zerbini.
Item 5.3 GA-RMP	ICG-4	Status and *IST*s-guidelines	Draft updates to the Guidelines for *Implementations* and *Implementation Reviews* to reflect decisions on evaluation status of stocks.	*Email: statistsguide@groups.iwc.int* Punt and Donovan (Co-convenors), Allison, Butterworth, Cooke, Givens, Zerbini.
Item 6.1 RMP	SG-5	WNP Bryde's Whale *Implementation Review*	Complete tasks and synthesise results of the *Implementation Review* of western North Pacific Bryde's whales.	*Email: wnpbrydes@groups.iwc.int* Donovan (Convenor), Allison, Butterworth, de Moor, Kitakado, Palka, Pastene, Punt, Tiedeman.
Item 6.2 RMP	SG-6	WNP common minke whales	Organize the First Intersessional Workshop on the *Implementation Review* of western North Pacific common minke whales.	*Email: wnpminke@groups.iwc.int* Donovan (Convenor), Allison, Butterworth, Kim, Kitakado, Palka, Pastene, Punt, Tiedeman.
Item 6.2 RMP	AG-7	Genetics	Advise on genetic matters related to the WNP common minke whale *Implementation Review.*	*Email: geneticwnpminke@groups.iwc.int* Baker, Goto, Hoelzel, Kim, Pastene, Tiedemann, Wade.
Item 7.1.2 AWMP	AG-8	Minke whale samples	Facilitate obtaining common minke whale samples in the North Atlantic.	*Email: minkesamples@groups.iwc.int* Tiedemann (Convenor), Donion-Valcroze, Witting, Víkingsson.
Item 8.9 AWMP	ICG-9	ASW	Work on ASW related issues.	*Email: asw@groups.iwc.int* Donovan (Convenor) Allison, Brandão, Butterworth, de Moor, Givens, Punt, Witting, Suydam.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 9.1.1 IA	SG-10	North Pacific humpback whales	Organise the First Intersessional Workshop on the Comprehensive Assessment of North Pacific Humpback Whales.	*Email: nphumpback@groups.iwc.int* Clapham (Convenor) Baker, Calambokidis, Donovan, Kato, Kitakado, Ivashchenko, Matsuoka, Punt, Urbán, Wade, Yoshida, Zerbini.
Item 9.1.2 IA	SG-11	North Pacific sei whales	Continue progress on developing the Comprehensive Assessment including to further data preparation and development of the assessment model.	*Email: npsei@groups.iwc.int* Cooke (Convenor), Allison, Hakamada, Kitakado, Matsuoka, Mizroch, Palka, Punt, Yoshida.
Item 9.1.3 IA	ICG-12	Antarctic minke whale publication	Continue editing the submitted paper that summarises the In-depth Assessment of the Indo-Pacific Antarctic minke whale to assist in publishing the paper.	*Email: antarcicminkepub@groups.iwc.int* Murase (Convenor), Donovan, Kato, Kitakado, Matsuoka, Palka, Pastene, Punt, Suydam.
Item 9.2.1 NH	ICG-13	North Pacific blue whale assessment	Review available data needed for a Comprehensive Assessment of North Pacific blue whales.	*Email: npbwa@groups.iwc.int* Branch (Convenor), Allison, Brownell, Donovan, Ivashchenko, Kato, Lang, Matsuoka, Mizroch, Rosenbaum, Širović, P. Olson.
Item 9.2.2.1 SH	ICG-14	Non-Antarctic blue whale catch allocation scenarios	Discussion on catch allocation scenarios to inform pygmy blue whale population modelling.	*Email: abwcas@groups.iwc.int* Branch (Convenor), Allison, Brownell, Buss, Cerchio, Jackson, Olson, Širović.
Item 9.2.2.1 SH	ICG-15	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.	*Email: shbluecat@groups.iwc.int* Olson and Jackson (co-Convenors), Double, Galletti, Salgado Kent, Torres Florez.
Item 9.2.2.5 SH	ICG-16	Blue whale morphometrics	Investigate morphometric measurements made for pygmy, Chilean and North Pacific blue whales, assess measurement comparability and address whether the Chilean blue whales are most similar in length to the northeast Pacific blue whales.	*Email: bluewhalemorp@groups.iwc.int* Brownell (Convenor), Branch, Pastene.
Item 9.2.3 SH	ICG-17	Analysis of baleen plates	Continued work towards analysis of baleen plates from whales caught during the 1946/47 Antarctic season and currently stored at the Smithsonian with the Japanese whaling logs.	*Email: anabaleen@groups.iwc.int* Brownell and Kato (co-Convenors).
Item 9.2.2.4 SH	ICG-18	Upload of New Zealand blue whale photo-IDs	Collate and upload photo-IDs collected around New Zealand to the Southern Hemisphere blue whale catalogue for the purpose of mark recapture abundance estimation.	*Email: nzbluepid@groups.iwc.int* Olson (Convenor), Galletti, Torres.
Item 9.2.5 NH	ICG-19	North Atlantic sei whales	Review available data for possible assessment, especially stock structure in the western North Atlantic without genetics (strandings, acoustics, sightings etc.).	*Email: nasei@groups.iwc.int* Cholewiak and Mallette (co-Convenors), Brownell, Palka, Robbins.
Item 9.3.8 NH	ICG-20	North Pacific sperm whale assessment	To investigate possible ways to assess sperm whales in the North Pacific.	*Email: npspermass@groups.iwc.int* Brownell (Convenor), Cipriano, Clapham, Hoelzel, Kato, Leaper, Mesnick, Miyashita, Murase, R. Reeves.
Item 9.4.1 SH	ICG-21	DuFresne *et al.*, (2014)	Use DuFresne *et al.* (2014) sighting surveys to determine best approach for future survey of BSD.	*Email: dufresne@groups.iwc.it* Weinrich (Convenor), Double, Butterworth, Kelly.
Item 10.1.3 CMP	SG-22	Western gray whale CMP Workshop	(1) Continue to guide the rangewide assessment; (2) update the CMP; and (3) modelling framework.	*Email: wgwcmpwksp@groups.iwc.int* Donovan (Convenor), Punt, R. Reeves.
Items 10.1.4 and 17.11 SM/CMP	ICG-23	Franciscana	Co-ordinate presentation of CMP projects across sub-committees at SC/68a.	*Email: franciscana@groups.iwc.int* Iñíguez (Convenor), Brito-Junior Santos, Cremer, Crespo, Cunha, Di Tullio, Domit, Ia Marcondes, Secchi, Siciliano, Ott, Zerbini,
Item 10.2.1 CMP	ICG-24	Arabian humpback whale abundance estimates	Guide the methods of the abundance estimates for Arabian Sea humpback whales.	*Email: arabianhumpback@groups.iwc.int* Collins (Convenor), Cerchio, Civil, Cooke, Jackson, Minton, Strindberg, Zerbini.
Item 11.2 SD&DNA	ICG-25	DNA quality	Review recent revisions in sections of the DNA quality guidelines that pertain to data produced using NGS approaches.	*Email: dnaquality@groups.iwc.int* Tiedemann (Convenor), Archer, Baird, Baker, Bickham, Carroll, DeWoody, Hoelzel, Goto, Jackson, Lang, Palsbøll, Pampoulie, Solvang, Taguchi, Waples.
Item 11.3 SD&DNA	ICG-26	Sample depletion	Discuss and provide recommendation on genomic approaches to maximize the utility of tissue samples, particularly those in danger of depletion.	*Email: sampledepletion@groups.iwc.int* Lang (Convenor), Baker, Bickham, Carroll, Goto, Taguchi, Tiedemann.
Item 11.4.1 SD&DNA	ICG-27	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 Working Group.	*Email: simulationtools@groups.iwc.int* Lang (Convenor), Archer, Bickham, Carroll, DeWoody, Hoelzel, Kitakado, Tiedemann.
Item 11.4.2 SD&DNA	ICG-28	Stock structure related terminology	Revisit the definitions that were previously put forward for stock-related terms at IWC 2014, particularly those related to large whale assessments, and revise them where necessary.	*Email: stockstructurert@groups.iwc.int* Tiedemann (Convenor), Baird, Bickham, Carroll, Cipriano, Lang, Scordino.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 12.1 ASI	ICG-29	Review of Abundance Estimates	(1) Coordinate the intersessional review of abundance estimates by the ASI Working Group; and (2) appoint expert small group to conduct review of abundance estimates required for next year's meeting.	*Email: reviewofae@groups.iwc.int* Zerbini (Convenor), Allison, Donovan, Fortuna, Givens, Herr, Suydam.
Item 12.2 ASI	SG-30	ASI Pre-Meeting	Develop a process to: (1) validate non-standard software and methods; (2) estimates computed from population models; and (3) consider status of stocks.	*Email: asipremeeting@groups.iwc.int* Butterworth (Convenor), Cooke, Donovan, Givens, Punt, Zerbini.
Item 12.3 ASI	SG-31	Amendment of RMP Guidelines	(1) Develop a set of specific instructions for the amendment of the RMP guidelines to consider model-based abundance estimates; (2) select a candidate to amend the RMP Guidelines according to these instructions.	*Email: rmpguidelines@groups.iwc.int* Fortuna (Convenor), Butterworth, Donovan, Herr, Kitakado, Palka, Punt, Suydam, Zerbini.
Item 13.5.3 HIM	ICG-32	Bycatch inferences from strandings	Provide advice to the Committee on general issues that need to be considered whenever estimates based on strandings are being evaluated.	*Email: bycatchinferences@groups.iwc.int* Slooten (Convenor), Currey, Bjørge, Cooke, Donovan, Herr, Fortuna, Lauriano, Leaper, Long, Northridge, Reeves, Ridoux, Stockin, Tarzia.
Item 14 HIM	ICG-33	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.	*Email: ssdatareview@groups.iwc.int* Leaper (Convenor), Brownell, Cañadas, Donovan, Double, Ferguson, Herr, Holm, Mattila, Panigada, Ritter, Rowles, Weinrich.
Item 14.2 HIM	ICG-34	Ships Routeing Group	Consider how best to respond to requests for advice on routeing measures.	*Email: shipsrouteing@groups.iwc.int* Leaper (Convenor), Bjørge, Donovan, Ferriss, Fortuna, George, Hubbell, Mattila, Rojas-Bracho, Panigada, Thomas, Weinrich, Willson.
Item 15.1 E	SG-35	Pollution	Planning activities and work priorities beyond Pollution 2020 (SC/68a).	*Email: pollution@groups.iwc.int* Holm (Convenor), Donovan, Ferriss, Hall, Rowles, Schwacke, Smith, Simmonds, Stimmelmayr, Walløe.
Item 15.4 E	SG-36	Noise	Planning pre-meeting for 2020 (SC/68b).	*Email: premeetplanningnoise@groups.iwc.int* Cholewiak (Convenor), Cerchio, Hubbell, Lund-quist, Širović, Torres, Williams, Simmonds.
Item 15.6.2 E	ICG-37	Climate change	Developing appropriate intersessional activities and suggestions for future engagement including potentially a workshop or pre-meeting (SC/68a).	*Email: climatechange@groups.iwc.int* Simmonds (Convenor), Bjørge, Donovan, Fortuna, Frey, Hall, Kitakado, Leaper, Parsons, Suydam, Williams, Ferriss, Smith.
Item 15.7.3 E	SG-38	Diseases of concern	Planning focussed session for 2019 (SC/68a).	*Email: diseasesofconcern@groups.iwc.int* Stimmelmayr (Convenor), Hall, Ferriss, Gulland, Mattila, Rowles, Ryeng, Smith, Suydam.
Item 16.2 EM	AG-39	Applications of species distribution models (SDMs)	Develop guidelines and recommendations for best practice in species distribution modelling.	*Email: appsdms@groups.iwc.int* Murase (Convenor), Friedlaender, Kelly, Kitakado, McKinlay, Miller, Palacios, Palka.
Item 16.4.1 EM	ICG-40	Effects of long-term environmental variability on whale populations	Compile a literature review on the subject of how environmental variability may affect whale populations.	*Email: eltevwp@groups.iwc.int* Cooke (Convenor), Butterworth, de la Mare, Kitakado.
Item 16.4.4 EM	SG-41	Cetaceans and Ecosystem Functioning: a gap analysis workshop	Prepare a workshop under a Steering Group.	*Email: cefgapanawksp@groups.iwc.int* Ritter (Convenor), Butterworth, Donovan, Galletti, Kitakado, Suydam.
Item 17.6 SM	ICG-42	Poorly documented takes of small cetaceans	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.	*Email: pdtsc@groups.iwc.int* Porter (Convenor), Baker, Brownell, Collins, Cosentino, Donovan, Fortuna, Frey, Jiminez, Parsons, R. Reeves, Scheidat, Simmonds.
Item 17.6.2 SM	ICG-43	Aquatic Wildmeat Database	Discuss: (1) which research questions the 'Aquatic Wildmeat Database' could help answer and to assess the best approach for data validation and quality control for data obtained other than from the SM committee; and (2) an overarching aim for any future IWC cetacean wildmeat database, and to identify specific questions that such a database might address.	*Email: aqwildmeat@groups.iwc.int* Cosentino (convenor), Avila, Double, Ingram, Suydam, Reeves, R., Slooten, Gallego, Trujillo, Collins, Simmonds.
Item 17.7 SM	AG-44	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.	*Email: smallcetaceantaskteam@groups.iwc.int* Simmonds (Convenor), Bjørge, Donovan, Fortuna, Genov, Parsons, Porter, R. Reeves, Scheidat.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 17 SM	SG-45	*Sotalia* Workshop	Organisation of two workshops focusing on *Sotalia*.	*Email: sotalia@groups.iwc.int* Domit (Convenor), Caballero, Porter, Scheidat, Zerbini.
Item 18.1 WW	ICG-46	Swim-with-whale operations	Assess the extent and potential impact of swim-with-whale operations.	*Email: swimwithwhaleop@groups.iwc.int* Rose (Convenor), Frey, Forestell, Gero, Jimenez-Assmus, Minton, Parsons, Ritter, Rodriguez-Fonseca, Simmonds, Sironi, C. Smith, Stack, Urbán, Weinrich.
Item 18.1.1 WW	SG-47	Modelling and Assessment of Whale Watching Impacts (MAWI) Steering Group	(1) Identify those whale watching locations that would be most suitable and amenable for targeted studies addressing these questions; (2) summarise and assess the current modelling tools available to analyse the data that will be collected; (3) develop a Strategic Framework, supported by a Decision Tree, to aid in the prioritisation of policy and research choices; develop toolkits and resources for whale watching research that can be accessed globally; (4) consider how to standardise data collection; and (5) organise the fourth MAWI workshop.	*Email: modassmawi@groups.iwc.int* New (Convenor), Baldwin, Cook, Cosentino, Forestell, Frey, Jimenez-Assmus, Leaper, Minton, Noren, Parsons, Robbins, C. Rose, Smith, Weinrich.
Item 18.1.3 WW	ICG-48	Human-induced behavioural changes of concern	Continue to monitor the relevant literature; seek to produce a new review of information for the Committee across the whole range of interactions; review the appropriate terminology; and continue to consider the relevance of this topic to the work of the sub-committee, including how this topic might best be studied in future.	*Email: hibcc@groups.iwc.int* Simmonds (Convenor), Cosentino, Forestell, Minton, Parsons, Rodriguez Fonseca, Vail, Wells.
Item 18.4 WW	ICG-49	Communication with the Conservation Committee	Discuss development of better methods for disseminating recommendations and advice on whale watching to the CC (joint with CC).	*Email: cccomm@groups.iwc.int* Parsons, Rendell (co-Convenors), Cosentino, Ferriss, Minton, Ritter, Rose, S. Simmonds, Smith, Weinrich.
Item 18.6 WW	AG-50	Communication with the Indian Ocean Rim Association	Help provide advice to IORA when appropriate and facilitate communication between IORA and the sub-committee.	*Email: commiora@groups.iwc.int* Ferriss (Convenor), Baldwin, Iñíguez, New, Parsons, Simmonds, C. Smith, S. Smith, Weinrich.
Item 18.1 WW	ICG-51	River dolphin interactions	Monitor, assess and report on commercial interactions, including watching, provisioning and swimming, with river dolphins, in the Amazon and elsewhere	*Email: riverdolphinint@groups.iwc.int* Trujillo (Convenor), Luna, Marmontel, Parsons, Rojas-Bracho.
Item 19 SC/SP	AG-52	Protocol on feasibility of biopsy sampling minke whales	(1) To provide advice on developing an experimental protocol for ascertain whether it is possible to reliably biopsy minke whales and, if so, under what circumstances (experience, vessel type, equipment, environmental conditions, etc.), starting from the advice provided by the Expert Panel (*JCRM* (Suppl.) 19:431-90); and (2) to reconsider and refine questions in Mogoe *et al.* (2016), as necessary.	*Email: pofbsmw@groups.iwc.int* Palka (Convenor), Clapham, Donovan, Double, Lauriano, Mogoe, Palsbøll, Tamura, Tiedemann, Yasunaga, Wade, Walløe and Zerbini.
Item 23.1 PH	ICG-53	Appendices for photo-ID guidelines	Continue compilation of technical appendices for photo-ID guidelines.	*Email: appphotoidguide@groups.iwc.int* Olson (Convenor), Dalla Rosa, Donovan, Double, Galletti, Genov, Mallette, Marcondes, Matsuoka, Minton, Panigada, Reyes, Stack, Taylor, Torres-Florez, Weinrich.
Item 23.2.4 PH	ICG-54	Search for missing SOWER photos	Search for and/or reconstruct archive of missing SOWER photos.	*Email: misssower@groups.iwc.int* Matsuoka, Taylor (co-Convenors), Donovan, Olson.
Item 24 ASI	SG-55	IWC-POWER/ SOWER	To provide advice on the 2018/19 and 2019/20 IWC-POWER cruises (including holding the Planning Meetings), on data analyses, storage and on requests for data/sample use of IWC-POWER/SOWER cruises.	*Email: iwcpowersower@groups.iwc.int* Matsuoka (Convenor), An, Bravington, Brownell, Clapham, Donovan, Ensor, Kato, Kelly, Kitakado, Miyashita, Murase, Pastene, Wade, Zerbini, Zharikov.
Item 24.2 SC	ICG-56	IWC-SORP	Provide advice on scientific and logistical matters related to the IWC-SORP (Southern Ocean Research Partnership) programme.	*Email: iwcsorp@groups.iwc.int* Double and Herr (co-Convenors), Bell, Burkhadte, Bjørge, Brownell, Charrassin, Donovan, Elwen, Fortuna, Fruet, Gallego, Galletti, Iñíguez, Jackson, Langerock, Lundquist, Lauriano, Luna, Oosthuizen, Reyes, Ridoux, Samaran, Vermeulen, Zerbini.
Item 28.3 SC	ICG-57	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/67b.	*Email: annexp@groups.iwc.int* Fortuna (Convenor), de la Mare, Donovan, Double, Lundquist, Morishita, H. Morita, Y. Morita, Moronuki, Okazoe, Palka, Rendell.
Item 29 IA	ICG-58	IDCR/SOWER volume	Complete the IWC Special Issue on the IDCR/SOWER volume.	*Email: idcrsowervol@groups.iwc.int* Donovan (Convenor), Brownell, Ensor, Kato, Palka.

Annex Z

Statements on the Agenda

ANNEX Z1. 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 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 Z2. STATEMENT BY THE JAPANESE DELEGATION CONCERNING WHALE WATCHING

It is the Government of Japan's position that whale watching is outside the competence of the IWC. Further, the International Whaling Commission has limited financial and human resources and should be focusing its efforts on important matters such as stock assessments.

ANNEX Z3. 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 Sub-Committee on Small Cetaceans and discussions in other Sub-Committees and/or Working Groups when/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 Sub-Committee on Small Cetaceans and relevant parts of draft reports related to small cetaceans prepared by other Sub-Committees and/or Working Groups, this should in no way be taken to mean that Japan concurs with or supports the contents of the report.

ANNEX Z4. 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, it continuously 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 report to the Sub-Committee on Conservation Management Plans (CMP) responding to the recent reformulation of sub-committees in 2017. 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, i.e. sustainable use of whales.

ANNEX Z5. JAPAN STATEMENT IN RELATION TO THE PROPOSED WORKSHOP ON CETACEANS AND ECOSYSTEM FUNCTIONING: A GAP ANALYSIS

As Japan expressed at the occasion of the adoption of Agenda of this Scientific Committee, it does not support the Scientific Committee to deal with issues outside the competence of IWC.

It found that most of the activities envisaged to be dealt with at the proposed Workshop [see Annex L, items 6.2, 7.1 and 7.2] are outside the competence of IWC.

For this reason, Japan cannot support the proposed Workshop, and especially it cannot support the allocation of a budget of Scientific Committee for this purpose.

Annex AA

Obituaries

The Committee was saddened to learn of the death of four scientists known to the Scientific Committee.

GREG KAUFMAN

Greg Kaufman, a longstanding member of the Scientific Committee, passed away in 2018, earlier this year. He first attended in 2006 when he took part in the Workshop on the Comprehensive Assessment of Southern Hemisphere Humpback Whales. He was an active member of the Scientific Committee's sub-committee on whale watching and the Whale Watching Working Group of the Conservation Committee.

In 1980 Greg founded the Pacific Whale Foundation as a non-profit research, conservation and education organisation and began land-based observations and boat-based photo-ID studies of humpback whales. In addition, he began the first photo-ID studies of humpback whales in Australia. To fund research, conservation and education programmes, Greg became involved in commercial whale watching on Maui and he pioneered the use of trained naturalists and low-impact eco-trips. He helped launch a newly developed whale watching industry in Japan and the Pacific Whale Foundation provided support for operator training workshops, photo-ID research and education programs for local children in Ecuador. Greg also travelled to Oman and Chile to identify ways Pacific Whale Foundation could support critical projects underway in both of those locations.

Greg was instrumental in the development of the Hervey Bay Marine Park in Australia and was an early champion of the Humpback Whale National Marine Sanctuary in Hawai'i. He was appalled at federal and state supported efforts to set up a high-speed super ferry service between the main Hawai'ian Islands in 2007, as it was obvious to him it was just a matter of time before the mammoth vessels would wreak havoc on the recovering humpback whale population. In part because of the public protests that he ignited, and in part because of an unsustainable business model, the enterprise was shut down. He also led a campaign that resulted in Maui County legislation that bans dolphins in captivity on any of the county's four islands.

Greg had a capacity to ask the question no one thinks to ask. In the late 1970s Greg attended the annual meeting of a national marine mammal conservation organisation in California. After what he described as a long and boring meeting the discussion turned to funding ideas. One of the representatives mentioned there was a local baker who wanted to make and sell whale-shaped cookies and donate 5¢ per cookie to the organisation if the baker could use its name. Immediately the group broke into two camps – one arguing that such an arrangement would debase the good name of the organisation; the other insisting it was a good way to raise much needed funds to support projects. The argument went on for some time. Finally, Greg raised his hand and cleared his throat, 'Just wondering' he asked, 'has anyone tasted the cookies?' It turned out no one had, so samples were immediately sent for. Once the cookies arrived, every took a bite, and there was a long silence. 'Wow' somebody finally said, 'these taste like crap!' Heads nodded in agreement all around the table, and the matter was quickly resolved. None of those cookies were ever sold on behalf of the organisation.

Greg was a smart, witty and deeply loyal friend. His life's mission was to bring whales and humans together in a way that would benefit whales and help people understand their magnificence and beauty. He will be sorely missed. – *Paul Forestell*

DOUG COUGHRAN

Doug Coughran did not attend the Scientific Committee meetings, but he was a participant in numerous IWC workshops on entanglement and stranding response. His classic direct and practical advice was deeply respected by all, so much so that he became a charter member of both the IWC's entanglement and stranding expert (advisory) groups. He came to the Center for Coastal Studies in 2004 on a Winston Churchill fellowship and he absorbed everything there with a passion. When he went back to Western Australia, he established a response network which is the gold standard for the rest of the World, especially in its professional structure and focus on training and safety.

IWC Global Network member Mike Morrissey, from Department of Conservation in New Zealand represented the IWC at his funeral. The following are excerpts from Mike's report back to the group.

The funeral itself was primarily a celebration of Doug's life and so mostly family spoke. However, the speaker on behalf of all non-family was the Deputy Director General (DDG) of the Department of Biodiversity, Conservation and Attractions. He mentioned that the IWC and the Global Whale Entanglement Response Network were an important part of Doug's life and that his contributions were greatly valued. It was obvious that Doug himself had wanted these acknowledgements made. Also, unbeknownst to virtually everyone, the DDG announced that a new vessel under construction will be named the Douglas T. Coughran and will be based in Perth. It will service Rottnest Island, one of Doug's favourite places, and where his ashes will be spread.

A necklace was presented to Doug's wife on behalf of all the IWC Global Network and the DOC. It was made of carved New Zealand Greenstone and considered to be a TONGA (treasure) to Maori people. It was specially made in a design that depicted the joining of two people for life. Throughout the whole ceremony Doug's 'Stay Safe' email sign off and his regard for everyone's personal safety was highly evident and this was once again highlighted when his wife signed off a thank you letter with 'Stay – Safe'. The establishment of a 'Doug Coughran Stay Safe' award will be discussed at the next GWERN meeting in June.

Finally, perhaps it was best put by a member from Argentina who wrote 'Doug was indeed a most inspirational person, an unmatched, ethical and thorough professional, and an incredible champion for whales and for keeping people safe in the process of undoing harm. He will be dearly missed.' – *David Mattila*

DALE W. RICE

Dale W. Rice passed away in September 2017. He was a born naturalist and published his first paper (on birds) at the age of 16 when he was still in high school. In 1958 Dale joined the newly-formed Marine Mammal Lab in Seattle (at the time under US Department of the Interior, Bureau of Commercial Fisheries, eventually under NOAA Fisheries) and his first assignment was to develop a research programme studying the large whales that were caught at the California whaling stations. In 1960 Dale began representing the US in the IWC Scientific Committee. He was also appointed as the US representative for the IWC's North Pacific Working Group, which was tasked with advising the IWC on management of whaling. Scientists from the North Pacific whaling nations, i.e. Canada, Japan, the US and the USSR, collaborated on whale marking studies and shared data freely. Dale conducted extensive whale marking and sightings cruises from 1962-69. The cruises ranged from northern California (where the whaling stations were located) down to the southern tip of Baja California, and in some years out west to the Revillagigedo Archipelago.

Dale's monograph on the 'Life History and Ecology of the Gray Whale' was his first '*magnum opus*'. Gray whale biology was mostly unknown until Dale proposed his innovative and large-scale gray whale research programme. Dale's monograph provided baseline information about gray whale seasonal migrations, morphology, food habits and reproduction. After the whaling stations closed, Dale continued to conduct whale surveys in many oceans. Dale's whale surveys in Mexico, Hawaii and Alaska helped initiate photo-identification studies on humpback whales. In his later years, Dale wrote a series of scholarly works, including many chapters in the *Encyclopedia of Marine Mammals*, edited by W.F. Perrin, B. Würsig and J.G.M. Thewissen. Over the course of his long career, Dale authored or co-authored 164 publications.

Dale was a very shy person, but one-on-one he was a witty and entertaining conversationalist and was so well-read he could converse on just about any subject. He was an avid book collector and a voracious reader. His library included many rare books. Dale's extensive marine mammal library will now be managed as a reference library. – *Sally Mizroch*

JOHN REYNOLDS III

John Elliot Reynolds III passed away in December 2017 after many years battling cancer. Even though John never attended an IWC meeting, he had close ties with many people who did. For years, he had a desire to attend IWC meetings but unfortunately was never able to do so.

His contributions to marine mammal science and conservation were extensive as a researcher, educator, and manager. Among other many other positions and roles, he chaired the US Marine Mammal Commission from 1991 to 2010 and was President-elect and President of the Society of Marine Mammalogy from 2004 to 2008. He was a Professor of Marine Science at Eckerd College, St. Petersburg, Florida from 1980-2001. Since 2001, John was a Senior Scientist and Program Manager at Mote Marine Laboratory in Sarasota, Florida. He won many awards for teaching, conservation and science and published of over 300 books, book chapters, and peer-reviewed and popular articles.

John was a friend, mentor, and collaborator of many. He was always a champion of using knowledge, whether science or traditional knowledge, for informing decisions about the conservation of marine mammals. His strength, passion, and extraordinary optimism are an inspiration to all who knew him. We will miss him greatly. – *Robert Suydam*

Report of the Planning Meeting for the 2018 and 2019 IWC-POWER Cruises in the North Pacific

Report of the Planning Meeting for the 2018 and 2019 IWC-POWER Cruises in the North Pacific[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 (convenor) welcomed participants to Tokyo and to the meeting.

Morita noted that the eighth POWER cruise had been completed successfully with the return of the vessel on 25 September 2017. On behalf of the Fisheries Agency of Japan, he thanked all the researchers and crew who participated in the cruise and also the Government of the USA for issuing the research permit in its EEZ. He expressed his wish that the planning meeting would be fruitful and constructive so that good preparation for the next two cruises in the Bering Sea would be achieved.

On behalf of the IWC, Donovan thanked the organisers for providing the excellent facilities in the Japanese Fisheries Agency Crew House. He also expressed continued appreciation to the ship's crew on behalf of the IWC and the researchers; the crew's 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 2018 and 2019 cruises; the 2017-19 cruises together will provide a comprehensive cover of the Bering Sea and complete the first phase of the IWC-POWER programme.

2. APPOINTMENT OF CHAIR AND RAPPORTEURS

Kato was elected Chair. Kitakado led the discussion for Items 6 and 7. Clapham, Palka and Donovan acted as rapporteurs, with assistance from Matsuoka.

[1] Presented to the meeting as SC/67b/Rep04.

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. DOCUMENTS AVAILABLE

Documents available are listed in Annex C.

6. REVIEW OF PROGRESS IN LIGHT OF DISCUSSIONS AT IWC 67A AND TAG REPORTS

6.1 Review of past cruises and TAG reports

The meeting briefly reviewed the status of recommendations and actions from the previous (2015) meeting of the Technical Advisory Group (IWC, 2016a) and the 2016 Planning Meeting (IWC, 2017a). The main focus was on updating the workplan developed in IWC (2016) in light of the discussions under Item 6.2. A summary of the data collected since the beginning of the IWC-POWER programme is given in Annex D. Fig. 1 shows the areas surveyed to date for the first phase of IWC-POWER.

6.2 Progress during intersessional period

6.2.1 Distance and angle experiments

Distance and Angle Experiments (DAE) comprise a routine component of line transect surveys because possible biases in distance and angle observations cause over- or under-estimation of the effective strip width and hence the population density/abundance. All primary observers take part in such experiments before/during IWC-POWER sighting surveys for each cruise since its launch. In discussion this year, the Planning Meeting was **pleased** to hear that the implementation of previous TAG recommendations that attempted to improve the experimental protocols were practically feasible and could thus continue in the future.

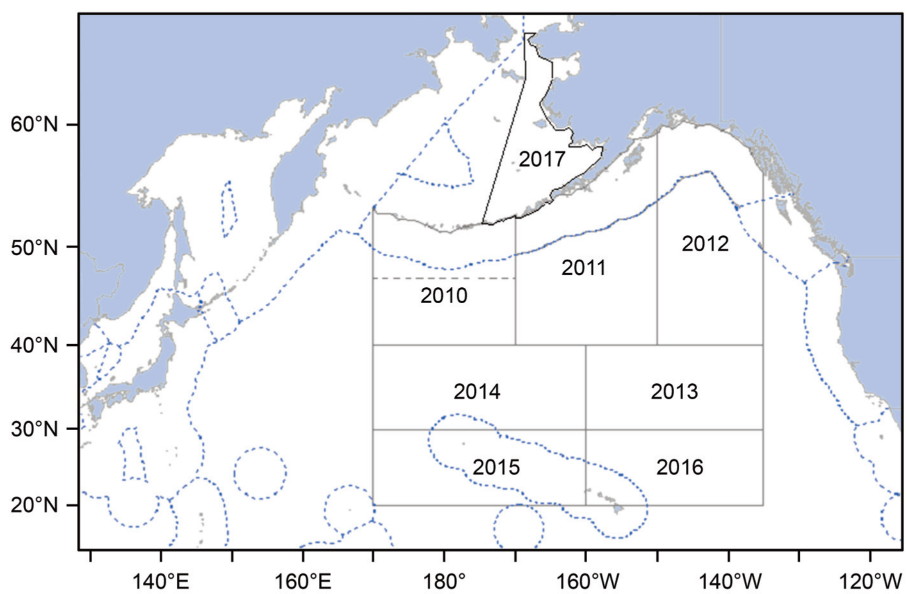

Fig. 1. Research areas covered thus far under the IWC-POWER programme.

Last year (IWC, 2016a), 'Team DAE' (consisting of a TUMSAT student group led by Kitakado) developed statistical models to conduct preliminary analyses examining: (1) the extent of bias for the observation of perpendicular distance (PD); (2) whether there is any difference in the performance of the measurements across observers; and (3) if there is any difference between the results of DAE using the new GPS approach and the conventional radar system.

This year, 'Team DAE' continued its work and focussed on aspects of the first two items suggested last year. Revised analyses were presented not only for PD but also for the radial distance (RD). Results from DAE experiments from JARPAII were also presented as supplementary information for comparison with those for IWC-POWER.

A total of four different models were considered for the expectation of PD and RD, given the true distance. Only the platform effect was taken into account. With respect to the standard deviation, a linear function of the true distance was assumed. All the parameters were estimated via a maximum likelihood method, and the models were compared by Akaike's information criterion (AIC). For both types of distance, although selected models were different across years (a platform effect was identified in some years), estimated functional forms were similar between the models within year. No consistent tendency over years in terms over-/under-estimation was observed. Results for JARPAII were similar although the extents of bias and variance were slightly different.

The Planning Meeting thanks Team DAE for the updated analysis and results and encourages further work on examining the Distance and Angle experiments. In particular, it agrees that a full paper be presented at the 2018 Scientific Committee that addresses the following important factors:

(1) examination of the bias of both direct distance and angle data simultaneously, in addition to looking at perpendicular distances, direct distances and angles separately. The simultaneous analyses could be conducted within a circular polar coordinates framework where the bias is defined by the distance between the actual location and estimated location where the locations are defined by the direct distances and angles;
(2) examination of the performance of the same observers across years and across the different experimental protocols;
(4) consideration of cloud coverage, Beaufort, wind speed, visibility, observer, year, and distance from ship when investigating the differences between the actual and estimated locations/measurements, accounting for possible correlations (aliasing) between these potential explanatory variables; and
(5) investigation of the implications of the errors on abundance estimates.

6.2.2 Cetacean abundance estimation

The Planning Meeting **recognised** the valuable work of the Japanese scientists in providing initial analyses of the IWC-POWER sightings data using standard line-transect methods. However, it **concurred** with previous recommendations (IWC, 2016a; IWC, 2017b) that it is important for the existing data to be analysed fully and to identify appropriate analyses of the available data to allow effective development of the medium-term programme.

This included recognising the importance of developing a spatial modelling approach and using photo-id capture-recapture methods that use IWC-POWER data in addition to using design-based estimation methods.

The Planning Meeting **agrees** that an intersessional group under Kitakado develops a proposal for spatial modelling for the key species seen during IWC-POWER for which sufficient data are available (and see Item 6.3), for presentation at the next Scientific Committee meeting.

The Planning Meeting also reviewed progress in developing design-based (line-transect) abundance estimates since the 2015 TAG meeting (IWC, 2016a). Table 1 summarises the current situation.

6.2.2.1 NORTH PACIFIC SEI WHALES

The design-based abundance estimate of North Pacific sei whales, assuming $g(0)$=1, using IWC-POWER data were accepted at the 2017 Scientific Committee meeting.

6.2.2.2 NORTH PACIFIC HUMPBACK WHALES

Inai presented a preliminary report on the abundance estimation of the North Pacific humpback whales using sighting data derived from 2010-2012 IWC-POWER surveys. Conventional line transect methods were employed for the estimation of detection functions, effective strip width, density and abundance. For the estimation of detection functions, half-normal and hazard-rate functions with factors such as survey year and weather were used as candidate models, and the best model was selected by an information criterion, AIC. The abundance in the central and eastern North Pacific (north of 40°N, south of the Alaskan coast including both the US and Canadian EEZs between 170E-135W), from July to August, was estimated using the best model, which was a hazard rate model with year, visibility and cue covariates. The authors noted that the results are still preliminary, and therefore they plan to show results by further investigation including spatial modelling at the workshop on the in depth assessment of North Pacific humpback whales in April 2017 and SC67b.

The Planning Meeting **thanks** the authors for this preliminary report and **agrees** that the revised manuscript on the abundance of North Pacific humpback whales should incorporate the following suggestions:

(1) clearly state how many sightings were used in the various parts of the analysis (detection function versus encounter rate, group size, etc);
(2) provide more information on the group size estimation;
(3) further investigate the preliminary analyses to determine why the CV was so high for the 2011 northern stratum;
(4) further investigate the most appropriate unit of effort to be used to estimate the CV(n/L); and
(5) in addition to developing abundance estimates for the entire IWC-POWER study area, also develop estimates for the separate stock areas developed at the 2016 North Pacific humpback whale assessment workshop by considering both post-stratification and mixing matrix methods.

In addition, the authors should consider analysing the data using spatial modelling techniques.

The Planning Meeting is pleased to assist in reviewing future versions of this paper and **agrees** that the authors should submit an updated paper to the POWER steering group by **15 January 2018** with the goal of that group submitting comments back to the authors in time for them to incorporate the comments into an updated paper to be presented to the April 2018 intersessional meeting on the in-depth assessment of North Pacific humpback whales.

6.2.2.3 NORTH PACIFIC BRYDE'S WHALES

Hakamada presented a work plan to estimate g(0) for North Pacific Bryde's whales that would use the standard mark-recapture distance-sampling method with the IWC-POWER sightings data collected in IO mode. The Planning Meeting **reiterated** the value of this *g*(0) analysis as it is important to determine whether the value was significantly different from 1 and if so whether a common correction factor was appropriate to update past and present abundance estimates to develop a time series incorporating the associated additional variance estimates (the non-*g*(0) corrected estimates were accepted for use in the RMP at last year's Scientific Committee meeting with a note that updated estimates incorporating *g*(0) may be developed).

The Planning Meeting **thanks** the author and **agrees** that Hakamada undertakes the analysis, noting that Palka is happy to assist. A draft of the analysis should be submitted to the IWC-POWER Steering Group for comment by mid-November 2017. The Planning Meeting **stresses** the value of developing a single synthesis paper presenting western North Pacific Bryde's whale abundance estimates, if appropriate containing a revised time series of abundance estimates series taking into account *g*(0) (and perhaps the results of the DAE analyses referred to under Item 6.2.1). This should be made available in advance of the February 2018 intersessional meeting of the *Implementation Review* of the North Pacific Bryde's whale.

6.2.2.4 OTHER SPECIES

Sperm whale data are not yet being analysed. The Planning Meeting **agrees** that Brownell contact the Southwest Fisheries Science Centre in La Jolla, California, to see if scientists there are interested in using the IWC-POWER data to estimate the abundance of sperm whales.

Fin whale abundance data are being analysed by ICR and TUMSAT scientists. The Planning Meeting **agrees** that those scientists develop a document with preliminary analyses for the 2018 Scientific Committee meeting using the data from 2010-12 and 2017. It also draws attention to the question of how to deal with unidentified baleen whales discussed in the 2015 TAG report (IWC, 2016a) and the issue of *g*(0) given the IO data available from the 2017 cruise.

Killer whale abundance data analysis is underway by TUMSAT but only for the northern strata thus far. The Planning Meeting **agrees** that data from all regions be analysed (if possible by ecotypes) and presented at the next SC meeting. It was suggested that Donovan extracts the available photographs and submits these to John Durban to examine ecotypes.

Dolphin abundance data are not yet being analysed. The Planning Meeting **agrees** that species previously exploited should be accorded highest priority (e.g. Pacific white-sided dolphins *Lagenorhynchus obliquidens* and Northern right whale dolphins *Lissodelphis borealis*). It **agrees** that Miyashita should contact colleagues at the Far Seas Fisheries Research Institute to request that they take the lead with the dolphin abundance analyses and report back the answer to the Steering Group as soon as possible.

6.2.3 Analyses of marine debris data

The issue of marine debris has been the topic of an IWC scientific workshop (IWC, 2014) and a Conservation Committee workshop (IWC, 2016b). The marine debris data collected during the IWC-POWER cruises can contribute to the knowledge of the distribution and density of different types of debris, particularly before and after the Japanese tsunami in 2011. Yasuhara presented an initial attempt to use Distance sampling methods to estimate density of marine debris using the IWC-POWER data. WP11 reported on the distribution of marine debris detected during the surveys and preliminary outcomes for the density estimates of marine debris. A statistical analysis was conducted to estimate density of marine debris in the North Pacific region using IWC-POWER data. Line transect methods were used for estimating the detection function and density for various categories of marine debris ('fishing gear net', 'long line', 'single fishing float', 'cluster fishing float', 'wood', 'unidentified styrofoam', 'styrofoam others', 'unidentified plastic', 'plastic small', 'plastic medium and large', 'garbage' and 'others'). To take environmental factors into consideration, a multiple-covariate distance sampling (MCDS) was used. The resultant MCDS analyses showed that environmental factors can affect the detectability of debris. Densities of debris in the 2013 survey area tended to be high, particularly for single fishing floats and small plastic; such debris may be attributable to the 2011 tsunami.

The Planning Meeting thanked the authors, noting that the distribution maps and Distance analyses were valuable. It

Table 1

Summary of status of sightings data analyses for IWC-POWER data. Numbers of sightings of blue whales and common minke whales preclude analyses of these data alone. The table refers to design-based estimates; a proposal for model-based estimates will be developed for consideration at the 2018 meeting.

Species	Analysts*	Status of analysis	Recommendations and comments
Fin whale	ICR/TUMSAT	Underway	See recommendation above. Preliminary analyses by SC67b including consideration of 2017 IO data (see Item 7 below)
Sei whale	ICR	Completed assuming *g*(0)=1	Hakamada and Matsuoka (2015). Accepted by the IWC Scientific Committee (IWC, 2017)
Bryde's whale	ICR	Completed assuming *g*(0)=1	Analysis assuming *g*(0)=1 accepted by the Scientific Committee (IWC, 2017). See recommendation under Item 6.2.2.1 with respect to updated estimates taking into account *g*(0)
Humpback whale	TUMSAT	Underway	See recommendation under Item 6.2.2.3
Blue whale	TUMSAT	Underway	Progress report at SC67b
Sperm whale	SWFSC?	None yet	See recommendation above regarding possibility of analysis by SWFSC
Killer whale	TUMSAT	Underway	See recommendation above regarding analyses by ecotype
Dolphins	NRIFSF?	None yet	See recommendation above regarding analyses for high priority species

*ICR=Institute of Cetacean Research, Japan; TUMSAT=Tokyo University of Marine Science and Technology, Japan; NRIFSF= National Research Institute of Far Seas Fisheries, Japan; SWFSC=Southwest Fisheries Science Center, La Jolla, California, USA.

agrees that an updated analysis should be submitted to a peer-reviewed journal and to appropriate conferences, such as the session on floating macro debris being held during the Sixth International Marine Debris Conference, San Diego, CA in March 2018[2]. It provided the following suggestions for the paper:

(1) provide more information on the definitions of the different categories of debris;
(2) include the 2017 debris data from the eastern Bering Sea to show the contrast in density of debris between areas;
(3) examine the correlation between the sea state and wind speed variables and consider whether it is appropriate to include both variables in the same model;
(4) also use a spatial modelling approach;
(5) check that the effort data appropriately reflect the times debris data were being collected; in particular appropriately account for the times when debris data was only collected for only 15 minutes within an hour; and
(6) as possible, compare these distribution patterns with other studies that collected debris data (Matsomuka, 1997; Hakamara, 2015) including any change in distribution patterns before and after the 2013 Japanese tsunami.

The Planning Meeting **agrees** to assist in reviewing future versions of this paper. It **agrees** that an updated paper is submitted to the IWC-POWER steering group by 15 January 2018 such that comments are submitted back to the authors in time for them to incorporate the comments into an updated paper for presentation to the 2018 Scientific Committee meeting and other relevant scientific fora.

[2] *https://internationalmarinedebrisconference.org/.*

6.3 Future work

The Planning Meeting **agrees** to the workplan provided in Table 2 with respect to data, analyses and plans for post-2020 cruises. Table 3 provides the workplan for the 2018 and 2019 cruises. A TAG meeting will be required in 2018.

7. PRELIMINARY RESULTS FROM THE 2017 CRUISE

7.1 Presentation

Matsuoka presented the preliminary cruise report from the 8th annual IWC-POWER cruise that was conducted between 3 July and 25 September 2017 in the eastern part of the Bering Sea (all within the US EEZ) using the Japanese R/V *Yushin-Maru No.2.* Researchers from Japan, the USA and the UK participated in the survey. The cruise had five main objectives (see Item 9) with a particular focus in 2017 on the critically endangered North Pacific right whale population in the eastern Pacific. The survey was undertaken in accordance with IWC protocols. For the first time under the IWC-POWER programme, an acoustic component was introduced. Survey coverage was about 72% of the planned trackline of about 2,200 n.miles, either in passing with abeam closing mode (NSP) or in Independent Observer passing mode (IO). An important number (9 schools/18 individuals, including 2/3 duplicates) of North Pacific right whales were found, five of the schools were detected and located acoustically. Fin (145 schools/198 individuals) and humpback (136/165) whales were the most frequently sighted large whale species. Gray whales (15/22) were sighted early in the survey, north of 64˚N, while sperm whales (25/33) were found in the southern part of the survey

Table 2

Workplan for IWC-POWER related work on data and analyses.

Item	Activity	Responsible persons	Time
Data			
(1)	Complete validation of IWC-POWER sightings and effort data for the period up to the 2017 cruise (give priority to humpback and gray whales so that information/analyses can be submitted to relevant workshops)	Hughes and Matsuoka	By Dec. 2017
(2)	Encourage collaboration with other groups holding: genetic samples; individual identification data	Steering Group and Secretariat	By SC/67b
(3)	Complete importation and classification of 2017 IWC-POWER photographs into the IWC photographic database	Taylor and Donovan	By SC/67b
(4)	Compile a list of habitat-related information sources for the time frame of the IWC POWER cruises to contribute to spatial modelling analyses	Palka and Matsuoka	By SC/67b
(5)	Develop integrated proposal for onboard data collection system and long-term database	Palka (with Donovan, Matsuoka, Hammond)	By SC/67b
(6)	Develop a matching exercise to compare different ID catalogues with data from IWC-POWER	Donovan, Taylor, Cooke	By SC/67b
(7)	Liaise with the NMFS on their surveys of the Hawaiian EEZ and California Current waters with respect to comparisons with IWC-POWER data in similar waters	Brownell	Report progress by SC/66b
Analyses			
(8)	Complete review of angle/distance experiments	Team DAE (Kitakado)	By SC/67b
(9)	Review IO data for Bryde’s (and fin whales – see discussion under Item 7.2.) with respect to *g*(0)	Hakamada, Palka and scientists from TUMSAT and ICR	By mid-Nov. 2017 for circulation to Steering Group
(10)	Develop single paper summarising ‘final’ abundance estimates for Bryde’s whales incorporating as appropriate for g(0), DAE and stock structure hypotheses from the 2017 RMP workshop	Hakamada and colleagues	g(0) Nov.; integrated paper to Feb. 2018 Bryde’s whale Workshop
(11)	Review results/progress of analyses outlined in Table 1	Steering Group	Progress report to SC/67b
(12)	Provide preliminary analysis of the acoustic data from the 2017 survey	Crance	By 67b
(13)	Develop proposal for spatial analyses of sightings data to inform *inter alia* medium-term plans for submission - and see Item (4) with respect to environmental data	Kitakado (with Palka, Donovan, Matsuoka, Kelly, Bravington, Redfern)	By SC/67b. TAG meeting to be held in Oct. 2018
(14)	Develop proposal for analyses of genetic data to inform *inter alia* stock structure discussions related to medium-term plans	Lang, with Pastene and Steering Group	By SC/66b
Future (post-2020 cruises)			
(15)	Develop initial proposal for the medium-term (post-2020) programme based upon the analyses of the data thus far	Steering Group	Full review at 2018 TAG meeting

area. There were no sightings of blue or sei whales during the cruise. The Estimated Angle and Distance Training Exercises and Experiments were completed successfully. Preliminary analyses of the photo-identification data revealed some 170 unique individuals from six species: North Pacific right (12), gray (14), fin (55 fin), humpback (32), common minke (1) and killer whales (56). Most North Pacific right whales were sighted at the western edge of Bristol Bay in the middle of the US-designated critical habitat. A total of 60 biopsy (skin and blubber) samples were collected from five species: fin (28), humpback (18), gray (9), North Pacific right (3) and killer whales (2). A total of 240 sonobuoys were deployed, for a total of 841 monitoring hours. Species detected include fin whales (on about 50% of sonobuoys) killer whales (about 20%), sperm whales (about 20%), right whales (about 15%), humpback whales (about 10%) and gray whales (about 2%). Considerably fewer items of marine debris were seen than on previous cruises.

7.2 Discussion

The Planning Meeting was **extremely impressed** with the provision of the draft report so soon after completion of the 2017 survey and thanked all of the scientists and crew for undertaking a most successful cruise. It also expressed thanks to the Government of Japan for the long-time provision of the vessel and the Government of the USA for providing the acoustic equipment and the scientific permits to survey in the US waters and enter a US port. Finally, the Planning Meeting thanked the cruise leader, Matsuoka, for his hard work and dedication to this project and gave him a round of applause to acknowledge his leadership skills.

It was noted that the several North Pacific right whale sightings reflected the historical catch distribution with some to the east of the US-designated critical habitat.

Fewer than half of the fin whales detected in IO mode were determined to be definite duplicates (14 out of 31 sightings). This strongly suggests that $g(0)$ is less than and not equal to one for this species (as has usually been assumed). The Planning Meeting **agrees** that the TUMSAT and ICR scientists examining fin whale abundance should use the IO data to attempt to estimate $g(0)$, recognising that additional data will become available in 2018 and 2019. Depending on the detection function shapes, group sizes and animal behaviour, it was also suggested that consideration should be given to examining whether pooling the fin and Bryde's whale IO data is appropriate for estimation of a combined $g(0)$.

The passive acoustic equipment that was used to record baleen whales worked well. The Planning Meeting **agrees** that at least preliminary analyses of the passive acoustic data should be presented to the 2018 Scientific Committee meeting and requests Crance to provide such a paper. Of particular interest is a comparison of the distribution of detections of whales as detected by the visual observers relative to the passive acoustic equipment, and the effect of sea state conditions on these detections.

Collaborating with other organisations to ensure full use (following the IWC data guidelines) of the IWC-POWER data has always been an objective of these surveys. In addition to general encouragement[3], the Planning Meeting **recommends** that:

(1) scientists from SWFSC (La Jolla) be given access to and analyse the gray whale biopsy samples and provide information to the March 2018 gray whale intersessional meeting;
(2) Matsuoka shares the humpback whale photographs with Cascadia Research who have a long-standing humpback whale catalogue and with T. Cheeseman (*https://www.happywhale.com/*) who has developed an accurate automated matching program; and
(3) the Secretariat shares the raw and hi-def jpg right whale photographs with MML (Seattle) and encourages scientists from MML to request access to the right whale biopsy samples.

Brownell liaises with the NMFS on their surveys of the Hawaiian EEZ and California Current waters with respect to comparisons with IWC-POWER data in similar waters.

[3] Collaboration is encouraged with other groups holding: genetic samples; individual identification data; marine debris data; other species data (e.g. turtles – *Peter.Dutton@noaa.gov,* NOAA Southwest Fisheries Science Center and seals *tom.gelatt@noaa.gov,* NOAA, Alaska Center).

8. AVAILABILITY OF RESEARCH VESSELS

8.1 Research vessel offered by Japan

Morita noted that the *Yushin-Maru No.2* or a similar vessel will be available, probably with the status of an international vessel although this decision has not yet been finalised.

The Planning Meeting **thanks** the Government of Japan for its generous provision of the vessel. It **stresses** the importance of using a vessel with international vessel status for the 2018 and 2019 cruises as 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 plans considered below assume that the vessel can use foreign ports.

8.2 Other possibilities

The Planning Meeting was informed that there were no dedicated US or Russian cetacean cruises expected in the Bering Sea in 2017.

9. PRIORITY FOR THE 2018 CRUISE

The Planning Meeting confirmed that the 2018 cruise objectives would be broadly the same as in previous years with continuation of the acoustic component first utilised in 2017 (if the cruise takes place in the Central Bering Sea). The cruise will thus 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 North 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 to meet the Commission's long-term conservation and management objectives.

Whether the 2018 cruise will occur in the western or central portion of the Bering Sea will depend upon obtaining a Russian permit in time to complete preparations. This is currently unclear; if working in Russian waters is not an option, then the cruise will focus on the Central Bering Sea in 2018 and then the Western Bering Sea in 2019.

Provided this is in accordance with Foreign Ministry protocol, the Planning Meeting **recommends** that Japan (as flag state) submits applications:

(a) to the USA for both 2018 and 2019, on the understanding that the vessel would work in US waters of the Central Bering Sea in only one of these years; and
(b) to Russia for 2018 for the western Bering Sea which is where the 2018 cruise will be held if the Russian permit is received sufficiently in advance.

The Scientific Committee had previously strongly urged the Russian Authorities to grant a permit for the IWC-POWER cruise (IWC, 2017) and it **strongly requests** that the Secretariat and the Commission co-operate with Japan in the permit process.

For logistical reasons (including preparations for the Japanese vessel to use the Russian port of Petropavlovsk-Kamchatskiy, essential for refuelling and also for CITES purposes for biopsy samples), a cut-off date is required, by which date the decision must be made to work in either the central or western Bering Sea. After consultation, the Planning Meeting **agrees** that the Steering Group decision must be taken by **15 April 2017**.

In light of the above, the Planning Meeting developed parallel plans for both the Central and Western Bering Sea for 2018, with the decision of which area to survey being postponed pending the disposition of permit applications. Should the Russian permit not be obtained in time for 2018, it was noted that a backup plan for 2019 would also need to be developed in case a permit was not granted for 2019.

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/67a/Rep 1. The Scientific Committee requested and was allocated by the Commission £36,000 for each of the years 2017and 2018. Donovan noted that there is a modest additional amount available due to savings from previous cruises.

11. CRUISE PLAN

11.1 Priorities and allocation of research effort

The broad priorities for 2018, most of which are also applicable to 2019, are given under Item 9. Taking into account the likely weather in the regions, the Planning Meeting planned for the vessel being 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.

11.2 Itinerary

As noted under Item 9 above, the Planning Meeting developed parallel itineraries and plans for the central and western Bering Sea, contingent upon the outcome for a Russian permit application for 2018.

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 central (either 2018 or 2019, see below) blocks is Dutch Harbor. For the western block in the waters of the Russian Federation, Petropavlovsk-Kamchatskiy on the Kamchatka peninsula would be used. The proposed itineraries (see discussion under Item 11.1 for assumptions) are shown in Table 3. Zharikov noted that entry into Russian waters would have to occur at a 'checkpoint" in the southern Kuril Islands; he agreed to provide details in due course.

11.3 Research area

The research area proposed for the 2017-19 period and agreed by the Scientific Committee is shown in Fig. 2. The Planning Meeting **reiterates** the boundaries for the central and western blocks which were based largely upon practical considerations of EEZs and research coverage.

11.4 Research vessel

As noted above, *Yushin-Maru No. 2* or a similar vessel 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.

Table 3

Revised proposed itinerary for the IWC-POWER cruise in the central Bering Sea assuming 85 days (option 1) and the western Bering Sea assuming 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 options.

Option 1: Central Bering Sea		Option 2: Western Bering Sea	
Date	Event	Date	Event
3 July 2018	Vessel departs Shiogama	12 July 2018	Vessel departs Shiogama
13 July	Vessel arrives Dutch Harbor	18 July	Vessel arrives Petropavlovsk-Kamchatskiy
15 July	Pre-cruise meeting	20 July	Pre-cruise meeting
16 July	Vessel departs Dutch Harbor	21 July	Vessel departs Petropavlovsk-Kamchatskiy
18 July	Vessel starts survey in research area	26 July	Vessel starts survey in research area
08 Sept.	Vessel completes the research area	12 Sept.	Vessel completes the research area
12 Sept.	Vessel arrives Dutch Harbor	16 Sept.	Vessel arrives Petropavlovsk-Kamchatskiy
14 Sept.	Post-cruise meeting	18 Sept.	Post-cruise meeting
15 Sept.	Vessel leaves Dutch Harbor	19 Sept.	Vessel leaves Petropavlovsk-Kamchatskiy
25 Sept.	Vessel arrives Shiogama	25 Sept.	Vessel arrives Shiogama

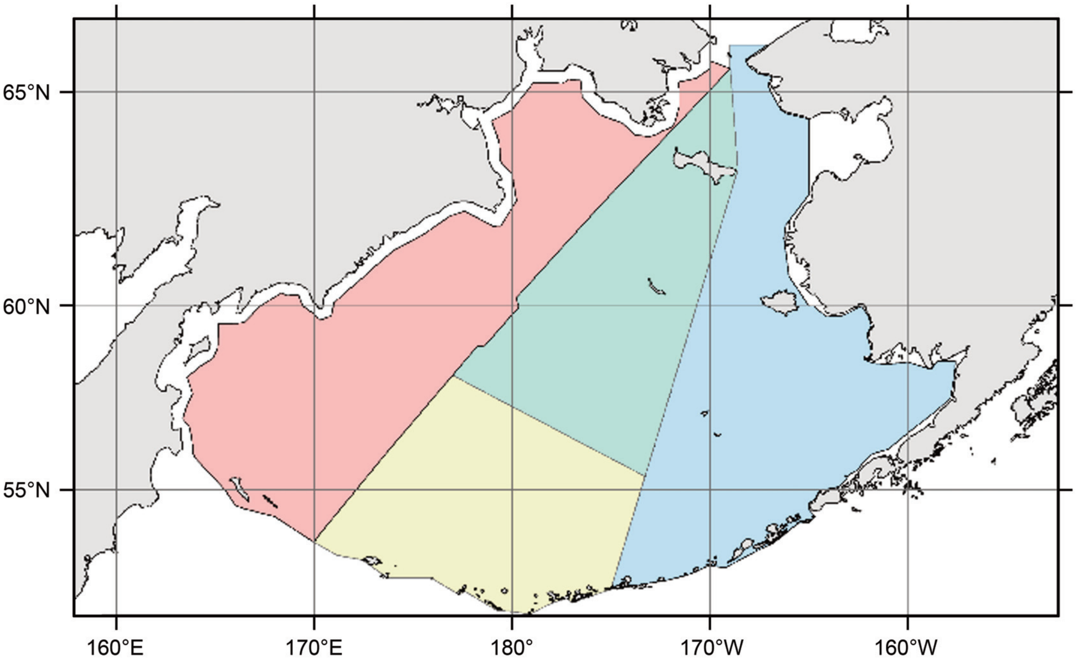

Fig. 2. Survey blocks and strata for the 2017-2019 IWC-POWER cruises (Western, Eastern and Central blocks).

Table 4

Specifications for *Yushin-Maru No. 2.*

Call sign	JPPV
Length overall	69.61m
Gross tonnage	747GT
Barrel height	19.5m
IO barrel height	13.5m
Upper bridge height	11.5m
Bow height	6.5m
Engine power	5280/3900(PS/kW)

12. DETAILS OF THE CRUISE

12.1 Cruise track design

The Planning Meeting **concurs** with the proposal for cruise track design for 2018 and 2019 developed last year using program DISTANCE (v. 6.2) The lines had been reviewed in the light of the guidelines for good track design included in the Requirements and Guidelines for Surveys under the RMP (IWC, 2010) 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 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 Central Bering Sea, 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 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 2018-2019 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 12hrs per day between 6:00 and 19:00, including 30mins

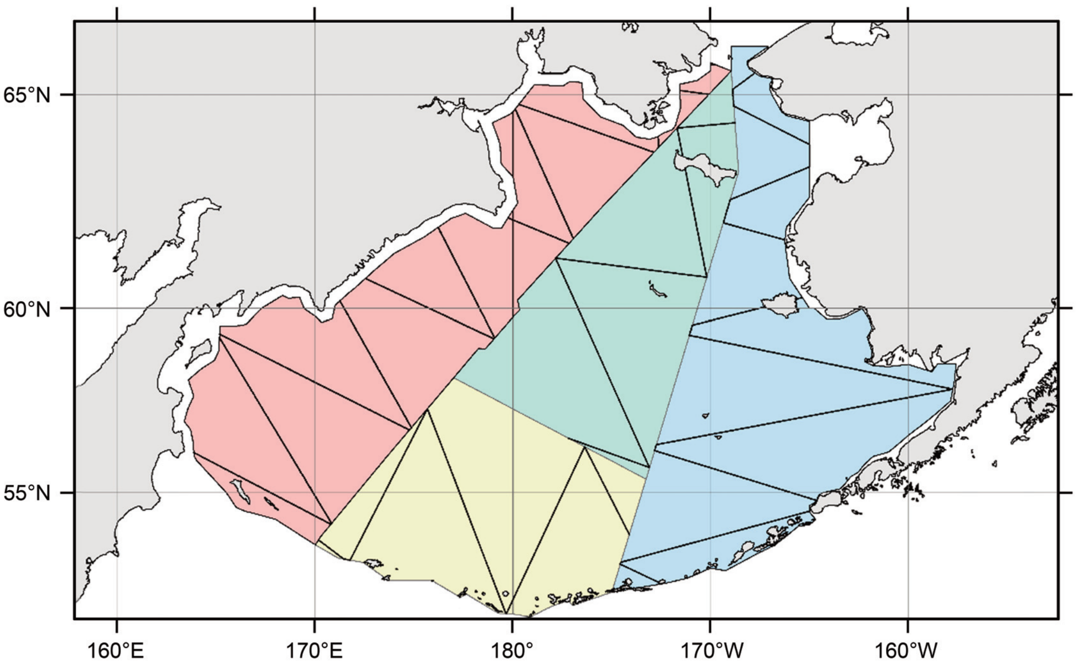

Fig. 3. Tracklines for the three blocks under the assumptions noted in Item 11.1.

for meal times (lunch and supper) during only IO mode. Days will begin 60mins after sunrise and end 60mins before sunset. 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 30mins after sunrise and end 30mins 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 30mins after sunrise and end 30mins 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 2017, 11.5kts (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

The usual guidelines will apply, i.e. visibility (in principle for seeing common minke whales) >2.0 n. miles; wind speed <21kts; 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 (and see discussion under Item 6.1). 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 the 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 had 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. Additional experiments were conducted in 2017; this work will be continued in 2018. A request was made to conduct the experiment in higher wind speeds (e.g. 15kts); this will be attempted, but with due consideration given to time and other constraints. The detailed protocol can be found in the Guide for Researchers.

12.7 Data format

The survey will be conducted using data forms modified in accordance with previous recommendations. As noted in the TAG report (IWC, 2016a), whilst cetaceans are of course the priority, opportunistic data on other taxa may be collected at the discretion of the cruise leader (if, for example, significant aggregations of pinnipeds are observed). Codes will be developed for such species.

It was agreed that Donovan and Matsuoka should update the Guidelines for Researchers as necessary for the 2018 and 2019 cruises.

12.8 Biopsy sampling

12.8.1 Priority of species

The highest priority species for biopsy sampling is the North Pacific right whale, followed by the blue, fin and sei whale. The eastern North Pacific 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 whales (given the IWC's ongoing basin-wide assessment), bowhead whales (unlikely though their occurrence in the research area is) and fin whales (to look at possible population structure on the feeding grounds).

Medium-priority species include sperm, common minke 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

For the Central Bering Sea cruise, the procedures followed will be those used in 2017 i.e. all samples will be frozen and stored in cryo-vials. Each sample will be split into skin and blubber, the latter not being required for genetic analysis. The skin samples will be divided at sea into the IWC samples and the Japanese samples. 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-iterates** 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 *www.iwc.int*).

For the Western Bering Sea, it was noted that the Russian authorities will also require portions of each biopsy sample. For practical reasons related to transportation, the Planning Meeting agrees that skin samples are stored in alcohol not frozen. The details of shipping will depend on the CITES import and export permits obtained. It established a small intersessional group comprising Morita, Brownell, Matsuoka and Zharikov to examine the CITES situation and determine the appropriate unloading and shipping procedures to be followed.

12.9 Photo-identification studies

12.9.1 Priority of species

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. It was agreed that, for North Pacific right whales, attempts should be made to obtain identification photos (of the head, with a lateral approach) before a biopsy sample is taken. If in the judgment of the cruise leader the animal concerned is very evasive, then a biopsy can be attempted from any angle; but the photos should be the initial priority.

12.9.2 Equipment

Recommended improvements to the equipment will depend on the resources available (see below).

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 (*www.iwc.int*) to apply for use of the photographs (available from the IWC Secretariat and 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, acoustic work using sonobuoys will be a priority for the Central Bering Sea. Permitting difficulties for the Western Bering Sea make the use of sonobuoys impossible.

12.10.1 Priority of species

As in 2017, the highest priority species for acoustics will be North Pacific right whales, followed by blue whales.

12.10.2 Equipment

For the Central Bering Sea, all necessary equipment will again be provided by the Alaska Fisheries Science Center (AFSC), including sonobuoys, laptop computer, antennae, cables and analytical software. AFSC would also again provide a dedicated, experienced acoustic observer to conduct all acoustic monitoring operations on the cruise (see Item 13.2). Because of voltage problems experienced in 2017, the cruise in the central Bering Sea would need to take the same technical approach used to resolve this issue last year.

The general acoustic schedule will involve deployment of one sonobuoy every 3hrs, 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); allowing for possible failures, six crates will be sufficient.

The Planning Meeting noted that it would be helpful if some solution could be found to the problem of trash generated through use of the sonobuoys, given that it is expensive to dispose of this in Dutch Harbor. It **agrees** that Matsuoka and Clapham should work on this intersessionally.

12.10.3 Keeping of data

The Planning Meeting agreed that the NOAA Marine Mammal Laboratory would act as the curator of acoustic data. Proposals for use of these data should be submitted through the IWC Secretariat.

12.11 Oceanographic studies

As noted previously (e.g. IWC, 2016a), sufficient time cannot be devoted to oceanographic studies to collect worthwhile data and thus no such studies will be undertaken. Consideration can be given to external requests for simple sampling if considered practicable but no such requests had been received.

Similarly, IWC (2016) 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 2018 cruise. IWC (2016) had agreed that the use of such equipment should be considered when designing the medium-term programme.

12.13 Marine debris

The Planning Meeting reiterated the importance of observations of marine debris (and see Item 6.1.3) e.g. in modelling the predicted movement of debris from the 2011 Tsunami across the Pacific. The protocol adopted for recording such material (15mins in every hour) will continue in 2018 to prevent compromising cetacean sightings searching effort.

13. INTERNATIONAL RESEARCHERS AND ALLOCATION RESEARCH PERSONNEL

13.1 Number of researchers

As in previous years, space in 2018 will be allocated for four researchers.

13.2 Nomination and allocation of researchers

For 2018 the following framework for researcher involvement was agreed, depending upon destination:

(1) Japan (IWC-POWER range state, vessel provider, Matsuoka appointed Cruise Leader).
(2) USA (IWC-POWER range state, acoustic, Crance, if central Bering Sea) or Russia (IWC-POWER range state, Zharikov, if western Bering Sea).
(3) IWC (provisionally Taylor, UK/USA, Secretariat contractor for photographic catalogue).
(4) Japan (IWC-POWER range state, Yoshimura).

14. GENERAL PREPARATIONS FOR THE 2017 CRUISE

14.1 Identification of the home port organiser

For Dutch Harbor, Crance will act as home port organiser if the 2018 cruise is to survey the Central Bering Sea. Zharikov will be the home port organiser in the event that Petropavlovsk is used for the western Bering Sea option.

14.2 Entry and other permits

The 2018 and 2019 cruises will either be within the US EEZ or Russian EEZ. As noted under Item 9, Morita will file the necessary documents, including the need for biopsy sampling, within the necessary time limit (at least six months prior to the cruise).

14.3 Review of recommendations from the 2017 cruise

The Planning Meeting agrees that Donovan and Matsuoka should review the recommended items for purchase and decide what can 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 2017, while recognising the need to move rapidly to and from the research area, the meeting **re-iterates** 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. For the Central Bering Sea, it will not be possible for biopsy/photo-identification effort in US waters in transit as no US scientists will be on board. For the Western Bering Sea it is expected that Zharikov will board the vessel in Japan and he will investigate the situation for Russian waters in transit. 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
For the Central Bering Sea, acoustic equipment will be loaded in Dutch Harbor, and the acoustician will also join the vessel there. No acoustic studies will be undertaken in the Western Bering Sea. Other equipment will be the same as in previous years.

The Planning Meeting **agrees** that Donovan and Matsuoka should arrange for additional Larsen darts to be obtained for the 2018 cruise.

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. The acoustic data will be archived at MML (see Item 12.10.3). The Cruise Leader will ensure that any borrowed equipment (except IWC cameras and lenses) will be returned to its owners. Biopsy samples will be dealt with in accordance with the findings of the intersessional group discussed under Item 12.8.3.

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 contact with the US Coast Guard by the US researcher, as needed (usually upon entry and exit from US waters); given that the vessel has AIS, there is no need for regular communication with the Coast Guard. For Russian waters, daily reports may be necessary depending on the area, and in this case Zharikov will be responsible for contacting the relevant authorities.

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.

17.3 Fog and sea temperature information
It was agreed that fog information will be required and for the Central Bering Sea, Clapham will liaise with Matsuoka regarding obtaining the latest NOAA information, otherwise the same arrangements as in 2017 will apply.

17.4 Other official communications
For the Central Bering Sea, for 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. Zharikov will investigate the situation for the Western Bering Sea.

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.

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
For the Central Bering Sea, the pre-cruise meeting will be held in Dutch Harbor on 13 July; for the Western Bering Sea, the meeting will be held in Petropavlovsk on 20 July.

The Cruise Leader will ensure that the report of the pre-cruise meeting is circulated to the IWC-POWER Steering Group when completed.

18.2 Post-cruise meeting
Depending on whether the 2018 cruise surveys the central or western Bering Sea, the post-cruise meeting will be held at either Dutch Harbor or Shiogama (respectively) when the vessel returns 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. Zharikov will co-ordinate arrangements for Petropavlovsk. For Shiogama, Hakamada will be the co-ordinator.

19. REPORTS

19.1 Planning meeting report
The agreed report will be tabled at the IWC/SC meeting in 2018.

19.2 2016 Cruise report
The 2017 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 2018 Cruise Report should be handled in the same way.

20. OTHER LOGISTICS

20.1 Press releases
As in 2017, the Cruise Leader in consultation with the IWC and the US or Russia will prepare a press release before and after the cruise. The IWC, ICR, US/Russia 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. Any additional press releases during the cruise precipitated by unusual observations (e.g. the finding of aggregations of right whales) will be circulated for comment and approval to the Steering Group and the Chief Scientist prior to release.

20.2 Security and safety
Based on previous experience, no security problems are anticipated. The IWC banner will be readily visible (efforts will be made to obtain a new IWC flag).

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. A request was made to make provision for alternative (no seafood) meals in the event that Crance is on board again.

20.4 Other matters

It was noted by the US researcher that at the end of the 2017 cruise in the eastern Bering Sea, the vessel returned to Dutch Harbor during daylight but that additional survey effort could have been conducted in the main North Pacific right whale area if the ship had instead conducted the transit overnight. Matsuoka responded that this was necessary because of the need to prepare for port entry, but in the event that the next survey operates in the Central Bering Sea effort will be made to maximise time working with right whales, as other obligations allow.

21. OTHER

21.1 Data validation and analysis

Work on data validation continues at the Secretariat. Where difficulties have arisen, these are being dealt with in cooperation with the Cruise Leader.

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. Press releases should be synchronised amongst the states and the IWC.

22. CONCLUDING REMARKS

A list of action points arising from the meeting with respect to the 2018 and 2019 cruises is given as Table 5. Table 2 summarised the actions points with respect to data, analyses and post-2020 planning.

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 (subject to final editorial work) and concluded its business at 1300hrs on 6 October 2017.

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Table 5

Summary of actions related to the conduct of the 2018 and 2019 surveys.

Item	Task	Responsible persons	Timeline
(1)	Update IWC-POWER pages on the website including announcing the POWER cruises for 2018-19 and encourage other range states to join the programme	Secretariat and Steering Group	Continuing task
(2)	Provide information regarding Russian 'checkpoint' location	Zharikov	As soon as possible
(3)	Submit permit applications to the USA for 2018 and 2019 and to Russia for 2018	Government of Japan (with support from, Clapham, Zharikov, the IWC and the Secretariat)	Timing to be determined by Japan (probably late 2017 early 2018)
(4)	Decide where the 2018 cruise will be in light of permit situation	Steering Group based upon advice from Japan	By 15 April 2017
(5)	Update 'Guide for Researchers'	Matsuoka and Donovan	By SC/67b
(6)	Develop detailed protocol for unloading and shipment of biopsy samples based on investigation of CITES permits	Morita, Brownell, Matsuoka and Zharikov	In time for permit applications
(7)	Contact researchers and check availability	Donovan and Steering Group	By end of October
(8)	Review equipment requests (e.g. biopsy darts, photographic equipment) in light of the budget and purchase accordingly	Donovan and Matsuoka	By end of 2017

Annex A

List of Participants

Robert Brownell	Southwest Fisheries Science Center, USA
Phillip Clapham	Alaskan Fisheries Science Center, USA
Greg Donovan	Head of Science, IWC
Kanako Inai	Tokyo University of Marine Science and Technology, Japan
Yulia Ivashchenko	Alaskan Fisheries Science Center, USA
Takashi Hakamada	Institute of Cetacean Research, Japan
Kohei Hamabe	Tokyo University of Marine Science and Technology, Japan
Hidenori Kasai	Captain, Kyodo Senpaku Co., Ltd., Japan
Hidehiro Kato	Tokyo University of Marine Science and Technology, Japan
Yoshimi Katayama	Tokyo University of Marine Science and Technology, Japan
Toshihide Kitakado	Tokyo University of Marine Science and Technology, Japan
Fang Lu	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
Masaomi Tsunekawa	Kyodo Senpaku Co., Ltd., Japan
Hiroyuki Morita	Fisheries Agency of Japan, MAFF, Japan
Debra Palka	Southeast Fisheries Science Center, USA
Tomoki Yasuhara	Tokyo University of Marine Science and Technology, 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 67a and TAG reports
   - 6.1 Progress during intersessional period
     - 6.1.1 Distance and angle experiments
     - 6.1.2 Abundance estimation
     - 6.1.3 Analyses of marine debris data
     - 6.1.4 Other
   - 6.2 Future work
7. Preliminary results from the 2017 cruise
8. Availability of research vessels
   - 8.1 Research vessel offered by Japan
   - 8.2 Other possibilities
9. Priority for the 2018 and 2019 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 2018 and 2019 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
      - 12.10.1 Priority of species
      - 12.10.2 Equipment
      - 12.10.3 Keeping of data
    - 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 2018 cruise

14.1 Identification of home port organiser
14.2 Entry and other permits
14.3 Review recommendations from 2017 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
19.3 Other
20. Other logistics
20.1 Press release
20.2 Security
20.3 Accommodation and food costs
20.4 Other
21. Other
21.1 Data validation and analysis
21.2 IWC website
21.3 Other
22. Concluding remarks

Annex C

List of Available Documents

1. Report of the meeting of the IWC-POWER Technical advisory Group (TAG) (SC/66b/Rep01)
2. Report of the planning meeting for the 2017 IWC-POWER Cruise (SC/67a/Rep02).
3. SC/67a/ SC Report (Extract)
4. SC/67a/ SC Report-AnnexG (Extract)
5. SC/67a/ SC Report-AnnexQ (Extract)
6. Draft Cruise report of the 2017 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER).
7. Summary of IWC-POWER surveys (2010-2017)
8. IWC-POWER 2018 required equipment
9. Updates of data analyses for distance and angle experiment (Katayama, Fang, Hamabe, Inai, Yasuhara and Kitakado)
10. Preliminary report of abundance estimation of the North Pacific humpback whales using IWC-POWER data (Inai, Matsuoka and Kitakado)
11. Attempt of abundance estimation of marine debris using IWC-POWER data (Yasuhara, Matsuoka and Kitakado)
12. Progress on an attempt to estimate g(0) for Bryde's whales in North Pacific (Hakamada)
13. Proposal for the 2018-2019 IWC-Pacific Ocean Whale and Ecosystem Research (POWER) in the Bering Sea

Annex D

Summary of IWC-POWER Results 2010-2016

Compiled by K. Matsuoka

Table 1

Some key characteristic of the three vessels used thus far.

Vessel	*Kaiko-Maru* (2010)	*Yushin-Maru No.3* (2011-2016)	*Yushin-Maru No.2* (2017-)
Call sign	JGDW	7JCH	JPPV
Length overall (m)	61.9	69.61	69.61
Molded breadth (m)	11.0	10.8	10.8
Gross tonnage [GT]	860.25	742	747
Barrel height (m)	19.5	19.5	19.5
Upper bridge height (m)	9.0	11.5	11.5
Bow height (m)	6.5	6.5	6.5
Engine power [PS/kW]	1471	5280 / 3900	5303 / 3900

Table 2

Summary of sightings. *KM=Kaiko-Maru*, *YM3=Yushin-Maru No.3, YM2=Yushin-Maru No.2.* Sch/ind=number of schools/number of individuals.

Year	2010	2011	2012	2013	2014	2015	2016	2017	Total
Vessel	*KM*	*YM3*	*YM3*	*YM3*	*YM3*	*YM3*	*YM3*	*YM2*	
Effort (n.miles)	1,816	2,398	2,126	3,036	3,233	3,249	2,238	1,571	19,666
Species	Sch/ind	Sch/ind	Sch/ind	Sch/ind	Sch/ind	Sch/ind	Sch/ind	Sch/ind	Sch/ind
Blue	3/3	9/9	4/4	0	1/1	0	0	0	17/17
Fin	23/48	80/139	114/169	1/1	0	0	0	143/195	361/552
Like fin	-	-	-	-	0	0	0	17/20	17/20
Sei	53/31	38/73	81/151	0	1/1	0	0	0	173/256
Bryde's	0	0	0	6/6	88/98	27/32	1/1	0	122/137
Like Bryde's	-	-	-	-	3/3	2/2	0	0	5/5
Common minke	8/8	2/2	2/2	0	0	0	0	23/23	35/35
Like minke	1/1	2/2	0	0	0	0	0	1/1	4/4
Humpback	5/8	76/133	7/7	0	0	0	0	129/157	217/305
Like humpback	-	-	-	-	0	0	0	9/12	9/12
NP right	0	0	1/1	0	0	0	0	7/15	8/16
Like right	-	-	-	-	0	0	0	2	2
Gray	0	0	0	0	0	0	0	15	15
Sperm	67/84	57/74	45/52	33/50	65/137	11/50	6/30	15/15	299/492
Baird's bkd	1/20	0	0	0	0	0	0	0	1/20
Cuvier's bkd	0	0	0	2/6	5/8	3/6	2/5	0	12/25
Longman's bkd	0	0	0	0	0	1/110	0	0	1/11-
Stejneger's bkd	0	0	0	1/4	0	0	0	0	1/4
Mesoplodon spp.	3/6	6/22	3/9	8/20	7/13	1/2	2/3	0	30/75
Ziphiidae	4/9	12/20	22/42	28/5	35/73	4/4	2/2	2/3	109/204
Killer	6/53	6/66	12/42	0	1/3	1/4	0	28/98	54/266
Unid. large	27/43	59/95	44/70	8/8	9/9	3/3	0	0	150/228

Table 3

Number of distance and angle experiments completed.

Year	2010	2011	2012	2013	2014	2015	2016	2017	Total
Barrel distance	36	42	42	42	36	60	72	84	414
Barrel angle	36	42	42	42	36	60	72	84	414
IOP distance	-	-	-	-	-	60	72	84	216
IOP angle	-	-	-	-	-	60	72	84	216
Upper distance	36	24	37	37	24	40	60	60	318
Upper angle	36	24	37	37	24	40	60	60	318
Total	144	132	158	158	120	320	408	456	1,896

Table 4

Summary of the photo-identification work undertaken (number of individuals photographed).

Photo-ID	2010	2011	2012	2013	2014	2015	2016	2017	Total
Blue whale	3	9	4	0	1	0	1	0	18
Fin whale	0	25	59	3	0	0	0	79	166
Sei whale	0	27	51	2	0	0	1	0	81
Bryde's whale	0	0	0	6	73	49	12	0	140
Common minke whale	0	0	0	0	0	0	0	0	0
Humpback whale	5	48	26	0	0	0	0	48	127
North Pacific right whale	0	0	1	0	0	0	0	12	13
Gray whale	0	0	0	0	0	0	0	16	16
Sperm whale	0	0	1	0	4	22	2	0	29
Killer whale	45	18	50	0	3	4	0	84	204
Total	53	127	192	11	81	75	16	239	794

Table 5

Summary of the biopsy work undertaken (number of individuals sampled).

Biopsy	2010	2011	2012	2013	2014	2015	2016	2017	Total
Blue whale	1	4	2	0	1	0	1	0	9
Fin whale	2	12	12	1	0	0	0	28	55
Sei whale	13	31	36	0	0	0	1	0	81
Bryde's whale	0	0	0	6	78	34	16	0	134
Common minke whale	0	0	0	0	0	0	0	0	0
Humpback whale	0	1	0	0	0	0	0	18	19
North Pacific right whale	0	0	0	0	0	0	0	3	3
Gray whale	0	0	0	0	0	0	0	9	9
Sperm whale	0	0	0	0	0	1	5	0	6
Killer whale	2	0	1	0	1	2	0	2	8
Total	18	48	51	7	80	37	23	60	324

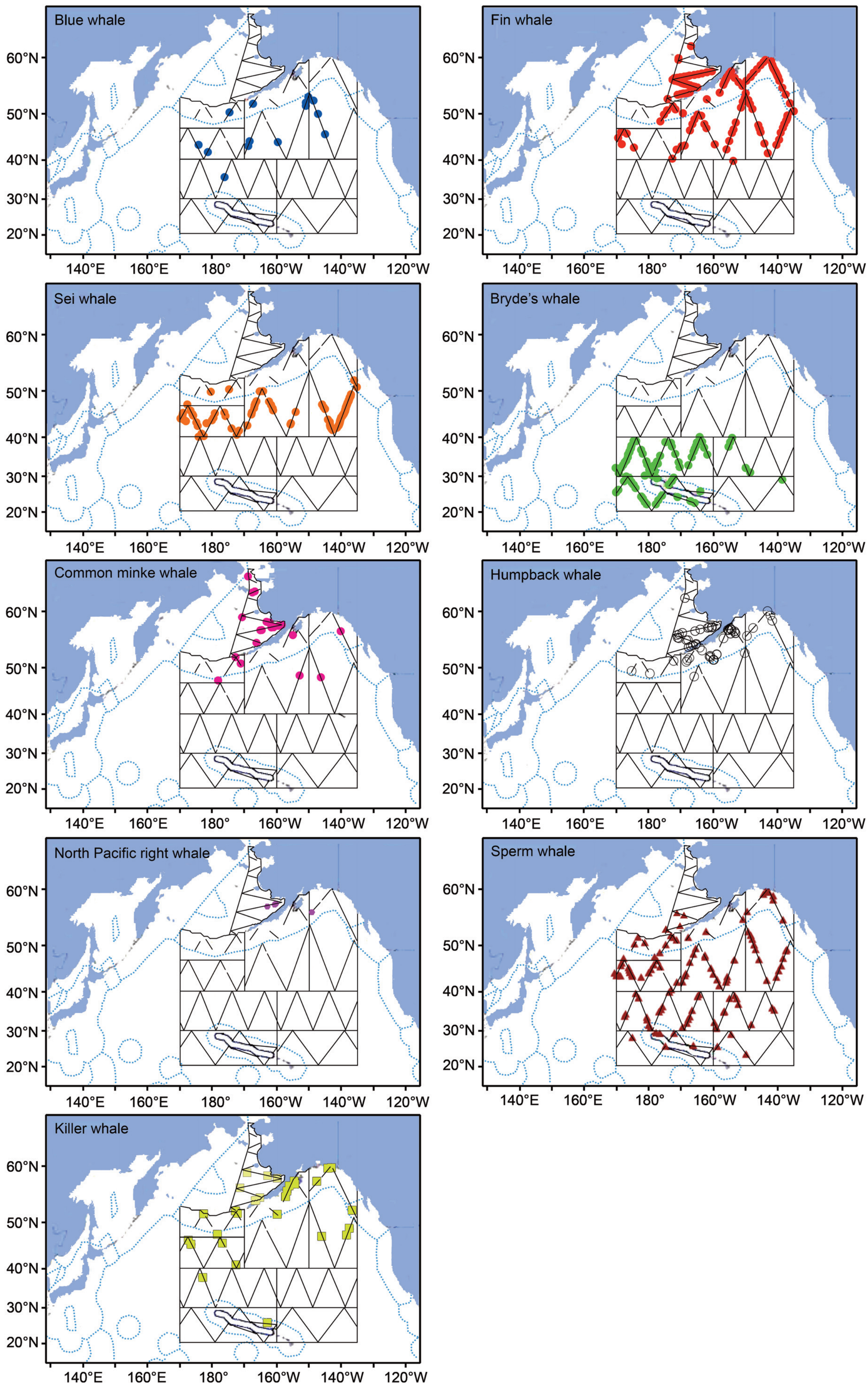

Fig. 1. Sighting positions by species, all years combined.

Report of the 2017 AWMP Workshops on the Development of SLAs for the Greenlandic Hunts

Report of the 2017 AWMP Workshops on the Development of *SLA*s for the Greenlandic Hunts[1]

1. INTRODUCTORY ITEMS

Two workshops were held at the Greenland Representation in Copenhagen: one from 18-21 October 2017 and one from 20-24 March 2018. In addition, a small technical group meeting was held at the offices of the OSPAR (Oslo Paris) Commission in London from 15-17 December 2017. This report consolidates the work at all three meetings. The consolidated list of participants is given as Annex A.

1.1 Convenor's opening remarks

Donovan thanked the Greenland Representation for their generous hosting of the two workshops. He also thanked the OSPAR Commission for so kindly hosting the small group meeting. He reminded the participants of the enormous amount of work that needed to be completed by the Scientific Committee meeting in order to finalise the work to develop *SLA*s for the remaining Greenland hunts.

1.2 Election of Chair and appointment of Rapporteurs

Donovan was elected Chair and Allison, Brandao, Butterworth, Tiedemann and Punt acted as rapporteurs.

1.3 Adoption of Agenda

The adopted agenda is given as Annex B.

1.4 Documents available

The list of documents is given as Annex C.

2. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: FIN WHALES

2.1. Summary of discussions at SC/67a

The Committee agreed with the conclusions of the December 2016 workshop (IWC, 2018, p.13) to model fin whale abundance estimates (past and future) 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. This was driven by the submission of a particularly low but at that time uncorrected abundance estimate for the year 2015 (Hansen *et al.*, 2016). Some new *SLAs* presented included mechanisms to filter out 'low' abundance estimates (such as that in 2015) to make allowance for occasional partial presence over the 100-year trial period. A workplan was agreed in October 2017 that further trials be designed to test thoroughly the conservation performance of *SLA*s incorporating such a feature, that had not been envisaged in the original trial development process.

2.2 Updated abundance estimate information

An updated analysis of fin whale (and other) abundance estimates from aerial surveys (Hansen *et al.,* 2018) provided revised estimates that took account of availability as well as perception bias. The observed surface time for the two fin whales tracked in West Greenland was 19.45% and the mean time-in-view of fin whale sightings was 4s in West Greenland (Table 5 of Hansen *et al*., 2018). Heide-Jørgensen and Simon (2007) observed that fin whales in West Greenland had a blow rate of 50 times per hour (CV=0.07) when excluding observation periods <30min. This corresponds to an average duration of surfacings per hour of 13.1s (3,600*0.20/50) and an average duration of dives of 58.9s (3,600-(1-0.20))/50). Using these values in the model by Laake *et al.* (1997) results in an availability for fin whales of 0.21 (CV=0.22) in West Greenland. Applying this to the previous (Hansen *et al.,* 2016) MRDS estimates gives a fully corrected abundance estimate of 2,215 (95% CI: 1,017-4,823) fin whales in West Greenland.

The 2005 and 2007 fin whale abundance estimates had not been corrected for availability bias but applying the same availability bias as for the 2015-survey, corrected for the specific time-in-view data from 2005 and 2007, provided fully corrected abundance estimates of 9,800 (95% CI: 3,228-29,751) in 2005 (Heide-Jørgensen *et al.,* 2008) and 15,957 (95% CI 4,531-56,202) in 2007 (Heide-Jørgensen *et al.*, 2010).These revised estimates (see Annex D) were substantially larger than the corresponding previous ones.

The Workshop thoroughly reviewed these estimates (see Table 1) and **agreed** to proceed using them, recognising that they will need to be approved by the ASI working group at the 2018 meeting of the Committee.

2.3 Final trial structure

Given the revised abundance estimates, the developers agreed that they would not include a feature within their proposed *SLA*s that ignored 'low' abundance estimates. This obviated the need to develop additional trials to account for this feature or for new formats for presentation of results that allowed the behaviour of such strategies to be reviewed.

The Workshop noted that in the case of BCB bowhead whales, experience showed that later surveys had poorer precision than assumed in initial trials. It was **agreed** that the CV for *Evaluation Trial* 10.2 (which considers a 'maximum' CV) be increased from 0.45 to 0.60.

The Workshop noted that the trials developed before and during the 2017 Scientific Committee assumed a 'large' WG-associated stock corresponding to the high survey estimates. An alternative 'influx' hypothesis was developed where only a total WG-associated stock is present for the years with low abundance estimates, and the years with high estimates reflect mixing from adjacent stocks (the 'extra' stock). Details of this hypothesis are given in Annexes E and G, as are the additional *Evaluation Trials* to incorporate this hypothesis. Incorporation of this more 'conservative'

[1] Presented to the meeting as SC/67b/Rep06.

Table 1

'Old' partially corrected and 'New' fully corrected abundance estimates for West Greenland fin whales.

Sub-area	Range of years	Method	Old Estimate	CV	Approx. 95% CI	New Estimate	CV	Approx. 95% CI
WG	1987/8	Cue counting	1,096	0.35	560-2,130	1,096	0.35	560-2,130
WG	2005	Line Transect	3,234	0.44	1,400-7,400	9,800	0.62	3,228-29,751
WG	2007	Line transect	4,359	0.45	1,900-10,100	15,957	0.72	4,531-56,202
WG	2015	Line transect	465	0.35	230 - 930	2,215	0.41	1,017-4,823

hypothesis into the *Evaluation Trials* does not imply any relative weighting compared to the original 'partial presence' hypothesis. The Workshop **recommended** that additional studies be developed and undertaken that would allow further consideration of the relative plausibility of these hypotheses at a forthcoming *Implementation Review.*

The Workshop noted that conditioning depends strongly on the upper bound on the uniform prior for *K*; it was **agreed** to use a 5,000 upper bound, with 2,000 as a sensitivity test, for the Influx trials.

2.4 Conditioning

Conditioning results were considered for the original *Evaluation trials*, trials based on the Influx model, and the *Robustness Trials*. Full results from the conditioning are archived by the Secretariat.

The Workshop **agreed** that the 'beta likelihood' plot could be dropped when reporting conditioning results for the *Evaluation trials*. It further **agreed** that the conditioning of these trials was satisfactory. An initially surprising feature of these results is that for $MSYR_{1+}$=1%, the median trajectories do not pass through the rough centroid of the two large estimates of abundance being fit. The reason for this is that the model is fitting to the lower abundance as well.

Conditioning of the Influx model trials was also **agreed** to be satisfactory. Again, it is surprising that for $MSYR_{1+}$= 1%, the median trajectory does not pass through the rough centroid of the two lower estimates of abundance used for these fits. The reason is the influence of the *K* prior for the local stock, which effectively downweights the higher of these two estimates because it is less compatible with the lower values of *K* covered by this prior (see Fig. 1).

Finally, the results from conditioning of the *Robustness Trials* were inspected and **agreed** to be satisfactory. For the 'partial presence' hypothesis where only some proportion of the stock is considered to be present in West Greenland in some years, it is difficult to specify the expected value for this proportion (for use in generating future proportions present). However, the meeting considered that the two distributions used for the *Evaluation Trials* and in these *Robustness Trials* are likely encompass the possible range.

2.5 Description of new or updated *SLAs*

The meeting considered results for three candidate *SLA*s. The *Interim SLA* (primarily for comparative purposes) and *SLA*s developed by Brandão and by Witting for the two workshops (SC/O17/AWMP01 and SC/M18/AWMP03).

In initial discussion of the process for comparison of the results for, and the ultimate choice amongst, different candidate *SLA*s, the meeting noted that trials for the Influx model would have particular importance because of the greater difficulties in meeting conservation objectives for these trials. To provide some guidance to the developers on the need *vs* conservation trade-off sought, and to assist in comparing results, it was suggested that developers attempt to tune to values of 0.8 and 1.0 for the lower 5%-ile of the D10 statistic for the F34-1B influx model trial. However, it was stressed that results for this trial alone would not be the final determinant for any *SLA* selection process. Rather, results would be considered across other trials as well for all candidate *SLA*s to provide an holistic basis for an *SLA* choice; this might result in the lower 5%-iles for D10 for some trials falling slightly below some 'threshold' value (such as 1.0).

2.6 Consideration of results with full trial set

It proved impossible to complete computation of results for all trials before the end of the meeting. However certain features were evident from those results that could be produced. These included that conservation performance for the candidate *SLA*s put forward (including the *Interim SLA*) was satisfactory for all except perhaps some of the Influx model trials. The Interim *SLA* appeared to perform competitively with the other candidates.

However, only abundance trajectories were available, and it was evident that trajectories of strikes/need would also need to be produced and considered. This would be of some importance for the *Interim SLA*, for which strike limit variability over time might prove unsatisfactorily large. The Workshop **agreed** that additional plots be produced of time-trajectories of strikes (with the need by year indicated) and plots of individual time-trajectories of strike limits, the associate need levels, and the abundance estimates available by year.

2.7 Conclusions and recommendations

The Workshop **agreed** that significant progress had been towards developing an *SLA* for the West Greenland hunt for fin whales. It noted that the most difficult trials were some of those associated with the new Influx model. The evidence for this hypothesis primarily relates to the low abundance estimates in some years; there is no genetic or other evidence to either support it or rule it out. The Workshop **recommended** that effort be put in to examining stock structure of West Greenland prior to the next *Implementation Review.* The final results of the trials for this hunt will be reviewed at the 2018 Scientific Committee meeting.

3. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: COMMON MINKE WHALES

3.1 Summary of discussions at SC/67a

The Committee completed the RMP *Implementation Review* for this species in the North Atlantic (IWC, 2018, pp.8-11)

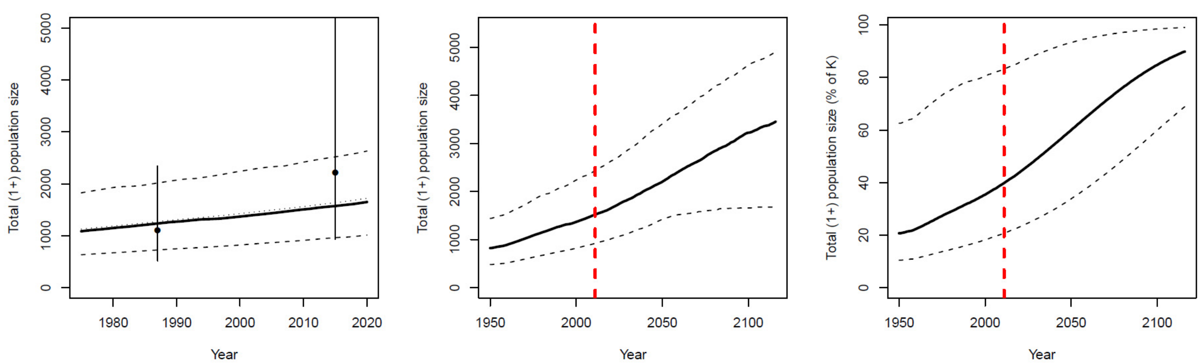

Fig. 1. Conditioning plots for the Influx trial GF34-1A.

and agreed that the operating model used should form the basis of that for *SLA* development, but that greater focus should be placed on the western and Central North Atlantic. The Committee had agreed to fund additional genetic work by Tiedemann and colleagues to assist in this process, and the need for some additional trials was identified. It was agreed that the SWG would evaluate the trial structure, conditioning, and identify any required modifications intersessionally. Any necessary modifications to the trial structure will be coded and final conditioning undertaken. Final evaluation of *SLA*s based on the full set of agreed trials will occur at the 2018 Scientific Committee meeting.

3.2 Stock structure and new genetic information

3.2.1 New information

New genetic data on 15 standard microsatellites and the mitochondrial DNA Control Region, in particular from sub-areas WC, WG, CG, and CIC have been produced (SC/M18/AWMP05). Furthermore, new data analytical approaches (kinship analysis, spatial Principal Component Analysis, sPCAs) were applied to evaluate stock structure hypotheses I, II, III and IV.

Hypothesis III (complete panmixia) seemed implausible, as kinship analyses revealed a significant underrepresentation of Parent-Offspring (PO) pairs among *Median Areas* W, C, and E, but a significant overrepresentation of P=-pairs within sub-areas (SC/M18/AWMP05). Hypothesis IV (mixing of two stocks in all sub-areas) is also not supported by the genetic data. Under this Hypothesis, there should be pervasive positive inbreeding coefficients (F_{IS}) for the microsatellites, a pattern not found in the genetic data.

The genetic data are indicative of minke whales in *Median Areas* W and C originating from more than one breeding stock: Sub-area WG is separated from sub-area CIC according to the sPCAs of both marker systems. Sub-area CG appears intermediate between sub-areas WG and CIC. The data are compatible with admixture of the W and C stocks at least in sub-areas WG, CG, and CIC. The sPCAs of both the mtDNA and the microsatellites separate out specimens from sub-area WC, such that there is some indication in the present data for two W stocks (Hypothesis I).

There are significant temporal fluctuations in the genotype composition in sub-areas WG and CIC. The changes in genotype composition indicate variation in mixing proportions among years. The observed genotype patterns are best reconciled in a scenario where sub-areas WG and CIC are predominantly used by two different (albeit genetically similar) stocks. In some years, the more western stock moves also into sub-area CIC, in some years the more eastern stock moves into sub-area WG. There is no clear indication that mixing among W/W-2 and C stock affects one sex preferentially.

3.2.2 Updated hypotheses

In the light of the new genetic information, the Workshop **agreed** that Hypothesis III seems less plausible and Hypothesis IV is not supported. Hypothesis I appears more likely than Hypothesis II, but sample sizes are still too small for WC for this statement to be conclusive. Both Hypotheses I and II should be modified such that they allow for migration of W/W2 stock into sub-areas CG and CIC

3.3 Final trial structure

3.3.1 Stock structure

The Workshop **agreed** that the trials based on Hypotheses III and IV could be dropped from further consideration (i.e. assigned 'low plausibility') because the results of the genetic analyses Item 3.2) indicate that these stock structure hypotheses are not consistent with the available information. The Workshop noted that the available genetic data were most compatible with Hypothesis I (two W sub-stocks), but that these data are insufficient to exclude Hypothesis II (no W sub-stocks). The trials consequently continue to involve these two Hypotheses (Fig. 2).

It was noted that the W-1 and W-2 sub-stocks are modelled conservatively as stocks (as is conventional in RMP/AWMP trials) even there is little information available about the genetic constitution of a putative W-1 sub-stock. The reason for considering trials in which there are W-1 and W-2 sub-stocks pertains more to the desire to find an *SLA* that allows for harvesting off West Greenland than conservation of (possibly) separate W-1 and W-2 sub-stocks (although the two objectives are related). As such, the W-1 sub-stock should be interpreted as a component of the W-stock that does not mix perfectly into the WG sub-area so that the impacts of possible depletion of the animals off west Greenland probably could not be made up by movement of animals off Canada into the WG sub-area. An exception to this are the trials (M11 and M12) in which allowance is made for density-dependent mixing into sub-area WG.

3.3.2 Mixing matrices and related issues

3.3.2.1 ABUNDANCE

Hansen *et al.* (2018) provided revised estimates of abundance for common minke whales in sub-areas CG and WG based on an improved approach for calculating the time-in-view correction factor (and see Item 2.2).

The MRDS analysis based on sightings from both East and West Greenland was truncated at 450m and at sea state <3 (this led to the exclusion of 4 observations) and was used to partially correct the estimates. A fully corrected MRDS estimate, including availability bias, was then developed for East Greenland (2,762, 95% CI: 1,160-6,574). However, the low number of sightings (n=12) and different detection distances prevented a similar estimate being developed for West Greenland, but a strip census estimate (truncated at 300m) provided a fully corrected estimate for West Greenland of 5,095 (95% CI: 2,171-11,961) minke whales.

Using the availability factor applied to the survey in 2015, a revised estimate of abundance for West Greenland in 2007 based on a previous aerial survey (Heide-Jørgensen *et al.,* 2010) was used to provide a new abundance estimate of 9,066 minke whales (95% CI: 4,333-18,973).

After review, the Workshop endorsed the use of these estimates (see Table 2) for use in conditioning as well as in the simulated application of the RMP. The Workshop **agreed** that these abundance estimates should be forwarded for approval by the ASI working group at the 2018 meeting of the Committee.

3.3.2.2 MIXING MATRICES

The Workshop noted that the mixing matrices reflected the outcomes of discussions that were focused on capturing uncertainties relevant to the application of the RMP to the C and E *Medium Areas*. Many of the values in the mixing matrices on which the current trials are based for the W-stock/W2-sub-stock were pre-specified owing to lack of information, with little basis. The Workshop **agreed** that it would be preferable to specify mixing proportions (e.g. the relative proportion of the C-stock animals in the WG sub-area in a given year) and estimate more entries of the mixing

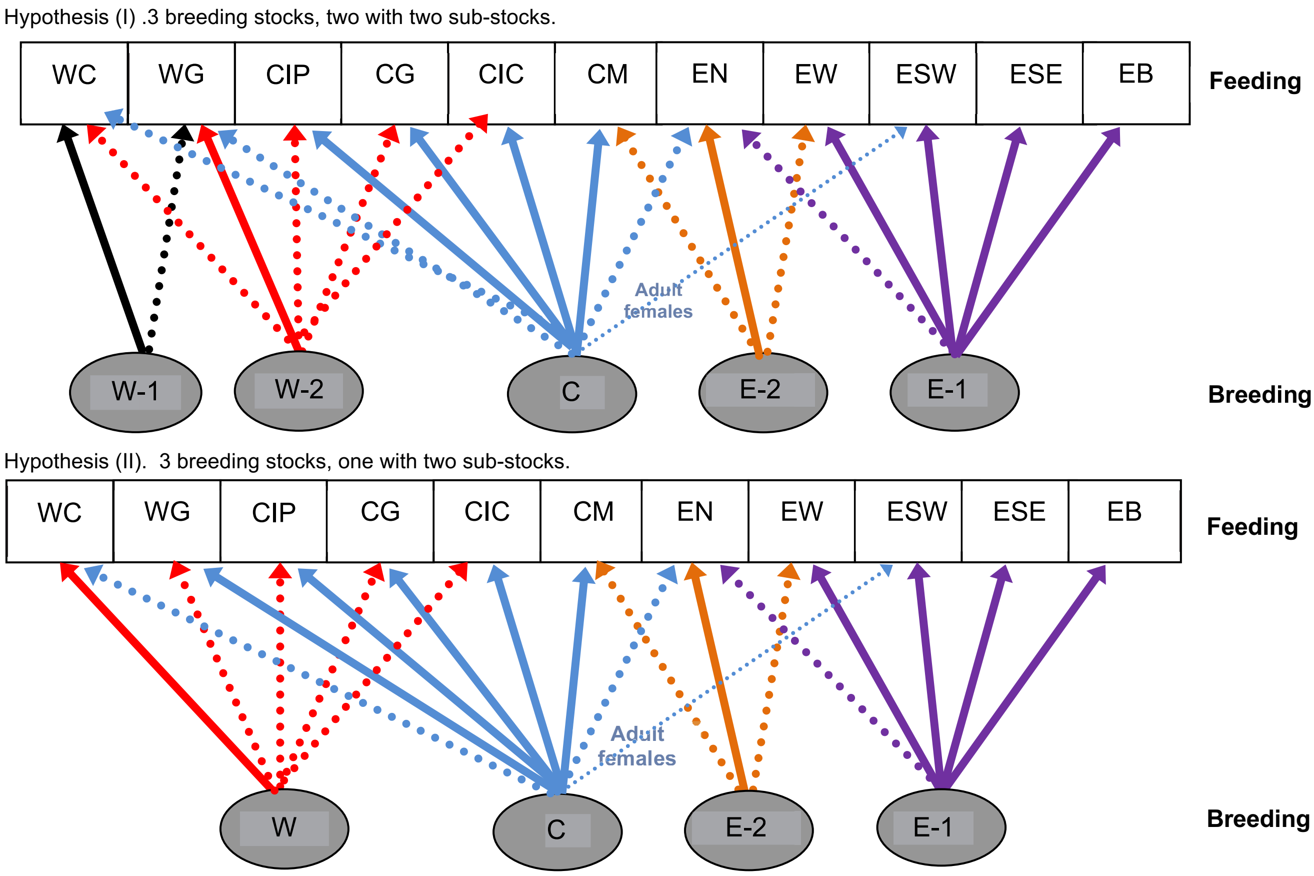

Fig. 2. Updated summary of the conceptual stock-structure hypotheses.

Table 2

Revised estimates of abundance for sub-areas CG and WG. The estimates in the 'New' columns are used in the trials. For the CG sub-area, the combined estimate is used. Information is provided about the 1987-8 and 1993 WG estimates, but these are not used in the trials.

Sub-area		Year	Old estimate	CV	Approx. 95% CI	New Estimate	CV	Approx. 95% CI
CG	1	2015	2,681	0.45	1,100-6,200	2,762	0.47	1,160-6,574
WG	2	2005	10,792	0.59	3,600-32,400			
WG	1	2007	9,853	0.43	4,433-21,900	9,066	0.39	4,333-18,973
WG	1	2015	5,241	0.49	2,114-12,992	5,095	0.46	2,171-11,961

matrices rather than set the values for the entries of the mixing matrices. The Workshop noted that the current specifications include 'high' and 'low' mixing matrices. However, these are averaged when used to project the operating model forward. The Workshop **agreed** that, for simplicity, only a single mixing matrix would be specified for each stock structure hypothesis. Table 3 lists the structure of the mixing matrices (the gs and Ws indicate estimable parameters).

The information needed to parameterize the mixing matrix (A) for stock structure hypothesis I are: the proportion of W-2 sub-stock animals in each of sub-areas WC, WG, CIP, CG and CIC, and the proportion of W-1 sub-stock animals in sub-areas WC and WG, while the information needed to parameterize the mixing matrix (B) for stock structure hypothesis II are: the proportion of W-stock animals in each of sub-areas WC, WG, CIP, CG and CIC (Table 3). The proportion of C animals in the different areas is then estimated from these proportions and the available abundance data.

Tiedemann outlined an approach for calculating the mixing proportions of W-stock animals in sub-areas CG, WG and CIC based on the available genetics data (SC/M18/AWMP-05). The Workshop thanked Tiedemann for this analysis, which provides a quantitative basis for specifying mixing proportions. There are several potential sources of uncertainty (and bias) that are not accounted for in the analyses in SC/M18/AWMP-05:

(a) Linear Discriminant Analysis rather than PCA could be a more appropriate approach for this problem;
(b) the classification should be based on normalized distance; to achieve this, Mahalanobis rather than Euclidean distance could be used – although it was noted that the PCA includes a normalization along the different PCs;
(c) it is unclear whether the classification should be prior-weighted by sample or population size;
(d) it is not clear how the data for 2007 (used as reference year) not being pure impacts the final results;
(e) there may be bias because each centroid is closer to the other than it should be, due to the samples for 2007 not being pure; and
(f) it is unclear how to deal best with different sample sizes in different years.

Given these and other uncertainties, the Workshop **agreed** that while trials should be conducted for the 'best' (rounded)

Table 3

The mixing matrices.

Stock structure hypothesis I (matrix A)

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W-1	1	γ_{10}	-	-	-	-	-	-	-	-	-
W-2	γ_{11}	1	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{16}	γ_{2}	γ_{3}	1	γ_{5}	γ_{4}	-	γ_{6}	-	-
Adult males (ages 10+) and juveniles											
W-1	Ω_{11}	$\gamma_{10}\Omega_{12}$	-	-	-	-	-	-	-	-	-
W-2	$\gamma_{11}\Omega_{11}$	Ω_{12}	$\gamma_{12}\Omega_{13}$	$\gamma_{13}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{16}\Omega_{12}$	$\gamma_{2}\Omega_{13}$	$\gamma_{3}\Omega_{14}$	Ω_{15}	$\gamma_{5}\Omega_{16}$	$\gamma_{4}\Omega_{17}$	-	-	-	-

Stock structure hypothesis II (matrix B)

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Adult females (ages 10+)											
W	1	γ_{11}	γ_{12}	γ_{13}	γ_{14}	-	-	-	-	-	-
C	γ_{15}	γ_{1}	γ_{2}	γ_{3}	γ_{4}	γ_{5}	1	-	γ_{6}	-	-
Adult males (ages 10+) and juveniles											
W	Ω_{11}	$\gamma_{11}\Omega_{12}$	$\gamma_{12}\Omega_{13}$	$\gamma_{12}\Omega_{14}$	$\gamma_{14}\Omega_{15}$	-	-	-	-	-	-
C	$\gamma_{15}\Omega_{11}$	$\gamma_{1}\Omega_{12}$	$\gamma_{2}\Omega_{13}$	$\gamma_{3}\Omega_{14}$	$\gamma_{4}\Omega_{15}$	$\gamma_{5}\Omega_{16}$	Ω_{17}	-	-	-	-

values for the mixing proportions in Annex H (i.e. during 2000-2016, 65% of the animals in the WG sub-area were from the W-stock; 60% of the animals in CG sub-area were from this stock; 30% of the animals in the CIC sub-area were from this stock) it was **agreed** that a broader range of values should be considered in the trials (0.55, 0.65, 0.80 for W-stock in the WG sub-area; 0.20, 0.30, 0.40 for the W-stock in the CIC sub-area) (Table 4). SC/M18/AWMP5 provides estimates for W-stock mixing proportions for the WC sub-area. However, the sample size for this sub-area is very low. The Workshop therefore a**greed** that the mixing proportions for the CIP sub-area would be set to those for the CIC sub-area while the mixing proportion for the WC sub-area would be set to that for WG sub-area. It also **agreed** that the values for the mixing proportions used for sensitivity testing would be paired to examine scenarios where (on average) the W- and C-stocks are concentrated and spread out.

Specification of trials for stock structure hypothesis I is based on the assumption that the mixing proportions specified for the W-stock for stock structure hypothesis II apply to the W-1 and W-2 sub-stocks combined. The Workshop **agreed** that the proportion of W-1 sub-stock animals in the WC sub-area should exceed that of W-2 sub-stock animals while the proportion of W-2 sub-stock animals in the WG sub-area should exceed that of W-1 sub-stock animals. It was therefore **agreed** to consider trials in which 80% and 93.75% of the W-stock animals in sub-area WC sub-area are from the W-1 sub-stock and the same proportions apply to the W-2 sub-stock in the WG sub-area (Table 4).

3.3.3 Alternative operating models

SC/O17/AWMP02 developed a stepping stone model with sex- and density-dependent migration to estimate potential immigration into the WG sub-area from other sub-areas in the western North Atlantic. Such a model is needed because the hunt of common minke whales in West Greenland is relatively large compared to the absolute abundance estimates for the WG sub-area, but the sex ratio is unchanged over time and female biased, indicating that the hunt is sustainable. This, combined with a female biased sex ratio for the early Norwegian catches that were taken further offshore, implies that the hunt is likely to be supported by whales from other sub-areas. The model behaved as

Table 4

The mixing proportions for use in the trials.

(a) Stock structure hypothesis I

Scenario	(and basis)	MSYR	Proportion of W-1 stock in sub-area		Proportion of W-2 stock in sub-area				
			WC	WG	WC	WG	CIP	CG	CIC
A1: Base line	(80% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.13	0.13	0.52	0.30	0.60	0.30
A2:	(94% of B1 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.60	0.05	0.05	0.60	0.30	0.60	0.30
A3: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.15	0.15	0.65	0.20	0.70	0.20
A4:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.75	0.05	0.05	0.75	0.20	0.70	0.20
A5: Concentrated	(80% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.45	0.10	0.10	0.45	0.40	0.50	0.40
A6:	(94% of B2 W stk)	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.52	0.03	0.03	0.52	0.40	0.50	0.40

(b) Stock structure hypothesis II

Scenario	MSYR	Proportion of W stock in sub-areas				
		WC	WG	CIP	CG	CIC
B1: Best	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.65	0.65	0.30	0.60	0.30
B2: Concentrated	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.80	0.80	0.20	0.70	0.20
B3: Spread out	$MSYR_{1+}$ = 1% & $MSYR_{mat}$=4%	0.55	0.55	0.40	0.50	0.40

expected, and illustrates the potential for reconciling the abundance and catch sex-ratio data for common minke whales in the western North Atlantic. The structure of the model setup, however, is not straightforward. The current abundance and catch data for Canada, West Greenland, and the western part of the central North Atlantic (sub-areas CG and CIP) leads to insufficient migration to adequately fit the abundance estimates off West Greenland. This raises the question of delineation to the east, and/or immigration from the west.

The Workshop thanked Witting for developing this model, which is somewhat similar to the alternative operating models for common minke whales in North Atlantic identified by the Scientific Committee at its 2017 meeting. The model results confirm that the catch sex-ratio data and the abundance estimates are in conflict, because estimated abundance for the WG sub-area from the operating model is higher than the observed survey estimates of abundance, particularly when more emphasis is placed on the sex-ratio data. The Workshop noted that most model configurations only allow for dispersal (permanent migration of individuals between stocks) between two stocks, unlike the alternative models developed in 2017 that allow for dispersal among the W-1 sub-stock, the W-2 sub-stock and the C stock. In addition, the models in SC/O17/AWMP2 do not account for the CIC sub-area.

The Workshop was **agreed** that operating model variants that allow for density-dependent mixing should be fitted to the catch sex-ratio data for the WG, CG and CIC sub-areas for 1994-2015 under the assumption the standard errors of the logits of the sex-ratios for these sub-areas are respectively 0.246, 1.44 and 0.859 (the standard deviations of the residuals about a global mean by sub-area).

The Workshop noted that the specifications in IWC (2017) assume that the extent of density-dependence in dispersal between two stocks depends on the ratio of the depletions of the two stocks. This is equivalent to whales 'seeking' to make depletion constant among the W-1 sub-stock, the W-2 sub-stock and the C stock (for stock structure hypothesis II). However, an alternative hypothesis is that the probability of whales not dispersing would be higher when they are close to carrying capacity. The Workshop **recommended** that an additional operating model be developed as part of the next *Implementation Review* that reflects this alternative hypothesis, recognising that both assumptions of how dispersal operate are approximations to the actual situation.

3.3.4 Final trials structure

The Workshop considered the trials that will be used to evaluate candidate *SLA*s for minke whales off West and East Greenland. It identified six factors (MSYR, number of W-stock sub-stocks, mixing rates, whether allowance is made for density-dependent mixing, the bias of surveys, the survey interval, and the CVs of future surveys) and levels for each (Table 5). The levels were selected based on past decisions by the Committee, past trials to evaluate *SLA*s, and the discussions within the SWG. The Workshop noted that the trials for North Atlantic minke whales developed to evaluate RMP variants were complex and that interpretation of the results from trials with time-varying carrying capacity, time-varying natural mortality and episodic events would be difficult. It therefore **agreed** to consider only *Evaluation Trials* for this case, ignoring *Robustness Trials* that incorporated time-varying parameters and episodic events.

Table 6 lists the set of trials and recommended that initial development of *SLA*s be based on trials 1-9 (each run for two levels of MSYR). These trials include six base-case trials (two levels of MSYR and three scenarios regarding mixing proportions).

The Workshop **agreed** that instead of applying the RMP to set the annual catch limits by sub-area and year for each simulation, the RMP catch limits would instead be pre-specified, with trial-specific catch limits by year based on the two Baseline Hypothesis 1 trials (M01-1 and M01-4). Pre-specifying the RMP catches will allow the trials to run more quickly, giving the developers more time to identify an *SLA* that satisfies the Commission's objectives. The trials used to calculate the RMP catches will involve (a) using the interim *SLA* to set the strike limit for the WG sub-area, (b) setting the strike limit to 20 for the CG sub-area and (c) applying RMP Variant 5 to determine RMP catch limits, but capping the CIC catch at 100 whales. The cap is introduced because catches in the CIC sub-area have the most impact on stocks in the WG sub-area, and the catch being set is much higher than is currently taken (the highest annual catch in the CIC sub-area since 1986 is 81 whales).

Need envelopes are a constant 164 (A), increasing from 164 to 250 over the 100-year period (B) and increasing from 164 to 350 over the 100-year period (C).

3.3.5 Conditioning

The Workshop **agreed** that it was necessary to ensure that the conditioning leads to the model predictions matching the above specifications, and **agreed** the mixing proportions should be fixed (not generated) in the conditioning process and assigned low CVs.

The Workshop developed a series of diagnostics plots to evaluate the ability to condition to the operating models. These included plots of the specified mixing proportions (i.e. the target proportion of the total (1+) numbers in a given sub-area that belong to a particular stock averaged over the years 2008-2013), along with the distribution over replicates for the model predictions (see Annex I for an example) and plots of observed and operating model-predicted sex-ratios. The Workshop also developed plots to understand and review the resulting mixing matrices (see Annex I). These plots illustrate the entries in the mixing matrices as well as the

Table 5

Factors considered in the *Evaluation Trials*. The base-case values are indicted in bold. Note: different Need scenarios are not included.

Factor	Values
MSYR	1% (1+), 4% (mature), 4% (1+)
Number of W-sub-stocks	2 (stock hypothesis I); 1 (stock hypothesis II)
Scenarios regarding mixing proportions	A1, A2, A3, A4, A5, A6, B1, B2, B3
Mixing	Density-independent[1], density-dependent
Survey bias	0.8, 1, 1.2
Survey period	10, 15
Survey CV (difference from the average CV)	-0.05, 0, 0.05

1: Default until additional trials are coded and evaluated.

Table 6

The final set of trials.

Trial	MSYR	Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
M01	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base	Yes
M02	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base	Yes
M03	1% (1+) & 4 % (mat)	1	A2	Independent	1	10	Base	Yes
M04	1% (1+) & 4 % (mat)	1	A3	Independent	1	10	Base	Yes
M05	1% (1+) & 4 % (mat)	1	A4	Independent	1	10	Base	Yes
M06	1% (1+) & 4 % (mat)	1	A5	Independent	1	10	Base	Yes
M07	1% (1+) & 4 % (mat)	1	A6	Independent	1	10	Base	Yes
M08	1% (1+) & 4 % (mat)	2	B2	Independent	1	10	Base	Yes
M09	1% (1+) & 4 % (mat)	2	B3	Independent	1	10	Base	Yes
~~M10~~	~~1% (1+) & 4 % (mat)~~	~~2~~	~~B4~~	~~Independent~~	~~1~~	~~10~~	~~Base~~	~~Yes~~
M11	1% (1+) & 4 % (mat)	1	A1	Density-dependent	1	10	Base	Yes &
M12	1% (1+) & 4 % (mat)	2	B1	Density-dependent	1	10	Base	Yes &

Come back to these additional trials intersessionally:

MSYR	Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
1% (1+) & 4 % (mat)	1	A1	Independent	0.8	10	Base	*
1% (1+) & 4 % (mat)	2	B1	Independent	0.8	10	Base	*
1% (1+) & 4 % (mat)	1	A1	Independent	1.2	10	Base	*
1% (1+) & 4 % (mat)	2	B1	Independent	1.2	10	Base	*
1% (1+) & 4 % (mat)	1	A1	Independent	1	15	Base	
1% (1+) & 4 % (mat)	2	B1	Independent	1	15	Base	
1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base + 0.05	
1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base + 0.05	
1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base - 0.05	
1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base - 0.05	
4% (1+)	1	A1	Independent	1	10	Base	*
4% (1+)	2	B1	Independent	1	10	Base	*

breakdown of the numbers at carrying capacity in each sub-area by stock/sub-area and sex.

The Workshop reviewed the conditioning diagnostics and **agreed** that the conditioning has been achieved satisfactorily.

3.4 Work plan

(1) Allison to revise the code for the plots to evaluate the mixing matrices so that the total area of the circles is similar among sub-areas.
(2) Allison to develop a diagnostic plot showing the fit to the sex ratio data.
(3) Brandão and Witting to develop candidate *SLA*s.

4. *SLA* DEVELOPMENT FOR THE GREENLANDIC HUNTS: BOWHEAD WHALES

Given time constraints, the Workshop ***agreed*** *to discuss the issues of the number of replicates and the 'interim relief' further at the 2018 Annual Meeting.*

5. PROGRESS WITH REVIEW OF THE PROPOSED MAKAH HUNTING STRATEGY

Donovan noted that the US government had developed a new Makah Management Plan for the proposed gray whale hunt. This will be discussed at the Gray Whale Rangewide Workshop from 28-31 March 2018.

6. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)

6.1 Summary of discussions at SC67a

The Aboriginal Whaling Scheme (AWS) is a set of protocols and provisions that augment the technical application of an AWMP *Strike Limit Algorithm* (*SLA*), such as requirements for timely abundance estimates and data sharing. A key component of the AWS is a carryover provision, namely how unused strikes from previous years may be used in subsequent years in addition to the normal strike limit. At present, carryover provisions are included in an *ad hoc* hunt-specific manner in the *Schedule* (see IWC, 2018a, pp.169-72).

With respect to carryover provisions, the Scientific Committee (Committee) had agreed in 2017 (IWC, 2018, p.16) that:

(a) Donovan should summarise the work the Committee has done so far at the Commission's ASWWG workshop (which will meet from 10-13 April 2018); and
(b) attention should be drawn to the willingness of the Committee to review any options referred to it at or before the 2018 Scientific Committee meeting.

The Committee had agreed that development of the full AWS would be included on the agenda of the intersessional AWMP Workshops, and established an intersessional correspondence group to review the existing AWS draft and provide a discussion document.

6.2 Discussions at the October 2017 AWMP Workshop

At the October Workshop, discussion of AWS provisions was limited to carryover. An enquiry from the Acting USA Commissioner prompted consideration of three topics:

(1) sustainability constraints on carryover provisions, and specific hypothetical provisions for BCB bowheads;
(2) the degree of specificity of carryover provisions; and
(3) the roles of the Committee and Commission in approving or determining carryover.

Topic (1) pertains to the type of carryover provisions that could be endorsed by the Committee without further scientific analysis because, in the Committee's judgment, the provisions would not jeopardise stock conservation goals.

During the initial development of *Strike Limit Algorithms*, at the suggestion of the Committee, 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.'

In 2017, the Committee recognised that its:

> '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. 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.' (IWC, 2018, p.16)

For example, for a 6-year block strike limit of 600 strikes with a corresponding annual limit of 100 strikes, no more than 150 (i.e. 50% more than 100) strikes could be taken in any single year, assuming sufficient carryover strikes (i.e., at least 50) were available at that time for use. If more than 100 strikes were taken in some years, then fewer than 100 would need to be taken in other years to avoid exceeding 600 strikes for the block. The Workshop reaffirmed this 50% allowance and recommended that such guidance be included in the final AWS proposed by the Committee in 2018.

A second guideline established by the Committee in 2017 arose because:

> 'it was important to establish an initialisation year for the carryover calculations to begin. [The Committee] agreed that this was a matter for the Commission but agreed 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).'

The Workshop deferred review of this guideline until its March 2018, meeting.

Finally, the Workshop considered how long carryover strikes could be held, unused, before expiring. It **agreed** that unused strikes must expire, eventually, so that allowable catches remain linked to stock status. Givens noted that an explicit guideline would be helpful for whaling countries to develop carryover proposals, and that the initialisation window mentioned above is inherently linked to any expiration limit.

As an example of evaluating such guidelines, the Workshop considered a hypothetical proposal by the USA for BCB bowhead whales, comprised of the following components: annual usage of carryover strikes limited to 50% of the annual strike limit; unused strikes began accumulating in 2003 (when the *Bowhead SLA* was first used); and unused strikes never expire. The Workshop **agreed** that the first two components were compatible with past Committee guidelines, but the third component (no expiration) would require further testing if it was proposed and would probably be scientifically untenable.

With respect to topics (2) and (3) above (specificity and roles), the Workshop viewed the Committee's role as establishing principles guiding carryover that would ensure, as a minimum, that they posed no risk to the population, rather than specific rules or numbers. The Workshop re-emphasised that the ultimate decision about specific carryover proposals rests with the Commission.

The Workshop noted that aboriginal subsistence whaling countries could benefit from describing desired carryover provisions to the Committee in advance of a Commission meeting where limits are to be established, although this is not required. The Committee could then review the proposed carryover provision and offer its scientific assessment on whether the proposal would meet management objectives, particularly maintaining acceptable stock conservation. Considering that aboriginal hunting limits will next be established at the 2018 Commission meeting, any such review would occur at the 2018 Committee meeting, if not earlier. Submitting a proposal to the March 20-24, 2018, intersessional AWMP Workshop would allow for preliminary review and possible amendment before the April 10-13, 2018, ASW meeting or the 2018 Committee meeting. In order to provide helpful advice, a proposer would need to specify, at a minimum, information about:

(1) the number of unused strikes considered to be accumulated (or the year accumulation began) before AWS initialisation;
(2) how further unused strikes are accumulated during a quota block;
(3) the system, if any, by which carryover and ordinary strikes are distinguished, tracked and used;
(4) how past carryover is capped or expires, if at all; and
(5) any limit on the number of carryover strikes that could be used in a single year in addition to the normal strike limit for that year.

With respect to item (3), the Workshop also considered that it might be important to clarify whether strikes carried forward into a new year are the first strikes (or last strikes) used in that year, if a distinction between the two types of strikes is maintained. As Convenor of the AWMP Working Group, Donovan could advise what information would be helpful for reviewing a carryover proposal that does not fit neatly in the above framework.

The Workshop **agreed** the following workplan:

(1) *Winter, 2017-18:* Intersessional correspondence group addresses any topics that arise and prepares draft AWS provisions.
(2) *March 20-24, 2018, intersessional AWMP Workshop:*
   (a) in-depth consideration of carryover guidelines and provisions;
   (b) receive any specific carryover proposals from ASW countries and provide a preliminary assessment of their scientific acceptability and assess whether full evaluation of a proposal would require technical analysis by the Committee; and
   (b) review the draft AWS provided by the intersessional correspondence group.
(3) *2018 Scientific Committee meeting:* Finalise the proposed AWS for recommendation to the Commission. Receive any carryover proposals from ASW countries and assess their scientific acceptability.

6.3 Discussions at the March 2018 Workshop

6.3.1 Carryover

At the March 2018 Workshop, the AWMP Working Group received a joint request from the US Acting Commissioner and the Danish Commissioner for a Committee assessment of the conservation performance and other scientific issues associated with a specific carryover scheme (see Annex F, Appendix for the full request). Specifically, they asked the Scientific Committee to evaluate a hypothetical three-block carryover provision, which would:

> …allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit.

The US and Denmark noted that this inquiry did not commit the countries to any specific proposals, but instead was intended to gain a sense from the Workshop about the conservation consequences of carryover. The Workshop noted that this provision specified (i) a period of accumulation (three blocks), (ii) a time until expiration (greater than three blocks), and (iii) a limit on usage (total strikes not exceeding 150% of the annual strike limit). In addition to evaluating the provisions of the US/Denmark scheme, the Workshop **agreed** that it would examine potential carryover provisions with different periods of accumulation, primarily focusing on the potential differences in the dynamics and levels of sustainability of the different carryover systems.

SC/M18/AWMP04 described a distinction between non-accumulating, semi-accumulating and accumulating carryover systems. In accordance with the Schedule, the US applies an accumulating carryover scheme for the harvest of BCB bowhead whales. Greenland uses a non-accumulating system for its harvests. SC/M18/AWMP04 also noted that it can be important to specify the order in which the carryover is used. Two approaches would be either to use all carryover before depleting baseline strikes ('first in, first out'), or to use all baseline strikes before depleting carryover ('last in, first out'). The conservation performance of other alternatives was expected to lie between that of these two options.

Non-accumulating systems allow only for the carryover of unused strikes from one year to the next (between years within a block, and/or between the last year of one block and the first year of the next).

A semi-accumulating carryover system allows for an accumulation of unused strikes across several years within a block, but most of the accumulation cannot be carried forward to the next block. The following is an example of a semi-accumulating system. Suppose only 50% of the *SLA's* annual strike limit is used in the first two years of a block. Then the system will carry the accumulation of unused strikes, namely 100% of the annual limit, forward for future use, but only 50% of these can be added to the baseline strike limit in any subsequent year. When the end of the current block is reached, the system will carry only up to 50% of the baseline strike limit (i.e., 'one year's worth') forward into the next block, as for the non-accumulating approach. Any remaining unused strikes are lost for future use.

Accumulating carryover systems allow for an accumulation of unused strikes both within a block and over one or more past blocks. To maintain sustainable management, there must be a limit to the accumulation of unused strikes. This limit can be specified either as a cap on the total accumulation that can be held as carryover, as a limit on the accumulation period, as a longevity before an accumulated unused strike expires, or some combination of these. The US/Denmark request for advice incorporated a system that accumulates unused strikes over three block periods. It was noted that if this proposal was implemented in 2019 for BCB bowhead whales, this would correspond to accumulating unused strikes from the time the *Bowhead SLA* began being used for management, namely 2003. In subsequent blocks, the earliest block of unused strikes would be 'lost'.

SC/M18/AWMP04 describes practical implications of carryover, noting that the reserve of unused strikes that is carried forward is strongly dependent on the carryover system. Given a 50% limit on the addition of unused strikes to any year, the non-accumulating and semi-accumulating systems can carry no more that 50% of the annual baseline into a new block, i.e., 8% of a total block given six-year block periods. For a three-period accumulating carryover provision where 75% of a constant baseline is taken annually over a longer period of time, the carryover of 8% increases to 75% for 'last in, first out', and 225% for 'first in, first out'.

Any carryover system will ensure that the long-term total harvest does not exceed the corresponding baseline strike limit. However, carryover schemes can allow for strikes taken to exceed the baseline limit temporarily (for which there must be compensatory underutilization before or after that period). A harvest that is 50% above the baseline is possible only for one year in the non-accumulating system. Dependent upon the actual harvest pattern, differences in carryover systems will likely lead to some differences in need satisfaction and conservation performance. Quite generally, one would expect a somewhat greater need satisfaction in hunts with a carryover system, relative to hunts with no carryover. Likewise, an increase in need satisfaction is expected with an increase in the allowed accumulation of the carryover. This will also affect conservation performance, at least to a small degree. However, it is essential to note that the simulation trials that are used to evaluate *SLA*s assume that the whole annual strike limit is taken. Since the long-term harvest is smaller than or equal to the baseline for all carryover systems, the conservation performance of an actual subsistence harvest may be no worse than the performance of harvest when all strikes are taken. It is potentially possible for up to four years for semi-accumulating carryover. While it is theoretically possible for a much longer period (up to 23 years) for a three-period accumulating carryover system this would not happen in reality as it would require a specific and unrealistic hunting patterns that in any case would be picked up during *Implementation Reviews*.

The Workshop **agreed** that the one-year delay of a non-accumulating system will have negligible effect on stock status. Noting the 50% interannual variation limit endorsed by the Committee, it is clear that a semi-accumulating system will also not degrade the performance of an *SLA* since the feedback lag between strike limit calculation and harvest will be a few years at most. However, an accumulating system has the potential to stretch that lag to one or several blocks. The dynamics of the harvest, and thus also to some degree of the population, is changed by the delay in the response time of the overall management system (i.e. the *SLA* plus the carryover system) that is introduced in accumulating carryover systems. Because this introduces a delay in the overall management system, the conservation performance of an accumulating carryover system must be more carefully examined. Hence, the Workshop **agreed** to conduct an evaluation of conservation performance for accumulating carryover of up to three block periods using simulation testing.

Full specifications of the simulation testing framework are given in Annex F. Briefly, the initial testing was completed for the *Bowhead SLA* for Bering-Chukchi-Beaufort Seas bowhead whales and the *Humpback SLA* for West Greenland humpback whales. A work plan was established to conduct analogous tests for the remaining *SLAs*. Over the 100 year simulation period, three carryover schemes were tested. First, trials were designed with no block-to-block carryover, and within-block strikes used as quickly as possible subject to the 150% limit. The Workshop **agreed** that these trials were an extreme case of the non-accumulating system and sufficed to evaluate that scheme. The second set of trials simulated an accumulating system where unused strikes from the previous block could be carried forward and used in the next. The third set of trials resembled the second, but unused strikes could be accumulated from three prior blocks. The

Table 7

Simulation results comparing carryover schemes. A full description of the schemes is given in Annex F. Briefly, they are Baseline taken annually, within-block frontloading, two cases with accumulation from one prior block, and two cases with accumulation from three prior blocks. See the text for more details. The statistics, pertaining to the age 1+ population, are D1 (final depletion), D10 (relative increase), and R1 (relative recovery). For each, the 5th percentile (.05) and median (.50) are given. These results are shown for four *Bowhead SLA Evaluation Trials*.

Trial	Scheme	$D1_{1+}$(.05)	$D1_{1+}$(.50)	$D10_{1+}$(.05)	$D10_{1+}$(.50)	$R1_{1+}$(.05)	$R1_{1+}$(.50)
BE01							
	Baseline taken annually	0.86	0.87	1.16	1.23	1.00	1.00
	Frontloaded	0.87	0.87	1.17	1.24	1.00	1.00
	1@67%, 1@≤150%	0.86	0.87	1.17	1.23	1.00	1.00
	1@80%, 1@≤150%	0.86	0.87	1.17	1.23	1.00	1.00
	3@67%, 2@≤150%	0.85	0.86	1.15	1.22	1.00	1.00
	3@80%, 2@≤150%	0.86	0.87	1.16	1.23	1.00	1.00
BE12							
	Baseline taken annually	0.23	0.34	0.71	1.03	0.46	0.55
	Frontloaded	0.22	0.34	0.69	1.03	0.46	0.54
	1@67%, 1@≤150%	0.22	0.35	0.69	1.06	0.47	0.55
	1@80%, 1@≤150%	0.22	0.34	0.69	1.04	0.46	0.54
	3@67%, 2@≤150%	0.23	0.35	0.72	1.06	0.49	0.56
	3@80%, 2@≤150%	0.23	0.34	0.72	1.04	0.47	0.55
BE13							
	Baseline taken annually	0.38	0.45	1.22	1.32	0.55	0.62
	Frontloaded	0.38	0.44	1.21	1.32	0.54	0.61
	1@67%, 1@≤150%	0.38	0.45	1.22	1.32	0.55	0.62
	1@80%, 1@≤150%	0.38	0.45	1.22	1.32	0.55	0.62
	3@67%, 2@≤150%	0.39	0.45	1.25	1.34	0.57	0.63
	3@80%, 2@≤150%	0.38	0.45	1.23	1.33	0.56	0.62
BE16SE							
	Baseline taken annually	0.41	0.53	0.85	1.06	0.76	0.86
	Frontloaded	0.41	0.54	0.85	1.06	0.76	0.86
	1@67%, 1@≤150%	0.43	0.54	0.87	1.07	0.77	0.86
	1@80%, 1@≤150%	0.42	0.54	0.86	1.07	0.76	0.86
	3@67%, 2@≤150%	0.43	0.55	0.89	1.08	0.78	0.88
	3@80%, 2@≤150%	0.42	0.54	0.86	1.06	0.77	0.86

Workshop **agreed** that these trials also sufficed to evaluate a scheme with accumulation from two prior blocks, as such results could be interpolated from the other trials.

The *Bowhead SLA Evaluation Trials* examined were BE01, BE12, BE13, and BE16SE. For West Greenland humpbacks, the *Evaluation Trials* were GH01BC, GH05BC, GH06BC, GH07BC and GH08BC. Trials BE01 and GH01BC are baseline trials, and the others are some of the most difficult trials in terms of maintaining adequate conservation performance. See Annex F for further description of the trials.

Tables 7 and 8 present the results of these simulations. The evaluation statistics shown here are D1, D10 and R1[2]. These statistics summarize conservation performance, i.e. depletion and recovery. No statistics about need satisfaction are given because carryover schemes will never allow for a long-term average catch that is larger than the *SLA* allows. Need satisfaction for each *SLA* without carryover was already deemed acceptable when the *SLAs* were adopted. For each tabled statistic, the 5th percentile and median value are shown.

The Workshop **agreed** that the results in Tables 7 and 8 show that the conservation and recovery performance of the tested carryover schemes are almost identical to the cases where the full strike limits are taken (under the *Bowhead SLA* or the *WG-Humpback SLA*, respectively). Thus, for these two hunts, the carryover provision described in the US/Denmark enquiry (Annex F, Appendix), namely accumulating carryover from three prior blocks with the 150% annual usage limit, meets the conservation and management objectives set by the Commission. This is also true for the non-accumulating Greenland carryover scheme. Results for other *SLA*s will be produced according to the workplan (see Item 7).

The five carryover schemes in Tables 7 and 8 are fully specified in Annex F. Briefly, 'baseline taken annually' refers to the case where all the annual strikes limits of a *SLA* are taken annually (in fact, this is extremely unlikely to occur in reality due to the variability in hunting conditions that originally led to the 'carryover' concept). This corresponds to the *Evaluation Trials* for BCB bowheads and West Greenland humpbacks. The 'frontloaded' scheme assumes that strikes are taken as quickly as possible within a block, subject to the 150% limit. It serves as a bounding case for evaluating a non-accumulating scheme. The scheme '1@67%, 1@≤150%' alternates between carryover accumulation and usage blocks: first only 67% of the strike limit is taken, then up to 150% of the strike limit is used. The scheme '1@80%, 1@≤150%' resembles the previous, but it assumes that 80% of the strike limit is taken in the accumulation block. The scheme '3@67%, 2@≤150%' refers to a scheme with three accumulation blocks (with 67% strike limit usage) followed by two carryover usage blocks (using up to 150% of the baseline strike limit). Finally, the '3@80%, 2@≤150%' scheme resembles the previous one, but 80% of the strike limit is taken during the accumulation blocks.

[2] D1. Final depletion: P_T/K.
D10. Relative increase of 1+ population size, P_T/P_0.
R1. Relative recovery: where is the first year in which P_t^* passes through *MSYL*. If P_t^* never reaches *MSYL*, the statistic is P_T/P_t^*. If P_0>*MSYL* the statistic is min (1, P_T/*MSYL*).

Table 8

Simulation results comparing carryover schemes. A full description of the schemes is given in Annex F. Briefly, they are baseline taken annually, within-block frontloading, two cases with accumulation from one prior block, and two cases with accumulation from three prior blocks. See the text for more details. The statistics, pertaining to the age 1+ population, are D1 (final depletion) and D10 (relative increase). For each, the 5th percentile (.05) and median (.50) are given. These results are shown for four *West Greenland Humpback SLA Evaluation Trials*.

Trial	Scheme	$D1_{1+}(.05)$	$D1_{1+}(.50)$	$D10_{1+}(.05)$	$D10_{1+}(.50)$
GH01BC					
	Baseline taken annually	0.87	0.95	1.85	5.58
	Frontloaded	0.87	0.96	1.86	5.59
	1@67%, 1@≤150%	0.87	0.96	1.85	5.58
	1@80%, 1@≤150%	0.87	0.96	1.85	5.59
	3@67%, 2@≤150%	0.87	0.96	1.85	5.58
	3@80%, 2@≤150%	0.87	0.96	1.85	5.59
GH05BC					
	Baseline taken annually	0.85	0.95	2.04	5.95
	Frontloaded	0.86	0.95	2.05	5.97
	1@67%, 1@≤150%	0.85	0.95	2.04	5.96
	1@80%, 1@≤150%	0.85	0.95	2.04	5.96
	3@67%, 2@≤150%	0.85	0.95	2.04	5.95
	3@80%, 2@≤150%	0.85	0.95	2.04	5.96
GH06BC					
	Baseline taken annually	0.96	1.04	2.00	6.05
	Frontloaded	0.97	1.04	2.01	6.07
	1@67%, 1@≤150%	0.97	1.04	2.00	6.06
	1@80%, 1@≤150%	0.97	1.04	2.00	6.06
	3@67%, 2@≤150%	0.96	1.04	2.00	6.06
	3@80%, 2@≤150%	0.97	1.04	2.00	6.06
GH07BC					
	Baseline taken annually	0.85	0.92	1.77	5.36
	Frontloaded	0.84	0.92	1.78	5.37
	1@67%, 1@≤150%	0.85	0.92	1.78	5.36
	1@80%, 1@≤150%	0.84	0.92	1.78	5.36
	3@67%, 2@≤150%	0.85	0.92	1.77	5.36
	3@80%, 2@≤150%	0.85	0.92	1.78	5.36
GH08BC					
	Baseline taken annually	0.85	0.97	1.54	4.86
	Frontloaded	0.85	0.98	1.55	4.88
	1@67%, 1@≤150%	0.85	0.97	1.54	4.87
	1@80%, 1@≤150%	0.85	0.97	1.55	4.87
	3@67%, 2@≤150%	0.85	0.97	1.54	4.87
	3@80%, 2@≤150%	0.85	0.97	1.54	4.87

Annex F explains why the five schemes in this table suffice to evaluate, *inter alia*, the existing Greenland carryover scheme, the proposal described in the US/Denmark enquiry, and other accumulating schemes with accumulation periods less than 3 prior blocks.

The Workshop noted that a key component of an AWS is the holding of regular *Implementation Reviews* with the option for emergency *Implementation Reviews* under special circumstances (IWC, 2013). Such reviews should also monitor the application of hunt-specific carryover systems. In particular, if with the inclusion of new abundance data, application of the *SLA* indicates that the strike limit must be severely reduced, this would almost certainly trigger an *Implementation Review* to understand the reasons for the strike limit reduction, assess stock status and consider whether additional measures should be taken, including the possibility of a reduction in carryover. This could be done by reducing the future accumulation of unused strikes, reducing the number of previously unused strikes held in reserve, or reducing the rate at which previously unused strikes may be used.

Broadly, the quantitative evaluation of carryover provisions for a stock may yield several possible outcomes. First, the Committee may judge that the carryover provision retains acceptable conservation performance compared to what the relevant *SLA* provides without carryover. For example, the Workshop has evaluated the conservation implications of the US/Denmark request for advice and **agreed** that the conservation performance of this carryover provision for BCB bowheads and West Greenland humpbacks is acceptable. Second, conservation performance on the trials may be ambiguous or not fully acceptable. In this case the Committee may be able to (i) recommend provisions on an interim basis while further analysis is undertaken, or (ii) suggest limiting bounds for acceptable carryover provisions, e.g. requiring an *Implementation Review* to examine carryover provisions if the Commission approves a substantially higher need request from the whaling country.

The Workshop **suggests** that whatever approach is agreed for carryover, rather than trying to incorporate detailed carryover scheme provisions/formulae in the Schedule, it would be most straightforward if the Scientific Committee, with the help of the Commission and relevant ASW countries, uses those provisions to generate specific numbers for each hunt that can be incorporated directly into the Schedule as necessary.

6.3.2 Draft Aboriginal Whaling Scheme

The Workshop received a draft AWS from the intersessional correspondence group (SC/M18/AWMP01). The carryover section of this document was incomplete; Givens provided a separate document with suggested wording for the remainder (SC/M18/AWMP/02). Witting provided SC/M18/AWMP04 which also contained information relevant for the AWS carryover section. After discussion, the Workshop revised the draft and asked Givens and Witting to lead an effort to add draft AWS carryover text so that a comprehensive draft AWS could be presented to the 2018 Scientific Committee. Draft language will be circulated to Workshop participants in advance of the Committee meeting for additional comment.

6.3.3 Creation of a buffer year

In addition to their carryover enquiry (Annex F, Appendix 1), the US and Denmark requested advice on the following:

> Additionally, we would like the AWMP workshop to consider the potential application of a one-time seven-year block for all ASW catch limits. This would create a 'buffer year' between the year in which the Commission approves catch limits and the year in which those catch limits take effect in order to: (a) reconcile the timing of Commission meetings with the 'objections' procedure where Schedule amendments may not become effective until after the start of the hunting season in the following year; and (b) provide time for an intersessional meeting should the Commission fail to agree upon catch limits at its regular meeting. After this one-time seven-year extension, all future catch limit renewals would be in six-year extensions so that all future catch limit renewals would benefit from the 'buffer year.'

The Workshop **agreed** that a one-time 7-year block would pose no conservation risk for any ASW stock. It emphasized that future blocks should revert to six years.

7. WORKPLAN

The Workshop agreed that the progress made at this Workshop should be incorporated into the work of the intersessional correspondence group that will report to SC67b.

8. OTHER BUSINESS

8.1 Progress with using *ISTs* to determine status

There had been insufficient time for the runs identified during previous discussions to be undertaken. The issue that will be on the agenda at SC67b.

9. ADOPTION OF THE REPORT

The final report was adopted by email, recognising that some of the technical annexes would take time to complete.

Before the March 2018 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 and efficient assistance with logistics, especially with respect to dining.

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Annex A

List of Participants

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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. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: FIN WHALES
    2.1 Summary of discussions at SC/67a
    2.2 Updated abundance estimate information
    2.3 Final Trial Structure
    2.4 Conditioning
    2.5 Description of new or updated SLAs
    2.6 Consideration of results with full trial set
    2.7 Conclusions and recommendation

3. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: COMMON MINKE WHALES
    3.1 Summary of discussions at SC/67a
    3.2 Stock Structure and new genetic information
    3.3 Final Trial Structure
    3.4 Work plan

4. SLA DEVELOPMENT FOR THE GREENLANDIC HUNTS: Bowhead whales

5. Progress with review of the proposed Makah hunting strategy

6. ABORIGINAL WHALING MANAGEMENT SCHEME (AWS)
    6.1 Summary of discussions at SC67a
    6.2 Discussions at the October 2017 AWMP Workshop
    6.3 Discussions at the March 2018 AWMP Workshop

7. SUMMARY OF WORK PLAN

8. OTHER BUSINESS

9. ADOPTION OF REPORT

Annex C

List of Documents

SC/O17/AWMP01: Witting, L. Updated candidate *SLA* for West Greenland fin whales.

SC/O17/AWMP02: Witting, L. A stepping stone model for common minke whales in the western North Atlantic

SC/O17/AWMP03 Brandao, A. Plots for baseline evaluation trials for the selected *SLA* for West Greenland bowhead whales based on 400 simulations

SC/M18/AWMP01: G.H. Givens, C. Allison, G. Donovan, J.C. George, J. Scordino, M. Stachowitsch, R. Suydam, R. Tiedemann, L. Witting. Draft language for the Aboriginal Whaling Scheme

SC/M18/AWMP02: G.H. Givens. Proposed carryover language for the draft Aboriginal Whaling Scheme

SC/M18/AWMP03: L. Witting. A potential *SLA* for West Greenland fin whales

SC/M18/AWMP04: L. Witting: On banks in management systems with carryover

SC/M18/AWMP05: R. Tiedemann, A. Ernst, M. Autenrieth. Interpreting currently available NA minke whale genotype data in the context of current stock structure hypothesis, with an attempt to estimate mixing proportions among putative stocks

Annex D

The Revised Fin Whale Abundance Estimates and Consequent Modifications to Trials

Hansen *et al*. (2018) provided revised estimates of fin whale abundance based on aerial surveys off Greenland. Previous estimates had taken account of perception bias, but the new estimates were also adjusted for availability bias. The table below compares the previous (old) and revised (new) abundance estimates. The revised estimates, which were appreciably larger, were accepted subject to confirmation by the ASI group.

The meeting **agreed** that trials should be conditioned on the new estimates, and that additional variance should not be included when a trial was fit to two estimates of abundance only.

In discussing what CVs to use for future abundance estimates, it was noted that high CVs are associated with the high abundance estimates and *vice versa*, perhaps because of the higher school sizes observed when there are more whales present. The meeting agreed that for trials based on fits to two estimates, to use a future CV of 0.67 (the average for the 2005 and 2007 surveys) when generating abundance estimates which include an influx, and of 0.38 (the average for the 1987.8 and 2015 surveys) for years without an influx.

REFERENCE

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.D., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2018. Abundance of whales in West and East Greenland in 2005-15 [*https://doi.org/10.1101/391680*]

				Old	Old	Old	New	New	New
Sub-area	Range of years	Method	Cor.	Estimate	CV	Approx. 95% CI	Estimate	CV	Approx. 95% CI
WG	1987/8	CC		1,096	0.35	560-2,130	1,096	0.35	560-2,130
WG	2005	LT	P	3,234	0.44	1,400-7,400	9,800	0.62	3,228-29,751
WG	2007	LT	P	4,359	0.45	1,900-10,100	15,957	0.72	4,531-56,202
WG	2015	LT	P	465	0.35	230 - 930	2,215	0.41	1,017-4,823

Annex E

Summary of Changes to the Control Program to Implement the 'Influx' Hypothesis

A.E. Punt

- Conditioning is based on the 1987 and 2015 estimates only. The 2005 and 2007 estimates are ignored – there are consequently no 'biased' estimates.
- The abundance of the 'extra stock' is 3,000 animals, with a probability of being off West Greenland of 0.5. The abundance of the 'extra stock' is 1,500 for the purposes of conditioning (but the abundance estimates pertain only to WG stock).
- The catches are allocated to WG stock in the proportion to the number of 1+ WG animals to the total number of animals (WG and Extra) off West Greenland.
- The factor used to determine the Poisson component of the process for generating future abundance estimates is carrying capacity for the WG stock plus half of the size of the 'extra stock'.
- The prior for carrying capacity for the WG stock is U[0, 5,000]

Annex F

Specifications for Testing Potential Carryover Provisions

The United States and Denmark have asked the Scientific Committee to evaluate the following hypothetical carryover provision:

> …allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit.

See Appendix for the full request. The Workshop agreed to conduct an evaluation of the conservation implications of carryover provisions based on simulation testing. A suitable carryover scheme should cause very little or no population reduction compared to what was already considered acceptable for the *SLA*.

Simulation trials to evaluate the conservation performance of possible carryover provisions were developed and tested first for Bering-Chukchi-Beaufort Seas (BCB) bowhead whales using the *Bowhead SLA* to provide strike limits and for West Greenland humpbacks using the Humpback SLA.

The *Bowhead SLA* trial structure is based on abundance estimates up to and including that for 2001, and *SLA*-based management is assumed to begin in 2003. The Workshop **agreed** to begin with this framework. If a proposed carryover provision did not exhibit adequate conservation performance on such trials, the Workshop **agreed** that it would conduct additional trials that involve reconditioning the operating model by including the (higher) abundance estimates for 2004 and 2011, and starting simulated management in 2018. The Workshop **agreed** to attempt the former framework initially because it is much faster to develop and might suffice for the task at hand, even though an assessment of carryover conservation performance would likely be more pessimistic than for an updated trials structure.

The *Humpback SLA* trial structure simulates management starting in 2013, with the most recent abundance estimate from 2007. As for the bowhead case, the Workshop **agreed** to retain this structure unless results indicated that an update was required.

Simulating the accumulation and usage of carryover strikes introduces complex issues of harvest timing. The Workshop **agreed** to adopt a simplified model based on the concept of 'superblocks'. A superblock is comprised of a set of temporally adjacent quota blocks. Strike usage is assumed to follow a specific pattern (see below) within a superblock, and then the same pattern is repeated for each superblock. The use of superblocks and the strike usage patterns within them are designed to provide a conservative basis for evaluating actual carryover provisions such as the US/Denmark one even though that provision is not based on superblocks.

The main set of simulations with the *Bowhead SLA* spanned 100 years, starting in 2003, with the period partitioned into four superblocks each consisting of five 5-year quota blocks (further sets of trials are discussed later). Five quota blocks are chosen so that unused strikes may be accumulated for three blocks (as per the US/Denmark inquiry) and then used in the remainder of the superblock. The same approach was used for the *Humpback SLA*, starting in 2013.

It was assumed that no carryover was held at the start of the projection period. For the first three blocks of the first superblock, only X% of the strike limit would be utilized. The remaining strikes would be reserved as carryover, accumulated over these blocks. For a set of simulations modelling very high rates of carryover accumulation and usage, X was set to be 66.67%. A more realistic variant, X=80%, reflected the historical 2003-2017 rate of BCB bowhead strike underutilisation. During the remaining two quota blocks of the superblock, the entire strike limit was taken, plus additional strikes available as carryover but subject to the limitation that the total strikes taken during any year did not exceed 150% of the annual strike limit that applied at the time. The simulation attempted to use as much of the carryover as possible in the first of the two remaining blocks. The subsequent superblocks were simulated in the same fashion.

At the end of a superblock, it is possible that some carryover strikes have not been used (e.g. if the baseline strike limit was reduced earlier in the superblock). If this happened, then the unused carryover was taken forward into the first year of the next superblock and added to the unused strikes from the accumulation phase (i.e, first three blocks) of that superblock. During the later usage phase (i.e. last two blocks) of that superblock, all carryover strikes were used as quickly as possible (subject to the 150% limit). If there were carryover strikes remaining at the end of the final superblock, these were discarded.

Table 1 shows three examples. Here, Q represents the block strike quota, U represents the used strikes, and AC is the accumulated carryover. Two five-block superblocks are shown, A and B. The *n*th block in superblock A is denoted A.*n*. These examples are purely for illustrative purposes and do not represent actual hunter behaviour or the particular numerical values tested by the Workshop. In example (a), the quota remains stable at 240 strikes per block (i.e. 48 per year for each of five years), and 3×80=240 unused strikes are accumulated over the first three blocks of superblock A due to a harvest level equal to only two thirds of the *SLA* strike limit. All these unused strikes are used as carryover during the final two blocks of superblock A where the actual strikes equal 150% of the *SLA* strike limit. The pattern repeats for superblock B. In example (b), the block strike limit is reduced starting in A.4. To abide by the 150% limit, the accumulated carryover must be expended more slowly, and some of it (120) is carried forward into superblock B. In block B.1, 80 out of 120 strikes from the baseline quota are used, plus as much of the remaining carryover as possible (100 out of 120) without exceeding the 150% limit overall. This leaves 20 carryover from the previous block plus 40 carryovers from the current block. In block B.2, 80 of 120 baseline strikes are taken, plus all (20) of the remaining carryover from superblock A. At the end of block B2, there are zero carryover from the previous block plus 80 (40+40) generated from B.1 and B.2. Another 40 carryovers are generated in B.3, and the entire 120 carryover are then expended in B.4 and B.5. This algorithm was used to bound the carryover schemes the Workshop was investigating, but actual hunter behaviour would certainly not follow such a

Table 1

Three examples of carryover accumulation and usage for two five-block superblocks (A and B). The nth block in superblock A is denoted A.n. Q is the block strike limit, U is the used strikes during the block, and AC is the accumulated carryover at the end of the block. For examples (a) and (b), only X=66.67% of the (new) block quota is used during accumulation periods, and 150% of the annual quota is taken during the carryover usage phase. In example (c), X=80% of the block quota is used during the accumulation phase, and the 150% limit is taken during the carryover usage phase. The final column, totalling quota strike limits and strikes used, demonstrates that carryover provisions do not increase the overall number of whales taken over time.

Example (a)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	Total
Q	240	240	240	240	240	240	240	240	240	240	2400
U	160	160	160	360	360	160	160	160	360	360	2400
AC	80	160	240	120	0	80	160	240	120	0	
Example (b)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	
Q	240	240	240	120	120	120	120	120	120	120	1560
U	160	160	160	180	180	180	100	80	180	180	1560
AC	80	160	240	180	120	60	80	120	60	0	
Example (c)	A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.3	B.4	B.5	
Q	240	240	240	240	240	240	300	300	300	300	2640
U	192	192	192	360	264	192	240	240	450	318	2640
AC	48	96	144	24	0	48	108	168	18	0	

pattern. Furthermore, because the block strike limit is substantially reduced in A.4, an Implementation Review would probably be triggered, and this could include a reassessment of carryover. Example (c) shows a more plausible case where *SLA* strike limits are under (over) utilized by 20% during the carryover accumulation (usage) phases of the superblock. In this scenario, the *SLA* strike limit also increases during superblock B. The final column in Table 1, totalling quota strike limits and strikes used, demonstrates that carryover provisions do not increase the overall number of whales taken over time.

It is also necessary to specify how strikes are to be allocated within a quota block. For instance, in example (a) of Table 1, the 150% limit was expressed on a per-block basis, whereas the US/Denmark enquiry describes a stricter requirement that the strikes taken each year do not exceed 150% of the annual strike limit. In the simulations, therefore, available strikes were taken as quickly as possible within the block, i.e. 150% of the annual limit was used in the first and each subsequent year until the block limit was been used. It is important to emphasize that this does not reflect likely hunter behaviour: the assumption is used only to provide a worst-case boundary to evaluate conservation performance. The previous Committee evaluation of carryover explored this case as it maximizes risk for an increasing stock.

Although the US/Denmark inquiry specifies a 3-block accumulation period, the Workshop **agreed** also to evaluate shorter accumulation periods. Thus, a separate suite of trials partitioned the simulation period into 10 superblocks of 2 quota blocks each (corresponding to a 1-block accumulation phase followed by a 1-block carryover usage phase). Altogether, these trials enabled evaluation of provisions such as those in the US/Denmark inquiry with either 3-, 2- (by interpolation), or 1-block carryover provisions.

In some cases, Greenland currently employs a more restrictive carryover scheme than any of the above, or what is permitted by the Schedule. In particular, unused strikes up to 50% of the annual quota for one year can be carried forward and used in the next year. No longer-term accumulation of unused strikes is permitted. The same one-year carryover is permitted between the last year of one block and the first year of the next. The Workshop **agreed** that the following simulation sufficed to bound the conservation performance of such a scheme (and was itself informative as another possible carryover provision). This simulation took as many strikes as possible, as soon as possible during the block, subject to the 150% limit. A consequence of this is that there would then be no harvest in the final two years of a six-year block. The same pattern was repeated for each block. No superblocks are needed for this simulation.

Conservation performance was assessed by implementing these scenarios for the following BCB bowhead *Evaluation Trials*: BE01, BE12, BE13, and BE16-SE. These include some of the most difficult (and less plausible) trials, so the performance evaluation should not weight the outcomes equally. Table 2 provides the description of these trials. For West Greenland humpbacks, the *Evaluation Trials* used were: GH01BC, GH05BC, GH06BC, GH07BC and GH08BC; see Table 3 for details. The factors varied in these trials are: MSYR, subsistence need levels, historical and future survey bias, various scenarios pertaining to variation in population status and environmental factors, and age data quality. The standard SLA performance evaluation statistics and graphs were used.

Table 2

The trials used to evaluate potential carryover provisions for BCB bowhead whales. See IWC (2003, p. 175) for a detailed description of these trials.

Trial No.	Description	Model	$MSYR_{1+}$	$MSYL_{1+}$	Final need	Historical survey bias	Future survey bias	Survey CV (true, est)	Age data[#]
BE01	Base case	D	2.5%	0.6	134	1	1	0.25, 0.25	Good
BE12	Difficult 1%	D	**1%**	0.6	134	**$1 \rightarrow 1.5$**	**1.5**	**0.25, 0.10**	**Poor**
BE13	Difficult 1%; constant need	D	**1%**	0.6	**67**	**$1 \rightarrow 1.5$**	**1.5**	**0.25, 0.10**	**Poor**
BE16SE	$MSYR_{1+}$ = 1%; 201 need	S_E	**1%**	0.6	**201**	**$0.67 \rightarrow 1$**	1	0.25, 0.25	Good

Table 3

The trials used to evaluate potential carryover provisions for West Greenland humpback whales. See IWC (2015, p.152) for detailed description of these trials.

Trial	Description	*$MSYR_{1+}$*	Need Scenarios	Survey freq.	Historic Survey Bias
GH01BC	$MSYR_{1+}$ = 3%	**3%**	C	10	1
GH05BC	Survey bias = 1.2; $MSYR_{1+}$ =3%	**3%**	C	10	**1.2**
GH06BC	3 episodic events; $MSYR_{1+}$ =3%	**3%**	C	10	1
GH07BC	Stochastic events every 5 years; $MSYR_{1+}$ = 3%	**3%**	C	10	1
GH08BC	Asymmetric environmental stochasticity (depletion = 0.3)	**3%**	C	10	1

The Workshop **agreed** that the same methods should be used to test the conservation performance of these carryover scenarios for the other aboriginal whaling SLAs. The schedule for this evaluation is given in the workplan (see Item 4.2.4).

REFERENCES

IWC. 2015. Report of the Scientific Committee, Annex E. *J. Cetacean Res. Manage*. 16 (Suppl.) p. 144-157.

IWC. 2003. Report of the Scientific Committee, Annex E. *J. Cetacean Res. Manage.* 5 (Suppl.) p. 154-225.

Appendix 1

REQUEST FOR ADVICE BY THE US AND DANISH COMMISSIONERS TO THE AWMP WORKSHOP, COPENHAGEN, MARCH 2018

Denmark, on behalf of Greenland, and the United States, on behalf of its Alaska Natives, would like to submit a request for consideration by the AWMP workshop this week in Copenhagen. For the purposes of the AWMP and the Aboriginal Whaling Scheme discussions, we'd like the workshop to evaluate the sustainability of applying a carryover provision to U.S. and Denmark stocks that would allow for the carry forward of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit. Given the deadlines with respect to ASW proposals, we would appreciate the AWMP group's thoughts in advance of the upcoming ASW WG meeting in early April, so that we can consider their input in our discussions there.

Additionally, we would like the AWMP workshop to consider the potential application of a one-time seven-year block for all ASW catch limits. This would create a 'buffer year' between the year in which the Commission approves catch limits and the year in which those catch limits take effect in order to: (a) reconcile the timing of Commission meetings with the 'objections' procedure where Schedule amendments may not become effective until after the start of the hunting season in the following year; and (b) provide time for an intersessional meeting should the Commission fail to agree upon catch limits at its regular meeting. After this one-time seven-year extension, all future catch limit renewals would be in six-year extensions so that all future catch limit renewals would benefit from the 'buffer year.' As we understand, in practice, a one-time seven-year extension would work as follows: Even though the seven-year block would not expire until 2025, at the 70th Commission meeting in 2024, the catch limits would be reviewed and, in accord with Scientific Committee advice, extended for an additional six years from 2026 through 2031. We would be very interested in the AWMP workshop participants' thoughts on any relevant scientific implications of this.

Regards,

Ryan Wulff (US) and Peter Linde (DK)

Annex G

Trial Specifications for North Atlantic fin whales

Editor's Note: See Report of the Scientific Committee, Annex E, Appendix 4, this volume.

Annex H

Trial Specifications for North Atlantic common minke whales

Editor's Note: See Report of the Scientific Committee, Annex E, Appendix 4, this volume.

Annex I

Example Plots used to Evaluate the Minke Whale Trial Conditioning

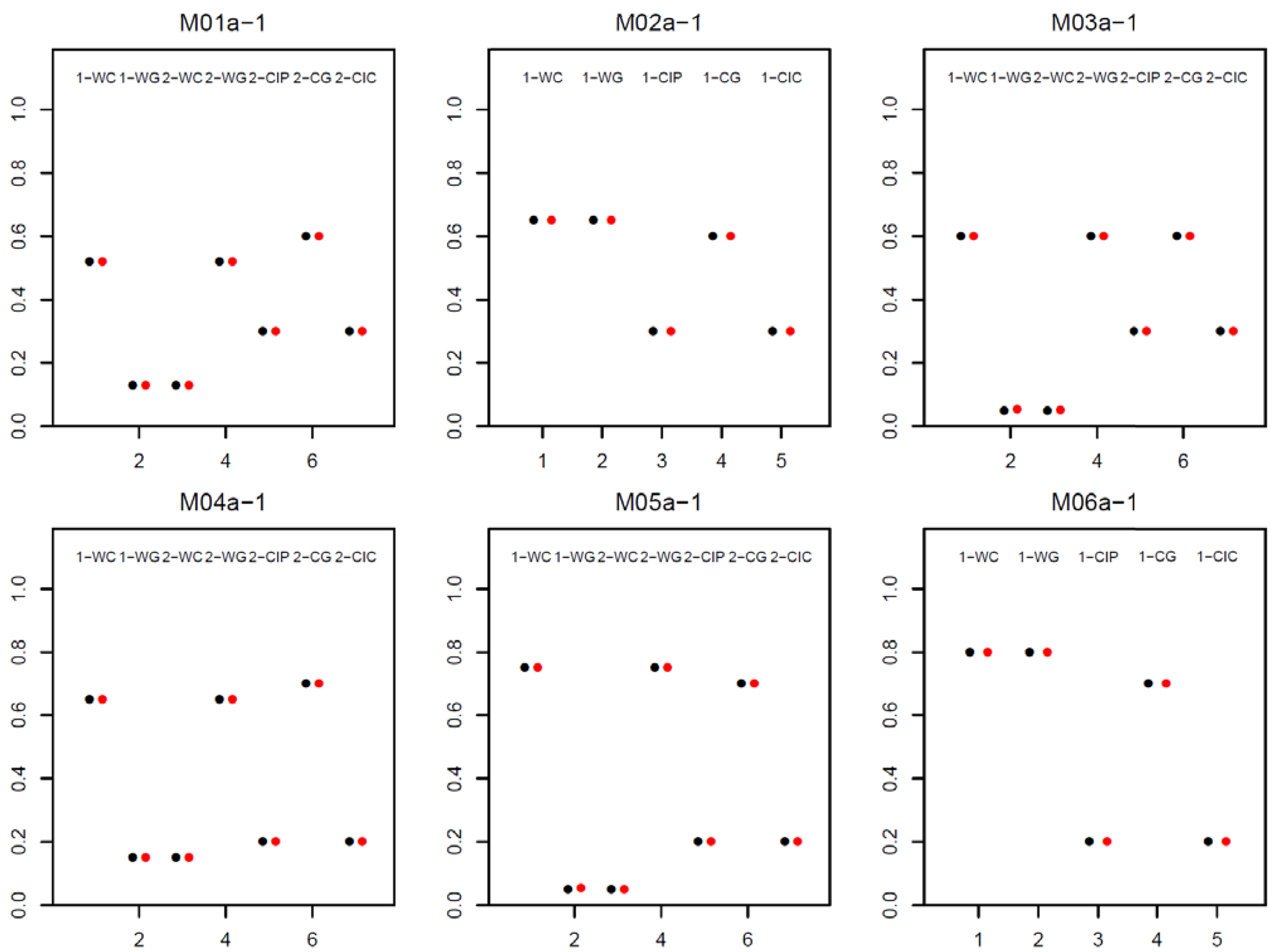

Fig 1. Example plots of the specified mixing proportions (i.e. the target proportion of the total (1+) numbers in a given sub-area that belong to a particular stock (stock 1 or stock 2) averaged over the years 2008-2013), together with the distribution over replicates for the model predictions.

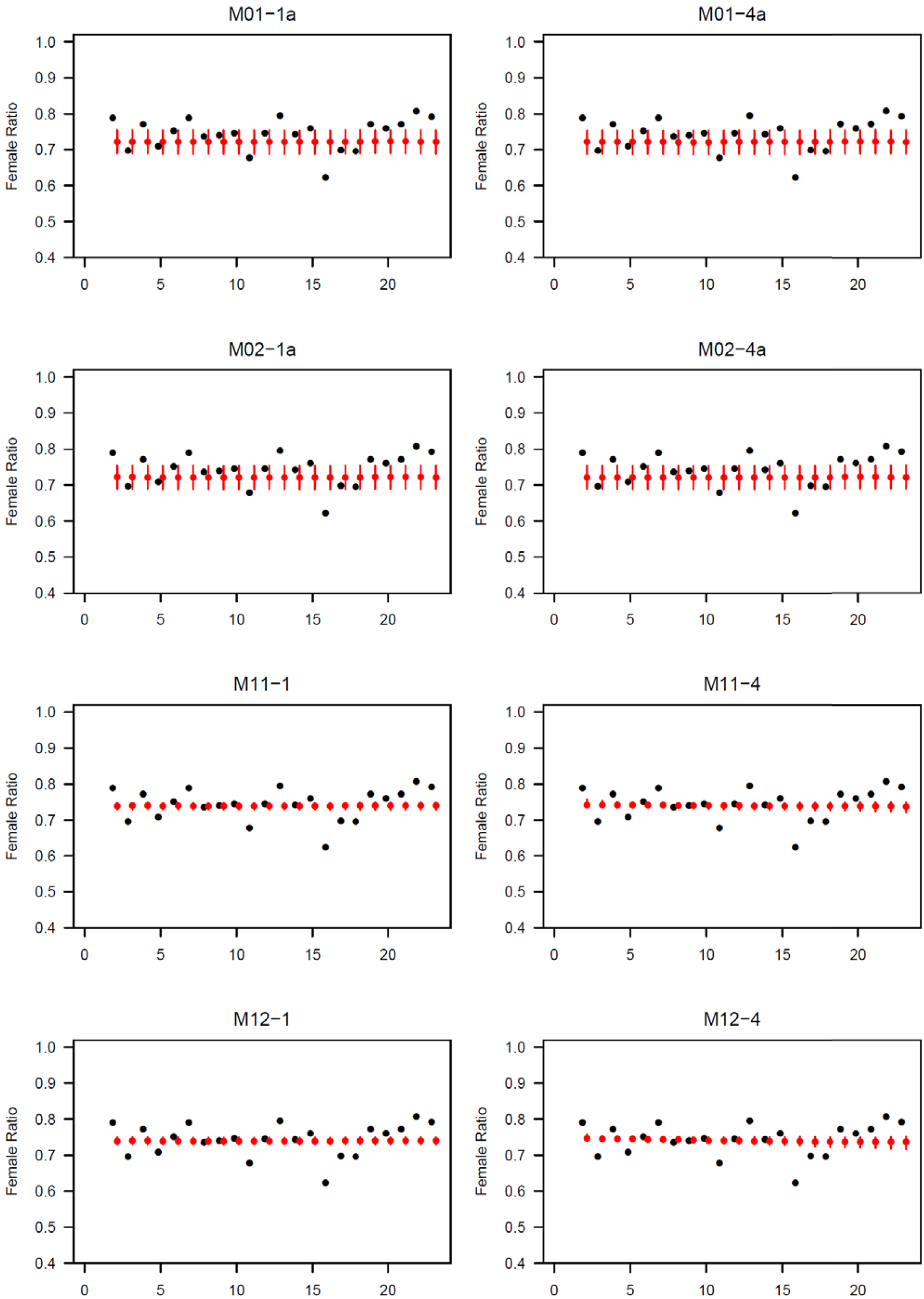

Fig 2. Plots of the observed and operating model-predicted sex-ratios for the M1, M2, M11 and M12 trials (MSYR = 1% and 4%). The black dots show the observed sex ratios for the years 1994-2015. The red dots and lines show the mean and 90-%iles of the modelled values over these years.

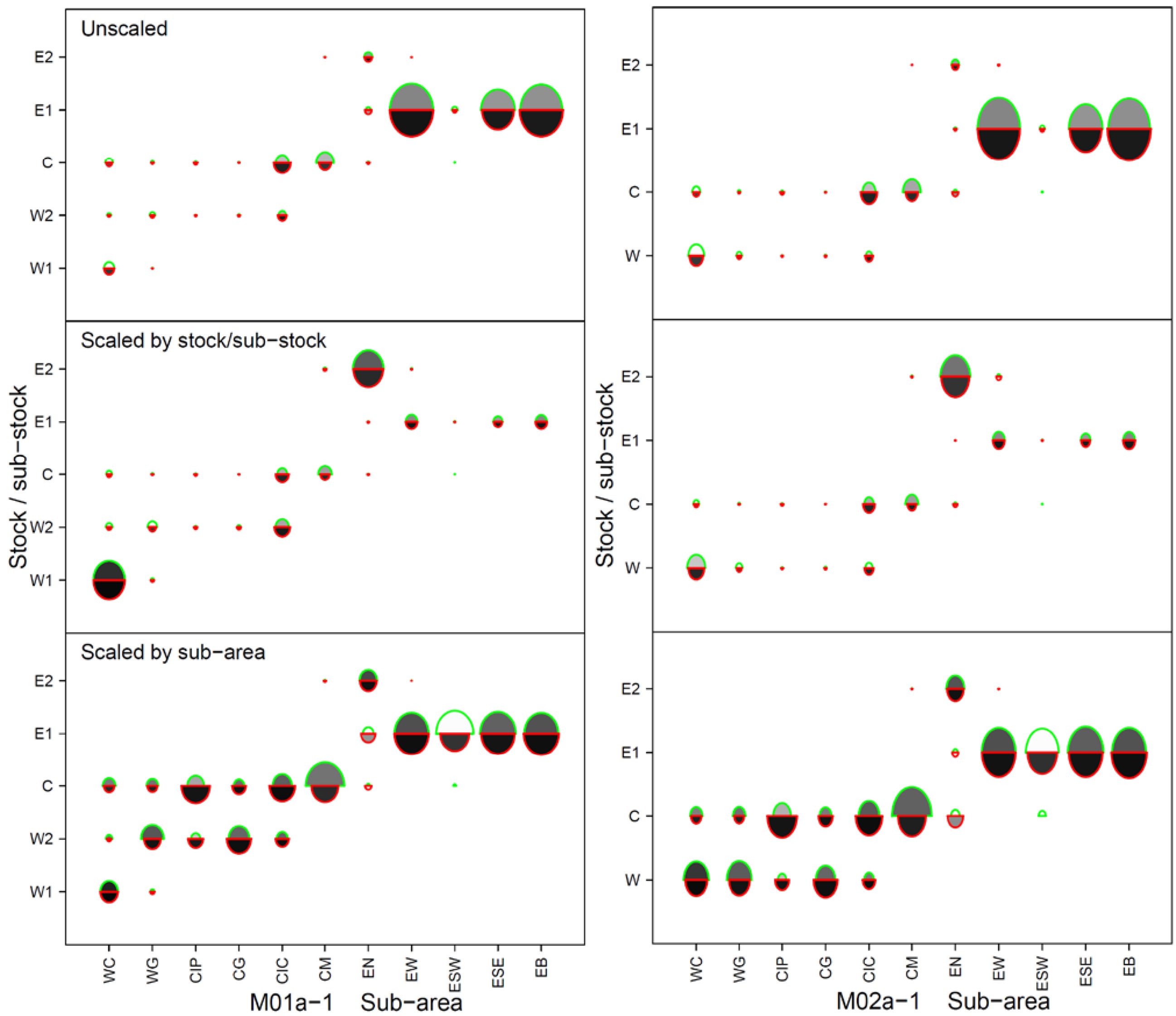

Fig 3. Example plots illustrating the entries in the mixing matrices set during conditioning. They also show the breakdown of the numbers at carrying capacity in each sub-area by stock/sub-area and sex.

Report of the Workshop: Resolving *Tursiops* Taxonomy Worldwide

Report of the Workshop: Resolving Tursiops Taxonomy Worldwide[1]

SUMMARY

An intersessional workshop was convened to evaluate taxonomy and population structure of bottlenose dolphins (*Tursiops* spp.) worldwide. This followed priority topic review in the IWC Scientific Committee's Small Cetaceans sub-committee over three years (2015-2017), divided into broad geographic regions. Bottlenose dolphins are known to show morphological and genetic divergence throughout their range, raising issues for recognition of discrete units needed for effective conservation and management. Summary data were compiled for studies presented at the Scientific Committee reviews and at the Workshop; these summaries were tabulated (see Annex D) and formed the basis for discussions concerning taxonomic and population distinction issues in each geographic region during the Workshop.

The Workshop considered the distribution of research efforts to date, identified data-deficient regions, **recommended** those areas as priorities for *Tursiops* research (see details in Item 3.2, priority recommendations in Item 6.1), continued compilation of specimen, study and researcher details, and concentrated effort to improve our understanding of *Tursiops* in data-deficient areas.

The Workshop considered unresolved species, subspecies and population questions in each region and what would be required for more confident recognition of such distinctions, and **recommended** that guidelines for recognition of cetacean species, subspecies and DIPs be followed for proposing taxonomic and population-level distinctions and for assessing the information used to support such distinctions. The Workshop **strongly emphasised** that such distinctions be examined within an appropriately wide and inclusive geographic context, using multiple lines of evidence.

Further priority **recommendations** included: (1) collect additional data to better characterise divergence between coastal and offshore forms in the western South Atlantic Ocean to help resolve whether *T. t. gephyreus* might more accurately be elevated to species status; (2) investigate *T. aduncus* lineages in the Indian Ocean and western South Pacific to assess potential subspecies recognition; (3) continued study of animals associated with the '*T. australis*' mtDNA lineage in the context of both *T. truncatus* and *T. aduncus;* (4) examine the level of male-mediated gene flow between the coastal and offshore forms in the western North Atlantic Ocean to determine whether the coastal form should be elevated to species or subspecies status; (5) conduct comprehensive morphometric analyses comparing *Tursiops truncatus* in the Mediterranean, Black Sea and eastern Atlantic to evaluate whether any regions may harbour a taxonomic unit above the level of population; (6) conduct comprehensive morphometric analyses of coastal and offshore *Tursiops truncatus* in the eastern North Atlantic Ocean and compare results to those from the western North Atlantic to evaluate potential taxonomic differences; and (7) perform morphometric analyses of Gulf of California coastal and offshore dolphins relative to those from California and the eastern tropical Pacific, with a particular focus on the level of divergence of coastal dolphins in the upper Gulf of California to other areas.

The Workshop was kindly hosted at NOAA Southwest Fisheries Science Center (SWFSC), La Jolla, California, from 12-14 January 2018. The list of participants is given as Annex A.

1. INTRODUCTORY REMARKS

1.1 Convenor's opening remarks

Natoli welcomed the group and the participants were introduced. The Workshop participants expressed their gratitude to SWFSC for providing the venue and to Aimee Lang and Julie Creek for organisation and logistics support.

1.2 Election of Chair

Natoli was appointed as Chair and Rosel was appointed as co-chair of the meeting.

1.3 Appointment of Rapporteurs

Cipriano, Rosel and Lang served as rapporteurs. The report was coordinated by Cipriano, with the support of Rosel, Lang and Natoli.

1.4 Adoption of the Agenda

The agenda was reviewed, updated and adopted by the Workshop participants. The adopted Agenda is provided as Annex B.

1.5 Documents available

A list of documents reviewed during the Workshop and cited in the text is given in Annex C.

[1] Presented to the meeting as SC/67b/Rep09.

2. TERMS AND A STRATEGY FOR ASSESSING TAXONOMIC AND POPULATION-LEVEL DISTINCTIONS IN *TURSIOPS*

2.1 Summary: context and motivation for the 2015-2017 Scientific Committee Review and 2018 Workshop on resolving *Tursiops* taxonomy worldwide

At SC/65b, the sub-committee on small cetaceans (hereafter, the sub-committee) identified as its next priority topic a review of the taxonomy and population structure of the genus *Tursiops*, to be conducted in stages over three annual Scientific Committee meetings. Understanding whether there is consistency in the recognition of the taxonomic and/or population status of various local forms across the distributional range and to which taxonomic or population unit(s) they should be assigned, has been challenging; the status of many forms worldwide is still unresolved. An additional aim of this exercise was to develop a widely applicable taxonomic-assessment framework for small cetaceans.

Bottlenose dolphins are among the most widely distributed cetaceans. Factors contributing to taxonomic uncertainty in this genus include the wide distribution across highly variable environments, variability among locally-adapted populations, sympatry of various forms in some regions, a lack of specimens from many regions, differences in research methods and designs, and a long and complex nomenclatural history in the taxonomic literature (Hershkovitz, 1966; Rice, 1998; Wang and Yang, 2009). Relationships among members of the entire family *Delphinidae* and in particular the subfamily *Delphininae* (*Sousa, Sotalia, Stenella, Tursiops, Delphinus* and *Lagenodelphis*), are poorly resolved, and the systematics of these species and genera is still unclear (Perrin *et al.*, 2013). Worldwide, more than 20 different *Tursiops* species have been described historically but only two, *T. truncatus* (Montagu, 1821) and *T. aduncus* (Ehrenberg, 1832), are currently recognised (Society for Marine Mammalogy Committee on Taxonomy 2017). *T. truncatus* has a worldwide distribution from temperate to tropical waters in both hemispheres, whereas *T. aduncus* is confined to the Indo-Pacific region and is principally found in near-shore waters. In many regions where bottlenose dolphins occur, different forms have been described, based on distribution, morphology and genetic profiles. Among the *T. truncatus* forms in the Atlantic and Pacific, two geographically and (to varying degrees) morphologically and genetically differentiated types have often been described as e.g. 'coastal morphotype' and 'offshore morphotype'. The morphological differentiation between coastal and offshore forms has raised questions about whether these forms represent different populations, species or subspecies. However, the correlation of morphotype with preferred habitat is not consistent across regions – for example, in the eastern North Atlantic the coastal and offshore forms are not morphologically distinct (Louis *et al.*, 2014), whereas in the western North Atlantic coastal animals are smaller than offshore animals (Mead and Potter, 1995). [See section 2.4 distribution-related terminology below for an explanation of the terminological conventions for names ascribed to these different types that we use here]. Relatively high levels of genetic differentiation have been observed among coastal *T. truncatus* populations in areas where detailed analyses have been conducted, e.g. Florida, Gulf of Mexico, western North Atlantic and the Mediterranean (Natoli *et al.*, 2005; Rosel *et al.*, 2009; Sellas *et al.*, 2005; Vollmer and Rosel, 2017).

Over the course of three years (2015-2017), the sub-committee reviewed all relevant morphological, genetic and occurrence information available for *Tursiops* worldwide according to the following regional subdivisions (Fig.1):

- SC/66a: Indian Ocean, adjacent western Pacific/Oceania;
- SC/66b: Atlantic Ocean, Mediterranean and Black Sea; and
- SC/67a: eastern Pacific Ocean and western North Pacific Ocean.

After reviewing the available information, the sub-committee then focused on evaluating the support provided for taxonomic (subspecies, species) and population-level distinctions proposed in the publications we reviewed. This included, *inter alia,* proposals for the recognition of new species and/or subspecies and evidence for population-level divergence significantly strong to warrant recognition of the bottlenose dolphins in particular areas as worthy of designation as distinct 'management units' (see detailed discussions below of the various names given to such units and the criteria used to identify them).

Detailed summaries of available evidence and conclusions from each of the 2015-2017 reviews are included in the sub-committee reports for that year (IWC, 2016; IWC, 2017; IWC, 2018). It should be noted that in all of the regions considered during the three-year review, sizeable areas have almost no information, thus presenting significant challenges in understanding bottlenose dolphin diversification worldwide.

At SC/66a, taxonomic and population distinctions for bottlenose dolphins in the Indian Ocean (EIO and WIO), adjacent western South Pacific Ocean (WSP) and Oceania regions were addressed. In the Indian Ocean and western Pacific, *T. aduncus* and *T. truncatus* are clearly distinguishable and the differences between them are consistent across many different areas for both genetic and morphological analyses (e.g. Ross and Cockroft 1990; Wang *et al.*, 1999; 2000). Some population structure has been documented for *T. truncatus* in the WNP (e.g. Chen *et al.*, 2017), but few such studies have been performed in this area. Reciprocally monophyletic genetic differentiation and some morphological differentiation was documented among at least three forms of *T. aduncus* across the region including distinct forms in South Africa, Pakistan and Australia (see Natoli *et al.,* 2004; Gray *et al.,* 2018). It was difficult to resolve the taxonomic status of '*T. australis'* (recently described from south Australian waters, Charlton-Robb *et al.*, 2011), in part because of discordance in results between morphometrics and different genetic markers (Hale *et al.,* 2000; Kemper, 2004; Charlton-Robb *et al.*, 2011; Jedensjö *et al.,* 2013).

At SC/66b, the Atlantic Ocean (WNA, WSA, ENA, ESA), Mediterranean (MED) and Black Sea (BS) regions were

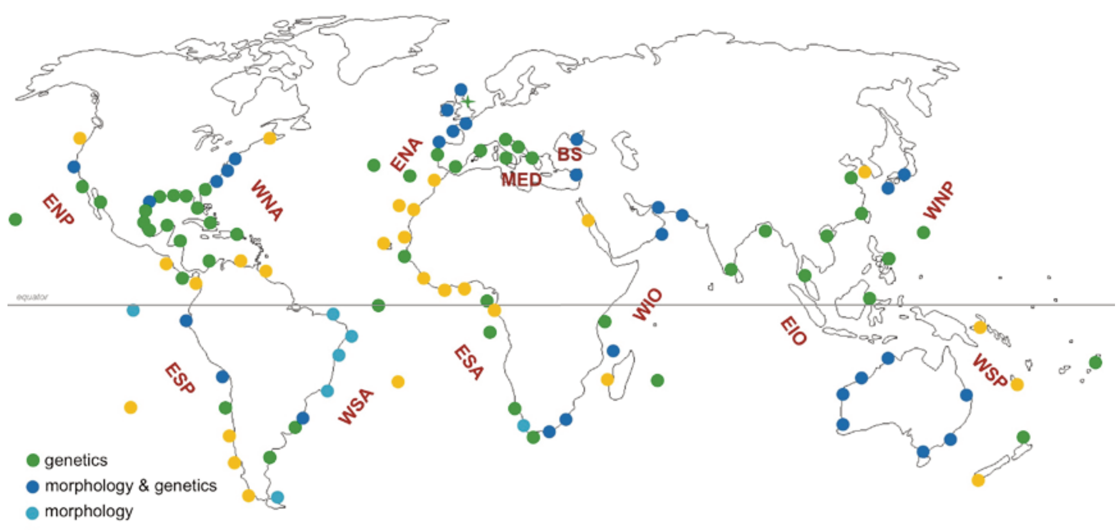

Fig.1. Map showing the regional subdivisions considered throughout the review: eastern Indian Ocean (EIO); western Indian Ocean (WIO); eastern North Atlantic (ENA); eastern South Atlantic (ESA); Mediterranean Sea (MED); Black Sea (BS); western North Atlantic (WNA); western South Atlantic (WSA); eastern North Pacific (ENP); eastern South Pacific (ESP); western North Pacific (WNP); and western South Pacific (WSP). Dots of different colours identify the locations where published information was available for review. Cross refers to an extinct population.

reviewed. Only one species, *T. truncatus*, is recognised to be present throughout these regions, with the Black Sea population recognised as a subspecies, *T. truncatus ponticus* Barabash-Nikiforov, 1940. Significant population structure has been found for this species throughout the Atlantic and Mediterranean (e.g. Natoli *et al*., 2005; Rosel *et al*., 2009; Fruet *et al*., 2014; Louis *et al*., 2014a, b). Ecological differences have been documented between coastal and offshore forms in both the eastern North Atlantic (ENA) and western North Atlantic (WNA) (Mead and Potter, 1995; Louis *et al*., 2014a; Louis *et al*., 2014b). Molecular genetic analyses revealed significant genetic differentiation for a wide range of molecular markers between coastal and offshore forms in the WNA (Kingston and Rosel, 2004; Kingston *et al*., 2009; Rosel *et al*., 2009; Vollmer and Rosel, 2017; Moura *et al*., pers. comm.) and also in the ENA (Natoli *et al.,* 2004; Louis *et al*., 2014a; Louis *et al*., 2014b; Moura *et al.,* pers. comm.). *Tursiops truncatus* appears to occur throughout both coastal and offshore areas in the African east Atlantic (Queroil *et al*., 2007; Van Waerebeek *et al*., 2016), but there are too few data to determine whether there is inshore/offshore differentiation of bottlenose dolphins in that region. In the western South Atlantic (WSA), significant morphological differentiation exists between coastal and offshore forms which may be indicative of species or subspecies-level differences (Costa *et al.,* 2016; Wickert *et al*., 2016); the two types are parapatric along the coast of southern Brazil and possibly sympatric in northern Argentina (Costa *et al.,* 2016). Although molecular genetic studies have been hampered by small sample size, but see Fruet *et al*. (2017), and further molecular genetic analysis is ongoing, the significant morphological differentiation between the large coastal form and smaller offshore form (a single, but strong line of evidence) is consistent with and supportive of subspecies-level distinction. However, it was difficult to draw firm conclusions about whether the coastal form should be elevated to species status, pending additional molecular genetic analysis to evaluate levels of male-mediated gene flow. The review of bottlenose dolphins in the Atlantic, Mediterranean and Black Sea further illustrated the need to standardise and widen the types of evidence (morphological, genetic, ecological and behavioural/acoustic) used to diagnose and delimit population-level differences and recognise taxonomic (species, subspecies) distinctions.

At SC/67a, the sub-committee considered published information on bottlenose dolphin distribution and potential taxonomic distinctions in the eastern North Pacific (ENP), eastern South Pacific (ESP) and portions of the western North Pacific (WNP) not covered at SC/66a. Newly available information on *Tursiops* from areas covered in SC/66a (2015) and SC/66b (2016) was also reviewed.

Well-differentiated forms of *T. truncatus* are present in the eastern North Pacific; both morphological and genetic data provide convincing evidence for the presence of two distinct forms of *T. truncatus*. In California, a coastal form (originally described as *T. gilli* Dall, 1873) is restricted to waters within 1km of the coast from at least Ensenada, Mexico to San Francisco, California while an offshore form (originally described as *T. nuuanu* Andrews, 1911) is also found off California. There is significant genetic differentiation between the Gulf of California and California coastal populations (of the same magnitude as between coastal and offshore populations), but a comprehensive morphological analysis comparing the two has not yet been performed. In the Gulf of California, there was significant differentiation between offshore populations in the central and southern regions and a coastal form restricted in range to the upper portion of the Gulf is of conservation concern given documented numbers of stranded dolphins observed in that area.

Both *T. aduncus* and *T. truncatus* appear to co-exist throughout much of the western North Pacific although this area has not been thoroughly examined. Existing data do not support the presence of multiple forms of either species in the western North Pacific, although population-level differentiation in some areas has been documented (Chen *et al*., 2017)

In the eastern South Pacific, comprehensive skull morphometry studies have not been conducted to date. Some studies suggest the presence of two forms in Peru, Ecuador and Colombia based on dorsal fin shape, tooth width and some qualitative differences in skull characters (Van Waerebeek *et al*., 1990; Santillan *et al.,* 2008; Felix *et al.,* 2017), but sample sizes have been relatively small. Only an offshore type and a small, possibly hybrid group are documented in Chilean waters. Further work is needed to determine whether a coastal type is present in Chile. The review of bottlenose dolphins conducted at SC/67a concluded that sample sizes for most of the studies in this region have been relatively low and increased sampling throughout the region is needed so that the distinctions between the different types in the eastern South Pacific can be better resolved; a wide range of data (morphological, genetic and other) from the eastern North and eastern South Pacific should be compared, so that the distributions of any potentially distinct units can be fully explored.

2.2 Review: a practical example of approaches for stock delineation used by US government agencies

Lang presented a brief summary of the report of a 2014 NOAA Fisheries workshop (Martien *et al.,* 2015) that focused on how multiple lines of evidence could be used to delineate demographically independent populations (DIPs) of marine mammals – historically referred to as ‘stocks’ or ‘population stocks’ for management purposes under the US Marine Mammal Protection Act (MMPA). The MMPA defines population stock as ‘a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature’. Under the MMPA, ‘population stock’ is the fundamental unit of legally-mandated conservation (Martien *et al.,* 2015). A set of guidelines (GAMMS) has been developed that includes guidance for how DIPs should be delineated under the MMPA (*http://www.nmfs.noaa.gov/pr/sars/guidelines.htm*). Although these guidelines indicate that many types of evidence may be used to delineate DIPs, most delineations have relied heavily on genetics, and there is little guidance on how other lines of evidence should/can be used. These guidelines are updated occasionally, the latest update was in 2016 (*http://www.nmfs.noaa.gov/pr/sars/pdf/gamms 2016.pdf*).

Distinct Population Segments (DPSs) are a similar ‘below-species’ unit recognised as eligible for protection under the US Endangered Species Act (ESA) (U.S. Department of the Interior, 1996). The criteria for identifying DPSs under the ESA and DIPs under the MMPA are not identical, as the levels of divergence described by these two categories relate to different time scales (Wood and Gross, 1998).

The 2014 NOAA Fisheries workshop was convened to examine ways to improve delineation of DIPs of marine mammals under the MMPA, particularly for cases where genetic data are unavailable. Prior to the workshop, discussion groups considered the strength and weaknesses of a suite of different potential lines of evidence that can be used to delineate marine mammal stocks, including acoustics, movements, stable isotope ratios and fatty acids, contaminants, morphology, life history characteristics, trends in abundance, physiographic and oceanographic data, distributional data and behavioural association data. The 2014 workshop participants then used the discussion group summaries to evaluate and rank the strengths and weaknesses for each line of evidence with respect to different marine mammal groups. Differences in genetics, morphology, and movement patterns between two groups were ranked as strong lines of evidence for delineating DIPs. The workshop participants agreed that there was no quantitative way to combine different lines of evidence in order to delineate DIPs and that, where (only) two or three weak lines of evidence were available, considerations had to proceed on a case-by-case basis. The 2018 *Tursiops* Taxonomy Workshop participants recognised that the process used by US government agencies in such deliberations is sensible and informative, and noted that such a clear and consistent approach is not used routinely elsewhere – the effort to delimit DIPs eligible for protected status independent of alpha-taxonomy status was seen as particularly valuable.

2.3 Review: species concepts and approaches for assessment of proposed species, subspecies and population-level distinctions

In order to address the objectives of this Workshop, participants briefly reviewed and discussed species and subspecies concepts, and criteria proposed for recognizing taxonomic distinctions at the species and subspecies levels, especially as proposed by the Workshop on Cetacean Taxonomy held in 2004 (Reeves *et al.,* 2004) and further developed in the series of papers in a recent Special Issue of Marine Mammal Science on delimiting cetacean subspecies using primarily genetic data (Taylor *et al.,* 2017a; Martien *et al.,* 2017; Rosel *et al.,* 2017a; Rosel *et al.,* 2017b; Archer *et al.,* 2017; Taylor *et al.,* 2017b). Although these efforts were not reviewed in detail during the 2018 *Tursiops* Taxonomy Workshop, they represent the context that participants shared while conducting deliberations on the strength of the evidence supporting the species-, subspecies-, and population-level distinctions we considered.

The 2004 workshop considered a variety of species concepts and approaches to species and subspecies delimitation, and concluded that both major species concepts, the Biological Species Concept (BSC) and Phylogenetic Species Concept (PSC), as well as their various sub-approaches, could be considered relevant and useful in cetacean taxonomy and that the different approaches to species delineation should be employed in a pragmatic way (Reeves *et al.,* 2004). The workshop also recognised that levels of divergence observed range across a continuum, and thus, for recognising species within that continuum, a general (guidelines) rather than specific (criteria) approach was more appropriate. With regard to species-level distinctions, the 2004 workshop agreed that species are ‘groups of organisms that are distinct, genetically and morphologically, because of evolutionary divergence from other groups’ and also that ‘such evolutionary entities, or lineages, are the focus of many of the species concepts that have been proposed...’. The workshop concluded that ‘a finding of congruent divergence for each of multiple distinct kinds of data should be taken as strong support for species designations’ and also that ‘such distinct kinds of data could include morphological data together with genetic data, or data from multiple independent genetic loci’. The 2004 workshop also concluded that additional kinds of data, such as geographical range, feeding behaviour and vocalisation repertoires, should not be used as the primary basis for species delineations, but could serve as useful lines of evidence (Reeves *et al.,* 2004).

With regard to subspecies distinctions, the 2004 workshop recognised that cetacean subspecies have primarily been designated on the basis of morphology, that no strict criteria for defining cetacean subspecies had been used historically and that cetacean subspecies recognised to date had been geographically-distinct forms that had been given a Latin trinomial. The workshop recommended that: ‘in addition to the use of morphology and genetics to define subspecies, the subspecies concept should be understood to embrace groups of organisms that appear to have been on independent evolutionary trajectories (with minor continuing gene flow), as demonstrated by morphological evidence or at least one line of genetic evidence. Geographical or behavioural differences can complement morphological and genetic evidence for establishing subspecies’. These conclusions of the 2004 workshop are now often quoted as a requirement that species-level distinctions be supported by multiple lines of evidence, while subspecies-level distinctions could be based on a single line of evidence. In both cases morphological or genetic divergence was considered primary, while geographical range and behavioural differences were considered secondary (Reeves *et al.,* 2004).

De Queiroz (2007) attempted to simplify the many long-standing disputes surrounding the ‘species concept’ by separating the idea of ‘species conceptualization’ from methods for inferring the boundaries and numbers of species (‘species delimitation’). De Queiroz (2007), and a series of preceding papers cited therein, recognised that most species concepts have a ‘common element’ – they all treat ‘existence as a separately evolving metapopulation lineage’ (in essence, using a variety of terms and descriptions) as the primary defining property of the species category, but the various species concepts (including BSC and PSC) differ in the importance they ascribe to specific properties acquired by lineages during the course of divergence (intrinsic reproductive isolation, diagnosability, reciprocal monophyly, etc.). De Queiroz refers to these properties as ‘secondary species criteria’ and argues that they should not be considered relevant to species conceptualisation but only as operational criteria used in the process of species delimitation, as they provide evidence for lineage separation. Similar to the pragmatic approach recommended by the 2004 cetacean taxonomy workshop, de Queiroz (2007) also concluded that the presence of any one of the ‘properties acquired by lineages during the course of divergence’ is evidence for the existence of a species and that ‘more properties and thus more lines of evidence are associated with a higher degree of corroboration’.

Building further on the ‘lines of evidence’ criteria proposed by the 2004 workshop (Reeves *et al.,* 2004) and the ‘properties acquired by lineages’ evidence described by de Queiroz (2007), a Special Issue series of six papers in Marine Mammal Science (Volume 33, summarised in Taylor *et al.,* 2017a) proposed a set of guidelines and standards for delimiting subspecies and species using (mainly) genetic evidence. Taylor *et al.* (2017a) developed the following subspecies definition: ‘a *subspecies* is a population, or collection of populations, that *appears to be* a separately evolving lineage with discontinuities resulting from geography, ecological specialization, or other forces that restrict gene flow to the point that the population or collection of populations is diagnosably distinct'. The 'Guidelines and Standards' chapter of the Special Issue (Taylor *et al.,* 2017b) pointed out that this definition is consistent with the subspecies concept discussed in Reeves *et al.,* (2004), but is more explicit in requiring *diagnosability* – as defined in another Special Issue chapter (Archer *et al.,* 2017): 'diagnosability is a measure of the ability to correctly determine the taxon of a specimen of unknown origin based on a set of distinguishing characteristics'. Diagnosability and its applicability for making subspecies-distinctions are discussed in detail by Archer *et al.* (2017).

Martien *et al.* (2017), recognising the increasingly important role of genetic data in cetacean species and subspecies delimitation, reviewed seven categories of analytical methods and focused on the ability of each to distinguish subspecies from populations and species, the degree of diagnosability between putative taxa and the extent to which the putative taxa have diverged along separate evolutionary pathways. Martien *et al.* (2017) recognised that two types of metrics are needed to evaluate taxonomic 'cases' (i.e. proposed taxonomic distinctions being reviewed to determine consistency with species-, subspecies-, or population-level divergence). These include the degree of genetic differentiation (which varies along a continuum from population-level divergence to subspecies to species) and the degree of diagnosability (useful for distinguishing subspecies vs. population-level divergence). They concluded that 'diagnosability is best estimated with either assignment tests or multivariate methods, while evaluating the degree of divergence requires a synthesis of multiple lines of evidence derived from different analytical methods and different data types, including nongenetic data' (Martien *et al*., 2017).

Rosel *et al.* (2017a) reviewed 32 peer-reviewed articles for methodology, consistency of markers and analytical methods used, and overall quality of arguments used, when genetic data were employed to delimit new species and subspecies of marine mammals. A mixture of both sound and inadequate practices for use of genetic data for cetacean taxonomy was found in these studies; limitations often included lack of basic background material such as distribution maps and sampling records and inadequate geographic coverage for broadly-distributed taxa. These common limitations suggested that improvements could be made when using genetic data in cetacean taxonomy by developing standardised guidelines for a minimum set of information to be included in such efforts, clear articulation of the taxonomic question being investigated, adequacy of sampling, choice of genetic markers used, and analytical methods and strength of evidence required to support taxonomic conclusions reached (Rosel *et al.,* 2017a). A separate Special Issue paper then went on to explore, using pairs of well-recognised cetacean populations, subspecies and species, a suite of metrics measuring molecular genetic differentiation to examine which best categorised those three levels of divergence when using the mitochondrial DNA control region as the genetic marker; Nei's estimate of net divergence (d_A) and percent diagnosability performed best for making such distinctions. Most species-level distinctions were unambiguously supported by use of these two metrics with this gene region and subspecies-level distinctions were generally supported by intermediate levels of divergence, but some recognised subspecies were more consistent with population-level divergence (Rosel *et al.,* 2017b). These results were combined with the description of a measure of diagnosability (Archer *et al.,* 2017) and recommendations in Rosel *et al*. (2017a), and culminated in a description of 'Guidelines and Standards' for delimiting cetacean subspecies (Taylor *et al.,* 2017b). However, as pointed out in Rosel *et al.* (2017a) and Taylor *et al.* (2017b) and during discussion at the 2018 Workshop, there are risks with relying on a single gene tree; confirmation from multi-locus genotyping should follow particularly for delimiting species. In addition, species identification of dolphins based only on mtDNA control region sequence similarity can be imprecise or misleading due to homoplasy in the recent delphinid radiation (Dizon *et al.*, 2000).

Schwartz and Boness (2017), in the introductory remarks to the Special Issue papers, provide a concise and thoughtful summary of the challenges involved in dividing up the genetic divergence 'continuum' into discrete species and point out that those working for natural resource agencies are charged with delimiting subspecies and other 'units' at and below the species level when such entities are eligible for protection under a legal framework, such as the US Endangered Species Act (1973) and Marine Mammal Protection Act (1972) – both of which give protected status to units below the species level. The current Workshop's consideration of the taxonomic and population-level distinctions proposed for bottlenose dolphins within each of the major geographic regions should be viewed within this context – resource managers in those regions need help in deciding whether such distinctions are warranted and whether the proposed population-, subspecies- and species-level distinctions are supported by sufficiently strong and diverse lines of evidence.

Workshop participants discussed the various recommendations in Reeves *et al.* (2004), Taylor *et al.* (2017a, 2017b), Martien *et al.* (2017), Rosel *et al.* (2017a and 2017b), and Archer *et al.* (2017) focusing on how the current Workshop could make practical use of the criteria, standards, and guidelines therein for making informed judgments about the population-, subspecies- and species-level distinctions proposed for *Tursiops* within each of the geographic regions we reviewed. The Workshop recognised that attempting to impose discrete categories on the continuum of genetic divergence is problematic, but accepted (at least in principal) the proposed species and subspecies definitions (as outlined above) and also that the 'Special Issue' proposed guidelines are useful for both proposing taxonomic and population-level distinctions and for assessing the information used to support such distinctions. The 2018 Workshop participants agreed to use these general guidelines: 100% diagnosability is not required for populations or subspecies; subspecies and species cannot be clinal; subspecies do not have to be reproductively isolated from other subspecies; reproductive isolation of species can be incomplete even when introgression is rare; phylogenetic analyses can be informative as they demonstrate evidence for independently evolving lineages, but should be cautiously interpreted whether or not reciprocal monophyly between the focal groups is found; the type of markers used for monophyly distinctions is important and such evidence must be considered cautiously; contradictions between evidence for lineage separation from nuclear and mitochondrial markers must also be thoroughly evaluated; and the context for differences found for such markers should take into account potentially confounding factors such as gender, sex-biased dispersal, effective population size, social structure, the potential for environmental plasticity, the different 'response time' of nuclear vs. mitochondrial markers, etc.

2.4 Review: distribution-related terminology

The earliest geographic distinctions proposed for bottlenose dolphins that we reviewed (Ross, 1977; Walker, 1981; Van Waerebeek *et al.,* 1990; Ross and Cockroft, 1990) were usually characterised as 'coastal' vs. 'offshore' and these authors carefully used the neutral term 'forms' to describe the types found in different areas while marshalling the evidence to (potentially) recognise them as different populations, subspecies or species. Occasionally there are references to 'inshore' (e.g. Chen *et al.,* 2017) or distinctions between 'coastal' vs. 'pelagic' (e.g. Louis *et al.,* 2014). For consistency, our usage here typically contrasts 'coastal' vs. 'offshore'; we use the terms 'types', 'forms' and 'units' as neutral descriptors while assessing the evidence supporting potential distinctions. Some authors recognise apparent differences in feeding ecology between the dolphins found in different areas as 'coastal ecotype' vs. 'offshore ecotype' (e.g. Felix *et al.,* 2017) and morphological differences have similarly been recognised as 'morphotypes' – we choose not to use either of these terms here. The definition of the term 'population' is hard to pin down and has widely different meanings for different disciplines (see Waples and Gaggiotti, 2006 for a full discussion). In our usage 'population-level distinctions' refers to populations that exhibit significant differentiation (primarily genetic), but below that expected for subspecies and satisfy the criteria found useful for delineating units deserving separate-management recognition (such as DIPs).

2.5 Strategy for objective recognition of taxonomic and population-level distinctions for *Tursiops*

The approach summarised below was developed over the course of the 2015-2017 *Tursiops* review, as we considered: (a) existing and proposed population, subspecies and species distinctions; (b) the evidence supporting each distinction; (c) species and subspecies 'concepts' and definitions; and (d) the criteria and guidelines for delimiting these taxonomic units that have been suggested by previous workshops and in publications we reviewed. This strategy is an update of the 'objectives' originally drafted in the proposal for holding the 2018 Workshop.

(1) *Use established criteria and guidelines for objective assessment of taxonomic and population-level distinctions in* Tursiops.

Using established and more recently proposed criteria and guidelines for the types of data, analyses, and supplementary information that should be included:
- identify key 'taxonomic' (subspecies, species) and population-level distinctions proposed for bottlenose dolphins within each of the major geographic regions that were reviewed previously by the sub-committee and at the 2018 Workshop;
- consider the relative importance of morphology, behaviour, mitochondrial and nuclear genetic data for consideration of differences at the species, subspecies and population levels;
- consider also the use of established and new genetic markers, morphological analyses, behavioural and ecological evidence, and their integration towards a consistent classification for the genus; and
- summarise evidence in support of or against the proposed distinctions, including sample sizes, amount of sequence data and diversity of genetic markers used, geographic coverage of specimens used and supplementary information (life history, parasites, ecology, etc.).

(2) *Evaluate the strength of evidence for recognition of* Tursiops *forms identified in various regions.*

Using the information compiled in the sub-committee's three-year review of *Tursiops* together with any additional information available to:
- review the evidence supporting proposed distinctions (morphological differences, genetic divergence/ connectivity, behavioural differences, ecological/ habitat differences); and
- determine whether proposed population-, subspecies- and species-level distinctions are supported by sufficiently strong and diverse lines of evidence.

(3) *Identify poorly known regional populations that are data deficient and highlight important outstanding areas for further research.*

3. REVIEW OF AVAILABLE EVIDENCE FOR TAXONOMIC AND POPULATION-LEVEL DISTINCTIONS OF *TURSIOPS* IN EACH REGION

Intersessionally, the participants worked in groups, each group on specific assigned geographic regions (see Fig. 1) to summarise all the information reviewed during the Scientific Committee meetings and relevant to the population, subspecies and species distinctions proposed in publications we reviewed. Proposals came from publications we reviewed during the 2015-2017 Scientific Committee meetings and supporting information came from those reviews plus any new information available to the Workshop. The Summary Table is available in Annex D.

3.1 Review of the intersessional summary table

The groups reviewed the Summary Table information, updated it where necessary and prepared concise summaries for their assigned regions aiming to highlight the key issues. Each region's information was presented in a PowerPoint presentation addressing the following questions:

(1) What are the population, subspecies and species distinctions at issue in this region?
(2) What lines of evidence have been used?
(3) What analyses have been performed to address the validity of the proposed distinctions?

Based on the Summary presentations, Workshop participants discussed the status of the existing taxonomy in each region, support for or against additional taxonomic (subspecies, species) and population-level distinctions, and what information, data, or additional analyses are still needed for final conclusions. Participants also identified data-deficient areas for which no decisions on *Tursiops* taxonomy and population structure could be made (see Item 6 below). A synopsis of each regional summary presentation and following discussions are given below and include: (a) newly-available information; (b) reviews of information compiled during 2015-2017 sub-committee reviews; (c) the 2018 Workshop's evaluation of the strength of the evidence; (d) our conclusions regarding the support for and against proposed population, subspecies and species distinctions, recommendations; and (e) suggestions for future work (Workshop agenda Items 3, 4, 5).

3.2 Summary of information available and evaluation of taxonomic and population-level distinctions of *Tursiops* in each geographic region

3.2.1 Indian Ocean / Western South Pacific

Both *Tursiops truncatus* and *Tursiops aduncus* are found throughout the Indian Ocean and western South Pacific.

Numerous studies of bottlenose dolphins in this region have been conducted, but there are large areas where data remain sparse and would be potentially very useful, especially most of the eastern coast of Africa and the region from Pakistan through to Indonesia and Papua New Guinea. Questions to address within this region include the resolution of multiple lineages of *T. aduncus*, the magnitude of the divergence between *T. truncatus* and *T. aduncus* (which exceeds that between some delphinid genera) and further assessment of a recently described new species from southern Australia, '*T. australis*' (Charlton-Robb *et al.,* 2011).

Data pertinent to these issues were available from South Africa, Tanzania, Eritrea, Oman, Pakistan, India, Bangladesh, many locations around Australia, the Solomon Islands, New Caledonia and New Zealand. Relatively high-resolution data, including mitogenomes (Moura *et al.,* 2013) and RADseq phylogenies from a manuscript in preparation made available to the 2018 Workshop (Moura *et al.,* pers. comm.) allowed comparison between South African, Oman, Pakistan, India and Australia, together with mitogenome data for further regions around Australia, Indonesia and New Zealand (Cornaz, 2015). The ddRAD data (~4 million bp sequence data) confirmed a relatively deep divergence between *T. truncatus* and *T. aduncus* and suggested a monophyletic *Tursiops* genus, with fairly extensive reticulation (especially between coastal and offshore populations in the North Atlantic). Within the *T. aduncus* lineages there were three well-defined lineages separating a South African through Oman named 'Holotype lineage', samples previously identified as '*T. australis*' from South Australia (Charlton-Robb *et al.,* 2011) and a lineage comprised of samples from eastern Australia. An extended mitogenome analysis (see Moura *et al.,* 2013; Gray *et al.,* 2018; Cornaz, 2015) identified at least five *T. aduncus* lineages with relatively deep nodes: the Holotype lineage, a newly identified 'Pakistan' lineage (see Gray *et al.,* 2018), western Australia, eastern Australia and samples previously identified as '*T. australis*' from South Australia.

Samples from Bangladesh sequenced for the mtDNA control region also formed a distinct lineage (Amaral *et al.*, 2015; Gray *et al.*, 2018), which should be compared with the Pakistan lineage at higher resolution when possible. Further sampling in Indonesia, Taiwan and China may reveal a further lineage associated with the eastern Australia lineage. An earlier study with limited samples within regions compared South Africa and Australia *T. truncatus* and *T. aduncus* body lengths and skull lengths. This study showed almost no overlap between species but no differentiation in relative skull length within species among regions (Hale *et al.,* 2000). A comprehensive study comparing cranial measurements among Oman and Pakistan specimens showed significant differentiation between the *T. truncatus*, *T. aduncus* Holotype and Pakistan *T. aduncus* lineages (most strongly differentiating *T. truncatus* and *T. aduncus*; Gray, 2018). The data for *T. truncatus* in the Indian Ocean are relatively few, mostly from Oman, where the mtDNA lineage fits into the broader lineage found worldwide (Gray *et al.,* 2018).

Low but significant population genetic structure was found for *T. aduncus* in South Africa and Tanzania (Natoli *et al.,* 2008; Sarnblad *et al.,* 2011). Populations of *T. aduncus* and *T. truncatus* around Australia have been intensively studied, using microsatellite DNA, mtDNA and in some locations Y-markers (at low resolution; Gross, 2014). Strong genetic differentiation between *T. aduncus* and *T. truncatus* is seen throughout this range, where *T. aduncus* is consistently coastal and *T. truncatus* consistently offshore in distribution. Population structure is seen for both species throughout Australia, sometimes at a fine geographic scale (e.g. Ansmann *et al.,* 2012; Wiznieswski *et al.,* 2010; Allen *et al.,* 2016; Moller *et al.,* 2007) and including *T. truncatus* lineages along the southern coast for which the geographic distribution is not fully known (Krützen *et al.,* pers comm.).

In southern Australia, samples from two regions (near Port Lincoln and near Melbourne) have been identified previously as a putative new species: '*T. australis*' (Charlton-Robb *et al.,* 2011). The samples from near Port Lincoln were those identified within the *T. aduncus* lineage in the ddRAD phylogeny (Moura *et al.,* pers. comm.) and have a mitogenome haplotype that is basal to the rest of the samples within the genus (Moura *et al.,* 2013). Those near Melbourne have this same mtDNA haplotype, but greater autosomal affinity to *T. truncatus* (based on microsatellite DNA data). It is possible that the 'Melbourne' population represents a population with *T. truncatus* ancestry introgressed with mtDNA from the 'Port Lincoln' lineage. Morphological studies for samples from throughout Australia and including the southern Australian range clearly differentiated *T. aduncus* from *T. truncatus* skulls, but did not find the differentiation between the '*T. australis*' and *T. truncatus* skulls reported in an earlier study (Jedensjö *et al.,* 2015; Charlton-Robb *et al.,* 2011).

In summary, both *T. truncatus* and *T. aduncus* are found in the Indian Ocean and western South Pacific, and both morphological and molecular genetic data provide strong evidence that their taxonomic rank as two separate species is valid. Little research has been conducted on intraspecific variation within *T. truncatus* in this region and the Workshop **agreed** that this should be investigated further, especially the potential for coastal/offshore differentiation. In contrast, numerous genetic and morphological studies of *T. aduncus* have been conducted and several distinct lineages have been observed. The Workshop **recommended** that these lineages be investigated further, using both morphological and molecular genetic data to assess possible subspecies classification. It was **noted** that extensive areas are lacking sample coverage (eastern Africa, throughout Indonesia and eastern Australia) and that the analysis of samples from those areas is critical to clarifying the species and subspecies classifications. Workshop participants concurred with conclusions of the Society for Marine Mammalogy's Committee on Taxonomy that the basis for the taxonomic status of '*T. australis'* is questionable due to discordant results using different genetic markers and from different studies of morphological differences between '*T. australis'* and *T. truncatus* specimens. The apparent mixture of multiple-species-lineages in mitochondrial and autosomal data of '*T. australis'* samples does not meet the criteria for species designation. The Workshop **encouraged** continued and collaborative studies of animals associated with the '*T. australis'* mtDNA lineage in the context of both *T. truncatus* and *T. aduncus*.

3.2.2 Eastern North Atlantic

Tursiops truncatus is the only species recognised in the eastern Atlantic. Data from the region are not homogeneous, with a large portion (south of the Strait of Gibraltar along and off the entire African Atlantic east coast) almost totally unrepresented, except for some data from oceanic islands. Occurrence of *Tursiops truncatus* in the coastal waters of most west African states is reported, including records from western Morocco, Western Sahara, Mauritania, Senegal, The Gambia, Guinea-Bissau, Sierra Leone and Liberia, Cote de Ivoire, Ghana and Sao Tome/Principe (summarised in Weir *et al.*, 2010; Van Waerebeek *et al.*, 2008; Van Waerebeek *et al.*, 2016). There are clearly also bottlenose dolphins farther offshore observed around the Cape Verde (Hazevoet *et al.*, 2010) and Madeira archipelagos (Queroil *et al.*, 2007), and many records from the Canary Islands (e.g. Arbelo *et al.*, 2013; Garcia-Alvarez *et al.*, 2014).

The main questions in the eastern North Atlantic are the extent of structure among coastal populations and whether the degree of differentiation between coastal and offshore forms warrants subspecies or species classification, or is more consistent with population-level divergence. For samples collected north of the Strait of Gibraltar, multiple lines of evidence have been considered. Nuclear (microsatellite) and mtDNA (control region) analyses identified significant differentiation between coastal and offshore forms, with further structure detected within each type (Natoli *et al.*, 2004; Natoli *et al.*, 2005; Louis *et al.*, 2014a), but shared mtDNA control region haplotypes have been found between the two forms (Louis *et al.*, 2014b). Stomach contents analysis confirmed differences in the dominant fish prey between offshore (bycatch) and coastal (beachcast) individuals, and stable isotope analysis also showed significant differences between the two groups (Louis *et al.*, 2014b). However, morphological data including total body length and measurement of different body parts failed to identify any significant differentiation between coastal and offshore individuals (Louis *et al.*, 2014b), corroborating results of the population demographic history analysis based on genetic data that suggested a recent divergence between coastal and offshore forms. Thus, some genetic differentiation between coastal and offshore *Tursiops* is observed in the ENA, but a lack of significant morphological divergence does not provide a strong second line of evidence supporting a change to the current taxonomy.

At the population level, dolphins along the coasts of Britain, Ireland and Europe tend to be found in isolated units with high levels of site fidelity (Fernandez *et al.*, 2011; Mirimin *et al.*, 2011; Louis *et al.*, 2014a). A now-extinct population in the North Sea was distinct from the Scottish and English Channel populations (Nichols *et al.,* 2007). No population structure was detected among the oceanic islands of the Azores and Madeira and *Tursiops* sampled from Madeira were placed within the 'global' Atlantic mtDNA lineage (Queroil *et al.*, 2007).

In summary, based on the data available *T. truncatus* is the only bottlenose dolphin species recognised in the ENA. Although strong morphological differences between coastal and offshore forms of *T. truncatus* have been found in the western North and western South Atlantic, there is no evidence to date that multiple diagnosable morphological forms exist in the eastern North Atlantic. Moderate genetic differentiation has been recorded between offshore and coastal populations off the coast of Europe and in concert with stable isotope data, indicate at least some ecological habitat partitioning among populations in the eastern North Atlantic. However, a comprehensive morphological study has not yet been conducted in the region and Workshop participants **recommended** such a study should be undertaken. Population structuring has been identified within the coastal animals, but molecular genetic comparisons across island-associated offshore dolphins have not revealed significant population structure. Studies of bottlenose dolphins in coastal and offshore waters of the African continent north of the Equator are lacking and this represents one of the data-deficient areas identified by the Workshop. Participants **recommended** collaborative efforts to be encouraged to examine *Tursiops* in the region, including sample collection for morphological and molecular genetic analyses.

3.2.3 Mediterranean and Black Seas

In the Mediterranean and Black Sea (and adjacent North Atlantic) only *Tursiops truncatus* is found, with the Black Sea population recognised as a distinct subspecies, *Tursiops truncatus ponticus.* This subspecies distinction was based principally on morphological data (Barabasch-Nikiforov, 1960; Geptner *et al.,* 1976) and evident geographical isolation. Conservation status of *Tursiops truncatus ponticus* was assessed by the IUCN (Birkun, 2012) and designated Endangered. The main taxonomic questions for this region are: (1) should the Black Sea bottlenose dolphin continue to be recognised as a subspecies? and (2) is the Mediterranean bottlenose dolphin also eligible for subspecies recognition?

Recent genetic and morphological studies (Natoli *et al.,* 2005; Viaud-Martinez *et al.,* 2008; Moura *et al.,* 2013; Moura *et al.,* pers. comm.) have assessed divergence of the Black Sea bottlenose dolphin and confirmed recognition as a distinct subspecies. Genetic data for this population included nuclear DNA markers (Natoli *et al.,* 2005; Moura *et al.,* pers comm.) and mitochondrial DNA (Natoli *et al.,* 2005; Viaud-Martinez *et al.,* 2008; Moura *et al.,* 2013); all these analyses compared Black Sea bottlenose dolphins with the neighbouring Mediterranean and Atlantic populations. Significant genetic differentiation at both nuclear and mtDNA was detected, but no complete lineage sorting (reciprocal monophyly) was observed at the mtDNA level (haplotypes were shared between the Black Sea, eastern and western Mediterranean and eastern North Atlantic). However, high-resolution nuclear DNA sequence data (ddRAD, Moura *et al.,* pers. comm.) resolved the Black Sea samples as monophyletic, suggesting therefore that such high-resolution genetic analysis is needed to identify and confirm lineage divergence in *Tursiops*. That resolving the divergence of Black Sea bottlenose dolphins is challenging might reasonably be expected, as the radiation can only be recent given the young age (about 8,000yrs) of the Back Sea (see discussion in Moura *et al.*, 2013).

New morphological studies have reinforced the original morphological data and supported the observed genetic differentiation. Principal component analysis based on cranial morphology and total body length (Viaud-Martinez *et al.,* 2008) confirmed the smaller cranial and body size of *T. t. ponticus* versus other populations. A more recent morphological study compared body length of Black Sea bottlenose dolphins with the original data of Barabasch-Nikiforov (1960) and suggested the possible presence of offshore (bigger) and inshore (smaller) forms within the Black Sea (Gol'din *et al.,* 2015).

Genetic analyses, utilizing both nuclear and mtDNA markers, showed significant genetic differentiation between the Mediterranean population and the neighbouring Atlantic populations (Natoli *et al.,* 2004; Natoli *et al.,* 2005). However, at the mtDNA level no lineage sorting is apparent, with haplotypes shared between the two basins (Natoli *et al.,* 2005; Moura *et al.,* 2013); ddRAD analysis clusters all the Mediterranean samples within the same lineage (Moura *et al.,* pers. comm.). No dedicated comprehensive morphological studies comparing the Mediterranean and Atlantic populations have been conducted, except for comparison of secondary data of total body length (Gol'din *et al.,* 2015). Stomach content comparisons between Mediterranean and Atlantic samples showed clear difference in diet (Blanco *et al.,* 2001).

Both nuclear and mtDNA genetic data suggested clear population structure within the Mediterranean Sea with genetically different populations (Natoli *et al.,* 2005; Gaspari *et al.,* 2015) distinguishable from east to west and within basins (i.e. Adriatic Sea), that well mirrors the environmental complexity and habitat variability of the Mediterranean Sea, and the tendency of this species for philopatry and adaptation to local habitats. This is supported by observed estimated low migration rates between different regions (Natoli *et al.,* 2005). In the Alboran Sea, comparisons across the Oran-Almeria thermal front showed differentiation consistent with that reported for various other species in this region (see Natoli *et al.,* 2005; Natoli *et al.,* pers. comm.). One morphological study investigated the total body length and skull morphology across the Mediterranean basin (but with no comparisons to the Black Sea animals) and identified the Levantine population as significantly smaller animals than the rest of the Mediterranean samples, suggesting the existence of a form of dwarfism in that region (Sharir *et al.,* 2011).

In summary, only *T. truncatus* is recognised across the Mediterranean and Black seas. *Tursiops* in the Black Sea have been isolated from those in the Mediterranean and Atlantic long enough to exhibit unique morphological and genetic characteristics. The Workshop **agreed** that multiple data types provide strong support for recognition of the Black Sea bottlenose dolphin as a separate subspecies *T. t. ponticus*. Within the Mediterranean Sea, molecular genetic data provide strong evidence for population structure within the Mediterranean basin but do not provide evidence to date for any higher taxonomic divisions. Few morphological studies have been conducted. Evidence for a genetically distinct population characterised by smaller size has also been provided for dolphins in the Levantine area. The Workshop **recommended** comprehensive morphometric analyses comparing *Tursiops truncatus* throughout the Mediterranean to those in the Black Sea and those in the eastern Atlantic to evaluate whether any regions may harbour a taxonomic unit above the level of population. It was also noted that large areas of the basin are data deficient and participants **stressed** the importance of gathering genetic and morphological specimens from those areas including offshore waters for a more comprehensive understanding of the population structure within the basin.

3.2.4 Eastern South Atlantic

This is perhaps the most under-represented area with respect to information on *Tursiops*. Little is known from this this region along the West African coast South of the Equator. As with the African coast North of the equator, the occurrence of *Tursiops truncatus* in the coastal waters of most West African states is likely, including reports from Gabon, Namibia and South Africa (summarised in Weir *et al.*, 2010; Van Waerebeek *et al.*, 2008; de Boer, 2010; Van Waerebeek *et al*., 2016). The main question in this region is the degree of differentiation between coastal and offshore forms. It appears that *Tursiops* are found in the coastal zone throughout the west African region, but only a few scattered samples are available; a few samples from Senegal and Namibia have been subject to genetic analysis and fall into the global lineage (Hoelzel *et al.*, 1998).

In summary, only *T. truncatus* is expected to be present in the eastern South Atlantic Ocean. The Workshop identified the eastern South Atlantic as the region with the least available information on bottlenose dolphin diversity. The lack of available information hampered the ability to draw conclusions about *Tursiops* taxonomy and population structure in this region. Workshop participants **recommended** comprehensive information be compiled on active researchers in the region and numbers and locations of morphological and molecular genetic samples that have been collected to date. This process was initiated intersessionally by the Workshop participants (see Annex E); the Workshop **recommended** progressing it forward. The Workshop also **noted** that coordinated efforts are needed to improve our understanding of *Tursiops* in the region. In addition, as with the eastern North Atlantic region, collaborative efforts to examine *Tursiops* throughout the region should be encouraged and facilitated, and it would be most informative if these efforts were extended to include West African waters North of the equator so that the full African coast is considered.

3.2.5 Western North Atlantic

A single species, *T. truncatus,* is recognised in the western North Atlantic. However, multiple lines of evidence support the existence of sympatric or parapatric coastal and offshore forms in this region, including morphology, genetics, parasite loads, habitat and prey preferences and biochemical markers (Hersh and Duffield, 1990; Mead and Potter, 1995; Hoelzel *et al.,* 1998; Kingston *et al.,* 2009; Rosel *et al.,* 2009; Costa and Rosel, 2016; Rosel and Wilcox, 2016; Vollmer *et al.,* 2017). The taxonomic question addressed for this region was: do available data support elevating the coastal form in the western North Atlantic to subspecies or species status?

Genetic data for the region include mitochondrial DNA (mtDNA) control region sequences, full mitogenome data, microsatellite data, anonymous fragment length polymorphism data and ddRAD sequence data (e.g. Kingston *et al.,* 2009; Rosel *et al.,* 2009; Caballero *et al*., 2012; Richards *et al.,* 2013; Moura *et al.,* 2013; Moura *et al.,* pers. comm.). All marker types indicate significant genetic differentiation between the coastal and offshore forms and the mitogenome and ddRAD data suggest the coastal form is sister to all other *T. truncatus* samples included in the analyses (Moura *et al.,* 2013; Moura *et al.,* pers comm.). All datasets reveal reciprocal monophyly between the two forms and control region haplotype networks indicate eight mutations between them. The amount of genetic differentiation between the two forms is greater than that found between offshore and coastal forms elsewhere in the world (i.e. ENP, WSA) and meets the Taylor *et al.* (2017) mtDNA control region threshold for species distinction. At the population level, significant genetic differentiation and fine-scale population structure have been found within the coastal ecotype in both the western North Atlantic and the Gulf of Mexico (Sellas *et al.,* 2005; Parsons *et al.,* 2006; Rosel *et al.,* 2009; Rosel *et al.,* 2017; Vollmer and Rosel, 2017). Within the offshore form, population subdivision has been detected in the northern Gulf of Mexico (Vollmer *et al.,* 2017).

Morphological data corroborate the genetic studies. Mead and Potter (1995) found significant separation between coastal and offshore forms using a differential relationship between specific cranial measurements. More recently, a principal components analysis of 19 cranial measurements in 101 physically mature skulls from the western North Atlantic revealed two well-separated groups corresponding to the coastal and offshore forms (Costa and Rosel, 2016). Offshore animals tend to be larger than coastal animals and have larger skulls. The level of difference between skulls of the two forms meets the diagnosability criterion of Patten and Unitt (2002) for at least subspecies (Costa and Rosel, unpublished). A principal components analysis of vertebral measurements also found significant differentiation between the two forms. The offshore form has more vertebrae than the coastal form, although sample sizes are relatively low (Costa and Rosel, 2016). While there is significant morphological and genetic differentiation between the two forms in the western North Atlantic, Costa and Rosel (2016) did not find significant differences in cranial morphology between the offshore forms in the western North Atlantic and western South Atlantic, suggesting the offshore animals in both hemispheres are members of a more broadly distributed pelagic form.

Overall, the genetic and morphological data provide strong support for recognition of the coastal ecotype in the western North Atlantic as at least a separate subspecies. Additional genetic analysis to rule out significant levels of male-mediated gene flow between the two forms and to put the level of divergence of the coastal animals in a worldwide context is needed in order to identify the appropriate taxonomic rank of the coastal bottlenose dolphins in the western North Atlantic.

In summary, only *T. truncatus* is present in the western North Atlantic Ocean but two morphologically distinct forms are documented. These two forms, a smaller coastal form and a larger offshore form, also differ in habitat, prey preferences and parasite loads, and exhibit significant molecular genetic divergence at multiple genetic markers. The degree of morphological and molecular genetic divergence meets their respective criteria for at least subspecies status for the coastal form. Workshop participants **noted** that an evaluation of male-mediated gene flow between the two forms is needed to complete the studies necessary to accurately assess and finalise the taxonomic status of the coastal form. Significant fine-scale population structuring and evidence for multiple demographically-independent populations has been found among the coastal animals in the western North Atlantic. Morphological and molecular genetic analyses of the offshore form in the western North Atlantic suggest it is a member of the more broadly distributed *Tursiops truncatus truncatus* subspecies.

3.2.6 Western South Atlantic

Two subspecies of *Tursiops truncatus* are recognised in the western South Atlantic, *T. t. truncatus* (offshore) and *T. t. gephyreus* (coastal). The taxonomic questions addressed here were: (1) do available data support subspecies status for *T. t. gephyreus*? and (2) do available data support elevating *T. t. gephyreus* to the species level?

Genetic data for the region include mtDNA control region sequences and microsatellite data (Fruet *et al.,* 2014; Costa *et al.,* 2015; Costa *et al.,* 2016; Costa and Rosel, 2016; Fruet *et al.,* 2017). Despite reasonable sample sizes, these studies found no shared haplotypes between offshore and coastal forms. However, Costa (pers. comm.) reports finding one shared haplotype between the forms – the haplotype of a specimen morphologically identified as *T. t. gephyreus* was shared with offshore animals. Based on the network in Fruet *et al.* (2017), reciprocal monophyly would not be expected in a phylogenetic analysis of the control region data.

Fruet *et al.* (2017) collected samples in oceanic waters >150m deep and >103km from shore from the state of Paraná (PR), in southern Brazil to Uruguay (~ 23°-34°S) representing *T. t. truncatus,* and compared them to samples collected in nearshore coastal waters and lagoons from ~ 23°-54°S, representing *T. t gephyreus*. Microsatellite analysis (11 loci) indicated the two sample sets were strongly differentiated. One individual biopsied in the offshore waters exhibited evidence of co-ancestry (~25%) with the coastal animals. However, Oliveira *et al.* (2016), using 7 microsatellite loci, provided some evidence for introgression between samples morphologically identified as *T. t. truncatus* and *T. t. gephyreus.* This result may be due to the small number of microsatellite loci used. Further work is necessary to determine whether there is any substantial male-mediated gene flow between the two subspecies.

Fine-scale population structure has been exhibited in the coastal form from southern Brazil down to Bahia San Antonio, Argentina (Fruet *et al.,* 2014). Oliveira *et al.* (2016) reported evidence for population structure, likely for the offshore form, *T. t truncatus*, between northern and south-central Brazil using stranded samples. Fruet *et al.* (2014) also suggested, based on microsatellite data, that the coastal *T. t. gephyreus* population in Bahia San Antonio was an evolutionarily significant unit, separate from *T. t. gephyreus* in Uruguay and Brazil.

The results of osteological comparisons of coastal and offshore specimens from the waters of Brazil, Uruguay and Argentina strongly support the presence of two taxa at least at the subspecies level, if not full species. Skulls from coastal dolphins are significantly larger than those offshore (Costa *et al.,* 2016; Wickert *et al.,* 2016) as well as other regions around the world (Hohl *et al.,* 2016). Up to six fully diagnostic skull characters have been described (Costa *et al.,* 2016; Wickert *et al.,* 2016). Skulls are also fully diagnosable using standard morphometric measurements (Costa *et al.,* 2016; Wickert *et al.,* 2016), or nearly so (98%-100%) using 2-dimensional geometric morphometrics (Hohl *et al.,* 2016). As demonstrated in Costa *et al.* (2016), in a small number of samples for which complete data were available (n=17), the forms are also fully diagnosable using a combination of vertebral formula and vertebral shape characters. Overall, the genetic and morphological data provided strong support for recognition of the subspecies *T. t. gephyreus*; in fact, the morphological differences observed are on par with those distinguishing other small cetacean species (e.g. *Neophocaena* spp., Jefferson and Wang, 2011). Additional genetic analysis to rule out significant levels of male-mediated gene flow between the two subspecies and estimate a divergent date between them is needed before species status can be robustly evaluated.

In summary, as in the western North Atlantic, only *T. truncatus* is recognised in the western South Atlantic Ocean, but here again two morphologically distinct forms have been identified. In this region, however, the coastal form is larger than the offshore form, in contrast to what is seen in the western North Atlantic. The degree of morphological differentiation between the two forms in the western South Atlantic recently lead to the coastal form being elevated to subspecies status, *T. t. gephyreus* while the offshore form appears to be a member of the more broadly distributed *Tursiops truncatus truncatus* subspecies. Workshop participants **agreed** that the morphological data strongly support the recognition of the coastal form as a separate subspecies, if not a full species. Molecular genetic divergence at mtDNA is less than that seen between the coastal and offshore forms in the western North Atlantic. At least one shared mtDNA control region haplotype has been reported between *T. t. truncatus* and *T. t. gephyreus,* and nuclear microsatellite data suggest the possibility of some interbreeding between the two forms, although the number of nuclear markers examined to date has been low. The Workshop **recommended** that additional nuclear DNA data be collected to more fully characterize the degree of divergence and potential for ongoing male-mediated gene flow between coastal and offshore forms in the western South Atlantic to aid in determining whether *T. t. gephyreus* might more accurately be elevated to species status. Molecular genetic data support multiple demographically-independent populations within *T. t. gephyreus,* while there are insufficient data to establish whether there is population structure within the offshore form in this region.

3.2.7 Eastern North Pacific

Bottlenose dolphins in the eastern North Pacific are considered to be *Tursiops truncatus*; no subspecies are currently recognised within the region. Coastal and offshore forms have been recognised, largely on the basis of morphology and genetics. The main question in this region regards the magnitude of the coastal/offshore divergence and some latitudinal differences between coastal forms – in each case the question is whether the divergence is consistent with population-level distinction; should the coastal vs. offshore bottlenose dolphins in the Southern California Bight, northern Gulf of California vs. mainland Mexico vs. southern Baja Pacific coast, and eastern tropical Pacific dolphins be recognised as distinct population units? Should any of the populations be considered subspecies?

Initial studies by Walker (1981) found two clusters in a multivariate analysis of skull measurements, one comprised of offshore animals, most of which were captured off the Channel Islands, and the other comprised of beach-cast animals from California and Mexico, including the Gulf of California. Subsequent analysis of cranial characters in larger samples of skulls collected from offshore and coastal dolphins (as verified genetically) in California waters were consistent with the earlier results, showing differences between the two forms primarily in characters associated with feeding (Perrin *et al.,* 2011). Coastal animals exhibited larger and fewer teeth and generally larger, more robust cranial features and the diagnosability based on these skull characteristics was high (96.4% for adults) (Perrin *et al.,* 2011). Genetic analyses comparing the coastal and offshore forms in California waters supported the recognition of the two types, with significant genetic differences observed in both mitochondrial and nuclear analyses (Lowther-Thieleking *et al.,* 2015). Only a single haplotype was shared; this haplotype was common among the coastal form but found in only a single offshore individual. Long-term photo-identification studies of these coastal dolphins have shown that they range from northern California at least as far south as Ensenada, Baja California, with little mixing with the coastal dolphins photographed only 150km to the South, off San Quintin, Mexico (Defran *et al.,*1999a, Defran *et al.,* 2015; Hwang *et al.,* 2014). Within this range, coastal dolphins are typically found within 1km of shore, while offshore bottlenose dolphins generally use waters 4km or more from the coastline (Defran *et al.,* 1999b).

Genetic analyses of the coastal and offshore forms off the coast of Mexico and within the Gulf of California revealed less-clear patterns. In general, mitochondrial and nuclear genetic differentiation were observed between types in most areas, and some genetic differences were identified within types (Segura *et al.,* 2006; Segura *et al.,* 2018). In particular, dolphins representing the coastal form within the Gulf of California as well as coastal animals sampled south of the Baja Peninsula along the Mexican coast were genetically differentiated from the coastal population sampled (Lowther-Thieleking *et al.,* 2015) in the Southern California Bight/Channel Islands/San Diego areas. Analysis of stable isotopes also revealed differences between the nearshore and offshore types within the Gulf of California and along mainland Mexico, as well as between the animals on either side of the Baja Peninsula (Segura *et al.,* 2018).

Offshore-type bottlenose dolphins are also found in the Eastern Tropical Pacific (ETP). Comparison of cranial parameters revealed differences between these animals and the coastal form in Walker's (1981) study. Some differences in cranial measures and reproductive data were also found between the ETP and the California offshore dolphins, suggesting that the ETP dolphins reach reproductive maturity at a smaller size. However, the number of samples representing both the ETP offshore stratum (n=20, most of which were collected from animals bycaught in tuna purse-seine fishery) and the California offshore stratum (n=12) was small. Comparison of stomach contents and parasite loads revealed differences between the ETP offshore and coastal dolphins.

In the waters surrounding the main Hawaiian Islands, island-associated populations of *T. truncatu*s are found close to shore while more pelagic *T. truncatus* are found in deeper offshore waters (Baird *et al.,* 2009; Martien *et al.,* 2012). Two samples collected from dolphins off Kauai showed evidence of *T. aduncus* ancestry (Martien *et al.,* 2012).

Relationships among the offshore dolphins of the Southern California Bight, Hawaii and the coast of Mexico and those involved in the tuna fishery of the eastern tropical Pacific should be examined with morphological and molecular approaches. The relationship between upper Gulf of California coastal dolphins and the California/mainland Mexico coastal dolphins should be examined more closely. The specimens, tissue samples and data needed for these comparisons exist; the studies only need to be done. For each comparison, the question of population vs. subspecies status also needs to be addressed. Where existing life history samples and data exist, life history parameters should be included in the comparison of putative populations.

In summary, evidence to date indicates that only *T. truncatus* is present in the eastern North Pacific although two dolphins sampled in Hawaii showed molecular genetic evidence for mixed ancestry with *T. aduncus*. Morphologically distinct coastal and offshore forms are documented along the coast of California South to at least Ensenada, Mexico. In this region, the coastal form tends to be larger than the more widely-distributed offshore form. Molecular genetic analyses using mtDNA and microsatellite data revealed significant differentiation between the coastal and offshore forms off California, although one shared mtDNA haplotype was identified and the level of genetic differentiation was lower than that seen of the coastal and offshore forms in the western North Atlantic. Further South along the Pacific coast of the Baja Peninsula, within the Gulf of California and along the mainland coast of Mexico, *T. truncatus* are also found in both coastal and offshore waters. Molecular genetic data provide evidence for population structure within and between both coastal and offshore animals in the Gulf of California and between this area and the coastal animals found along the California coast. Morphological data are sparse and Workshop participants **recommended** morphometric and further genetic analyses of coastal and offshore dolphins throughout Mexican waters be conducted and compared to those from California and the eastern tropical Pacific, with a particular focus on the relationship of coastal dolphins in the upper Gulf of California to other areas.

3.2.8 Eastern South Pacific

Tursiops truncatus is found in both coastal and offshore waters along the coastlines of Columbia, Ecuador, Peru and Chile (see summary of records reported in Van Waerebeek *et al.,* 1990). To date, there is no evidence for the presence of *T. aduncus* in the region. The main question in this region is potential coastal/offshore differentiation. Five different groups have been proposed in this region: (two offshore, three coastal): Colombia-Ecuador Offshore stock (probably= ETP Offshore), Peru-Chile Offshore, Ecuador Coastal, Peru Coastal and a unique community (Pod-R) on the North-central coast of Chile (Van Waerebeek *et al.,* 2017). Evidence for these distinctions is based on several data types including differences in tooth width (Van Waerebeek *et al.,* 1990), skull morphology (Santillan *et al.,* 2008), dorsal fin proportions (Felix *et al.,* 2017), parasite prevalence (Santillan *et al.,* 2008; Van Bressem *et al.,* 2007; Van Bressem *et al.,* 2015) and genetics (Bayas-Rea *et al.,* 2017; Sanino *et al.,* 2008). Resolution and power of these analyses were hampered by small sample sizes, limited sampling along this immense geographic area, use of low-resolution genetic markers and use of a limited range of analytical methods. The 2018 Workshop concluded that compared to many other regions, there are insufficient morphological and genetic data available to examine potential differences between dolphins found in this area and that more specimens and analyses are needed before the existence of separate forms of *Tursiops truncatus* in this region can be assessed and their taxonomic and population-divergence status determined.

In summary, only *T. truncatus* is recognised in the eastern South Pacific. A few regionally local studies suggest the presence of offshore and coastal forms but a broad-scale synthesis of morphological or genetic data has not been conducted. This region ranked high in the assessment of data deficient areas and Workshop participants were unable to draw conclusions concerning distinctions between offshore and coastal animals. Participants **concluded** that more genetic and morphological specimens and studies are needed throughout this region before assessment of taxonomic or population-level distinctions will be possible. They also **recommended** this work be conducted in a broader geographic context that would include coastal and offshore waters of Central America to Mexico, similar to the recommendation made for the eastern South Atlantic. It would also be useful to expand comparisons around the southern tip of South America to Argentina to examine relationships between dolphins in these two regions

3.2.9 Western North Pacific

Both *Tursiops aduncus* and *Tursiops truncatus* are found in the western North Pacific. Recognition of the two species within this region is supported by morphological and genetic differences. Analysis of available genetic samples of *T. aduncus* from the WNP has shown that they are more closely related to *T. aduncus* found in Australian waters than they are to *T. aduncus* from the Red Sea and the western Indian Ocean (Natoli *et al.,* 2004; Sarnblad *et al.,* 2011; Moura *et al.,* 2013). The key outstanding issues in this region include the occurrence and distribution of these two species in regions where genetic and/or morphological data are currently limited or unavailable and the potential for significant population-level divergence within them in, e.g. island-associated groups.

The differences between the two species are best described for the waters off China and Taiwan. Genetic analyses revealed the presence of seven fixed differences in mtDNA control region sequences between *T. aduncus* and *T. truncatus* (as identified based on morphology) within this range; sequence divergence at the mtDNA control region was estimated at 4.4% (Wang *et al.,* 1999). Differentiation in external morphology and osteological characters also exists between the two species, with non-overlapping distributions of several cranial proportions, total number of vertebra and rostral length characters (Wang *et al.,* 1999; Wang *et al.,* 2000). Of note, the majority of samples utilised in these studies were collected from Taiwanese waters, with only a few samples collected from areas off mainland China. Samples representing *T. truncatus* were primarily collected from the northeastern and southern coasts of Taiwan and the Taiwan Strait, with a few samples collected from the waters of mainland China. Samples representing *T. aduncus* were collected in the Taiwan Strait, off mainland China and in the Gulf of Tonkin; no *T. aduncus* samples were collected from the northeastern or southern portions of Taiwan.

Principal components analysis of cranial measurements of skulls collected along both coasts of Japan revealed the presence of two groups within this region (Kurihara and Oda, 2006, Kurihara and Oda, 2007). When compared with cranial measures from the type specimens, skulls collected from island-associated dolphins in Japanese waters grouped with *T. aduncus*. Reports of *T. aduncus* indicate that this species is found: (1) within the Sea of Japan (Notojima, Mori, 2013; Kunda Bay, Morisaka *et al.,* 2013); (2) in the western and southern waters off Kyushu (Amakusa-Shimoshima Island, Shirakihara *et al.,* 2002; Kagoshima Bay, Nanbu *et al.,* 2006; Hirose 2013); (3) around Amami Island between Kyūshū and Okinawa (Funasaka *et al.,* 2016); and (4) in coastal waters of the Izu Island chain (Mikura Jima, Kakuda *et al.,* 2002; Koji *et al.,* 2013; Tori Shima, Morisaka *et al.,* 2013) and south to the Ogasawara (Bonin) Islands (Mori, 2005; Mori and Okamoto, 2013), ~1400km north of the Marianas. Genetic and acoustic differences between islands have been reported (Hayano, 2013; Morisaka *et al.,* 2005).

Skulls collected from the waters surrounding mainland Japan, including those collected off Taiji on the eastern coast and a single skull collected from Joetsu on the Sea of Japan coast, grouped with *T. truncatus*. Genetic studies also indicate that the bottlenose dolphins caught off of Taiji are *T. truncatus* (Kita *et al.,* 2013). Analyses using both mtDNA control region and microsatellites suggested at least two populations of *T. truncatus* are found off Taiwan and Japan, one with a distribution corresponding with the shallow continental shelf waters and another inhabiting deep continental slope habitat (Chen *et al.,* 2017). Comparison of mtDNA control region sequence data from these populations with published data derived from *T. truncatus* off the Hawaiian Islands and Palmyra (Martien *et al.,* 2014) revealed statistically significant differences between all strata (Chen *et al.,* 2017).

Examination of bycaught individuals in Korean waters suggests that *T. truncatus* is found in the Sea of Japan (=East Sea), Yellow Sea, and East China Sea (unpublished data, referenced in Kim *et al.,* pers. comm.). Evaluation of external morphology from photographs as well as cranial measures from the skull of a stranded animal indicate that the bottlenose dolphins found off Jeju Island, in the southwestern sea of the Korean Peninsula, are *T. aduncus* (Kim *et al.,* 2010; Kim *et al.,* pers. comm.). Published genetic data from these regions is not currently available.

Limited morphological and genetic data exist for bottlenose dolphins in the Philippines. Dolar *et al.* (pers, comm.) notes that both *T. truncatus* and *T. aduncus* are found in Philippine waters, with the former being widely distributed but the latter being found in only a few areas (Balabac Strait, Tanon Strait, and the South China Sea). Photographic verification of the occurrence of *T. aduncus* in the Tanon Strait is provided in Tiongson and Karczmarski (2016). Two samples of *T. truncatus* from the Philippines were included in the microsatellite analysis in Chen *et al.* (2017); although the small sample size precluded drawing any conclusions, it was noted that these two samples formed a cluster distinct from those identified off the coasts of Japan.

Only limited data on *Tursiops* spp. in Vietnam waters exist. A small number of samples (n=3, genetics; n=4, morphology) from the Tonkin Gulf have been analysed and were identified as *T. aduncus* based on both morphology and genetics (Wang *et al.,* 1999; Wang *et al.,* 2000). Smith *et al.* (1997) collected tooth count data from nine *Tursiops* spp. skulls found in Vietnamese temples; at least eight of the skulls were considered to be *T. aduncus* based on small skull size.

Bottlenose dolphins are generally poorly documented in Micronesia. Sightings of *T. truncatus* have been reported in the Mariana Islands (Hill *et al.,* 2014) and samples were collected from 14 individuals (Martien *et al.,* 2014). Nine of the sampled individuals had haplotypes consistent with *T. truncatus*, including two haplotypes that had also been found in bycaught animals from the Philippines. The remaining five samples had haplotypes that were very similar to those collected from Frasier's dolphins in the Philippines, suggesting that introgressive hybridization of Frasier's dolphins mtDNA has occurred into the *T. truncatus* population found near the Marianas (Martien *et al.,* 2014). No morphological or genetic data collected from *Tursiops* spp. in other regions of Micronesia are available.

In summary, morphological and molecular genetic data support the presence of both *T. truncatus* and *T. aduncus* in the western North Pacific. The *T. aduncus* in this region appear to be more closely related to those found in Australian waters than those found in the western Indian Ocean. Morphological and molecular genetic data collected to date do not indicate the presence of intra-specific variation above the population level for either species in this region; mtDNA data do provide evidence for population structure within *T. truncatus*. A major outstanding issue in this region is the need for more comprehensive sampling of both species to better delineate the geographic distributions of both species within and throughout the region. Workshop participants **noted** that large areas are underrepresented in terms of sampling and analyses (e.g. Philippines, Vietnam, Micronesia) and therefore **encouraged** more comprehensive sampling for morphological and molecular genetic analyses.

4. STANDARDISATION OF GENETIC AND MORPHOLOGICAL DATA AND ANALYSES FOR *TURSIOPS* TAXONOMY

4.1 The use of genetic data for understanding odontocete diversity

Use of multiple markers and/or multiple lines of evidence is recommended for a molecular genetic analysis of taxonomy as a single genealogy alone can be misleading. Neutral and selected markers have different utilities and attention should be paid to the type of markers being used to address particular questions.

As high-resolution markers (SNPs, RAD-Seq, ddRAD, etc.) become more accessible, future studies will likely go beyond use of microsatellites and mtDNA sequences. More markers generally equate with an increased power to detect differences. Paired with coalescent-based analyses, even based on only a few samples initially, such studies can help determine a useful level of effort (sampling and marker choice) for the likely level of divergence being tested and that information can be used to design a more complete study. Given enough molecular genetic markers, however, samples can be placed into different clusters that may represent social groups rather than taxonomic entities, so it is critical to have an understanding of the appropriate amount of difference that accurately reflects species-level, subspecies-level and population-level divergences before drawing conclusions concerning taxonomic distinctions. New analytical tools for species delimitation using multi-locus genomic data continue to be developed (e.g. Pei *et al.,* 2018). Finally, more traditional markers like mtDNA for taxonomic studies and mtDNA and microsatellite markers for population-level studies still retain utility and should not be discounted.

The marker system, analytical approach, number of samples and coverage of potential range should all be designed for relevance to the hypotheses to be tested (population structure, subspecies-level differences, species-level differences). Rosel *et al*. (2017a) and Taylor *et al.* (2017b) provide information and guidelines appropriate for making strong taxonomic arguments, irrespective of genetic marker type. Martien *et al.* (2015) discuss the strength of evidence different types of data provide for studying population-level distinctions. Waples *et al.* (2010) also provide detailed information on which approaches and analytical methods are applicable for different sorts of questions. Since the level of divergence is likely not known *a priori*, an open mind and willingness to expand the study methods, objectives, sample sources and sample types (morphological, genetic, behavioural, parasite loads, etc.) is recommended.

Collaborative analyses where samples are already available (e.g. bottlenose dolphins around Australia) can allow progress to be made more quickly. Finally, it is extremely important to place local taxonomic studies in a broader geographic context. Without a broader context, determinations concerning taxonomic status will remain unresolved.

4.2 The use of morphology for understanding odontocete diversity

Prior to the 21st Century, odontocete taxonomy was accomplished with the use of morphological characters. If adequate series of specimens differed absolutely in at least one character, separate species were inferred, e.g. in the differentiation of two species in *Kogia* (Handley, 1966), revision of the spotted dolphins (Perrin *et al.,* 1987) and confirmation of the existence of Fraser's dolphin, *Lagenodelphis hosei* (Perrin *et al.,* 1973) and the Clymene dolphin, *Stenella clymene* (Perrin *et al.,* 1981). Distribution was also used in addition to morphology in the differentiation of subspecies. If large geographical series differed modally to the extent that most specimens could be assigned to one or the other form, they were adjudged to represent subspecies, e.g. of the pantropical spotted dolphin, *S. attenuata* (Perrin, 1975) and the spinner dolphin, *S. longirostris* (Perrin *et al.,* 1999). Where absolute differences were many and/or very large (large effect size), smaller series were believed adequate to differentiate species, e.g. for the mesoplodont beaked whales (Moore, 1968).

Morphological features include cranial and postcranial osteology, external size and shape, and colour pattern. The most used characters in taxonomic morphology have been metric and meristic features of the skull (measurements and tooth counts). Advantages of these include repeatability and large amounts of data from individual specimens. One disadvantage is that different workers may vary in exactly how they take measurements and count teeth, although this can and should be addressed by intercalibration using the same skulls. Another drawback is the difficulty of obtaining adequate series of specimens to sufficiently characterize individual variation. Finally, because most analyses of skull metric characters are limited to adults and skulls with complete sets of measurements, sample sizes can often be drastically reduced. However, modelling allometric growth of features with respect to total skull length can sometimes allow for use of entire series (Bookstein, 1982). Additionally, although they should be used carefully, there are several missing data imputation schemes that can fill out datasets and permit use of samples only represented by partial measurements.

Studies using metric features have predominantly used similar lists of individual landmark-to-landmark measurements across multiple surfaces of the skull. There have been several 2-dimensional and 3-dimensional geomorphometric studies, which create a representation of the skull based on measurements among sets of linked landmarks. These methods are likely better able to quantify and describe differences in shape among forms. However, they are more reliant on having entire skulls on which all landmarks can be recorded (but see Churchill *et al*., 2018) and of course, analysis of skull metric characters must be limited to adult specimens. Postcranial meristic features, e.g. total vertebral count, number of ribs, or position of particular neural foramina, often vary between species, but sample size is usually a problem because few complete skeletons make their way to museums and further, postcranial elements are often lost in specimen preparation. The same disadvantages apply to the use of external size and shape, to an even greater degree. Here it is well known that different workers may vary greatly in how they take measurements, e.g. of the dorsal fin and flukes, and it is difficult to intercalibrate because very few dolphins and porpoises are preserved in the whole; nearly all wind up as osteological specimens, usually as skulls only. In addition, size and shape vary with attitude of the body, e.g. length differs between a beached dolphin and a fresh carcass in rigor mortis; body length may continue to increase beyond sexual maturity; growth only stops when physical maturity has been attained (when the vertebral epiphyses have all fused with the centra). For these reasons, measurements of external size and shape have not been considered very reliable or useful in taxonomy.

Colour pattern is subject to similar disadvantages; it can change with age (e.g. degree of spotting in the two spotted dolphin species, Perrin *et al.,* 1987) and even ecophenotypically (e.g. darkening induced by increased exposure to the sun in captive dolphins). A beached carcass also quickly darkens, often obscuring colour pattern completely. If a colour pattern element is well marked in adults and easily observed, it can be useful in delineating species, e.g. the obvious shoulder blaze that differentiates the Atlantic spotted dolphin from the pantropical spotted dolphin (Perrin *et al.,* 1987). Care should be taken in descriptions of colour patterns from photos of live animals as angle, lighting conditions, sea state and even habitat can influence how they appear in an image.

Simple bivariate analyses or ratios have been useful for identifying diagnostic differences, e.g. for differentiating between the skulls of *Stenella clymene* and *S. coeruleoalba* (Perrin *et al.,* 1981), while multivariate analyses have been effectively used to delimit subspecies and stocks of odontocetes for dolphins of the genus *Stenella* (Perrin, 1975) and *Tursiops truncatus* in California waters (Perrin *et al.,* 2011). Ordination based approaches such as Principal Components Analysis (PCA) are useful for reducing the dimensionality of the data set and more easily visualizing the degree of differentiation across all characters. To address taxonomic questions, classification approaches are common as they are designed to identify features or combinations of features useful for separating *a priori* defined sets of voucher specimens. The models thus defined can then be used to assign specimens of unknown origin. For example, Discriminant Analysis (DA) was used to assign holotype specimens of nominal species to species of spotted dolphins (Perrin *et al.,* 1987) and to assign the type specimen of *T. aduncus* to one of the two species of the genus delimited on the basis of molecular data (Perrin *et al.,* 2007), based on multiple skull dimensions. Machine learning and ensemble-based methods such as Random Forest (Breiman, 2001; Berk, 2006) have been shown to produce more robust classification models. With classification models, it is critical to consider how voucher specimens used to train them have been selected and ground-truthed, as inappropriate *a priori* designations (e.g. based on features where overlap may occur such as geographic location) can degrade the effectiveness of classification models. Conversely, designations based on features which are used in building the model or heavily correlated with them can lead to inflated estimates of classification ability.

In general, multivariate analyses can be a sharp tool for delineation of species. However, with enough characters, any two arbitrary groups of specimens can be completely separated. Multiple, correlated, minor modal differences can interact to produce apparent significant differentiation. Thus, ordination approaches should be used in conjunction with classification models to gain a complete understanding of the number of functionally independent features in a set of measurements. Characters exhibiting high diagnosability should be closely examined for biological significance and validated with samples not used in model construction.

5. IMPORTANT OUTSTANDING AREAS FOR FURTHER RESEARCH AND POORLY KNOWN REGIONAL POPULATIONS THAT ARE DATA DEFICIENT

Throughout the revision process, areas in each region where data and samples were lacking were identified. An effort was made to identify and connect with people operating in these areas, gather further published or unpublished information of the presence of *Tursiops*, obtain information about morphologic (skulls) and genetic samples available. A detailed list of these data deficient areas and corresponding countries, whether a person contact was identified and approximate type and number of samples potentially available for future analyses is given in Annex E.

Below is a summary of the data deficient areas identified in each region:

Indian Ocean and western South Pacific: most of the eastern coast of Africa, the Arabian/Persian Gulf, the Red

Sea, the region from Pakistan throughout Indonesia and oceanic islands (Papua New Guinea, Micronesia, Polynesia, Melanesia), eastern Australia.

Western North Pacific: including Japan South Korea, northern China, Vietnam and Philippines.

Eastern North Pacific and eastern South Pacific: including Oregon (USA) and all the central Pacific area from Mexico to Colombia, Ecuador, Peru and Chile.

Western North Atlantic: more samples from morphological analysis would be useful from the Caribbean area, lack of data from Colombia through Suriname.

Western South Atlantic: Need to better define limits of the distribution of *T. t. gephyreus* by sampling in Argentina and in Brazil, North of Santa Catarina and Parana states. An effort to sample both coastal and offshore waters should be also made (Fruet *et al.,* 2017 workshop report).

Eastern North Atlantic and eastern South Atlantic: the entire Atlantic African coast is data deficient. A limited number of dedicated surveys have been conducted, data available are sparse and occasional, and only reporting the occurrence of *Tursiops*.

Mediterranean and Black Sea: the southern portion of the Mediterranean delimited by the African coast, the eastern Mediterranean (Aegean Sea) including main islands (Crete, Cyprus) and the Dardanelle/Bosphorus Strait System is data deficient. In the Black Sea, efforts should concentrate on gathering more comprehensive sample sets from different areas including offshore regions.

6. CONCLUSIONS, FUTURE WORK AND WORKSHOP RECOMMENDATIONS

Due to their worldwide distribution in temperate and tropical waters, remarkable ability to adapt to local conditions, adoption of unique feeding strategies for different habitats and complicated social structures, including strong tendencies for strong site fidelity, bottlenose dolphins (*Tursiops sp.*) exhibit significant habitat partitioning throughout their range. Some adaptations to different environments have been accompanied by morphological differentiation as well. These characteristics have led to the naming of more than 20 nominal species of *Tursiops*. Whether the two currently accepted *Tursiops* species accurately represent separate taxa and whether there are more *Tursiops* subspecies and/or species than are currently recognised was the focus of this Workshop. The highly complex nature of the question required three-years of review within the 2015-2017 Scientific Committee meetings and culminated with this Workshop to collate all the information on a global scale and make recommendations. The opportunity to bring researchers and experts together from around the world to discuss this single topic during the three years and at the Workshop was a very successful aspect of the review. It also spurred research forward in some areas and promoted future collaborations among scientists. The Small Cetaceans sub-committee annual priority topic reviews programme provide this unique opportunity to take a global view on issues related to small cetaceans.

Overall, the Workshop participants **agreed** that the current taxonomy provided by the Society for Marine Mammalogy's Committee on Taxonomy (Committee on Taxonomy, 2017) is well supported by morphological and molecular genetic data, as well as ecological and distributional data. This taxonomy includes the common bottlenose dolphin *T. truncatus* and the Indo-Pacific bottlenose dolphin *T. aduncus*. Three subspecies are recognised within *T. truncatus*: the nominate subspecies, *T. t. truncatus*, the Black Sea bottlenose dolphin, *T. t. ponticus* and Lahille's bottlenose dolphin, *T. t. gephyreus*. Participants thoroughly reviewed the available support for the more recently described species *T. australis* and **concluded** that discordance in results from morphometric analyses and across different genetic markers call into question the basis for describing this new species at this time.

Several important outstanding taxonomic questions remain. In the Indian Ocean and western South Pacific, genetic and some morphological data support the existence of multiple, distinct lineages of *T. aduncus* with considerable, i.e., above the population level, amounts of genetic divergence among them. The evolutionary relationships among them remain unresolved and geographically comprehensive morphological and molecular genetic analyses will help determine whether some of these lineages should be elevated to subspecies status. In the western North Atlantic, multiple lines of evidence support significant differences, again above the population level, between coastal and offshore bottlenose dolphins and Workshop participants **agreed** the level of divergence meets criteria for at least subspecies status for the coastal form. Future work will concentrate on examining the degree of male-mediated gene flow between the two forms. In the western South Atlantic, morphologically diagnosably-distinct coastal and offshore forms of *T. truncatus* are present and during the three-year review period, the coastal form was elevated to subspecific status, *T. t. gephyreus*. Participants discussed whether the Lahille's subspecies of bottlenose dolphin should be elevated to species status and **concluded** that additional molecular genetic data examining the potential for male-mediated gene flow are needed before making such a decision. Finally, the taxonomy of coastal and offshore forms of *Tursiops truncatus* off the US California coast and down to the central Baja Peninsula remains unresolved. Workshop participants **agreed** that there is strong evidence for morphological and genetic differences between these two forms. But genetic data from the Pacific coast of Baja California, the Gulf of California and further south in Mexican waters suggest a complicated population structure and whether the structure observed to date is sufficient to warrant any taxonomic changes is still unclear. Given a significant conservation concern for the dolphins in the upper Gulf of California, future genetic and morphological studies throughout this region are essential.

Discussions at the Workshop **identified** several data deficient regions (in samples/specimens, data and publications) within the distribution of *Tursiops* (see below 6.1.1 and Section 5) and highlighted the importance of increased communications and collaborations in these regions.

Recognising molecular genetic techniques are advancing at a lightning pace, new analytical tools are being developed for delimiting species from these molecular genetic datasets and even new morphometric analytical tools, such as 3D geomorphometric analyses, are being incorporated into studies, participants **noted** there are still some general guidelines and standards that can and should be followed in taxonomic studies. Reeves *et al*., (2004), Taylor *et al*., (2017b) and Waples *et al*., (2018) all provide important background on, and useful advice for designing research plans and presenting data and arguments when delimiting new subspecies or species. Participants **strongly encouraged** that these resources be considered in future studies. Several points highlighted during discussions include the importance of using multiple lines of evidence and the critical importance of placing local taxonomic studies in a broader geographic context. Without that context, new taxonomic proposals will remain unresolved.

6.1 Summary of recommendations

6.1.1 Data-deficient areas

Participants identified geographic regions where data on *Tursiops* are sparse. In particular, there is poor coverage of the eastern South Atlantic, the African coast of the eastern North Atlantic, the southern and eastern Mediterranean Sea, the eastern South Pacific, and the Mexican mainland and Central American coasts of the eastern North Pacific, eastern Australia and in the western Pacific islands of Micronesia, Melanesia, Polynesia, the Philippines and Vietnam.

The Workshop **recommended** these areas as priorities for *Tursiops* research and **recommended** compilation of regional information on active researchers, numbers and locations of morphological and molecular genetic samples collected to date and effort to complete work initiated during the Workshop (see Section 5). Collaborative efforts should be encouraged and facilitated to examine *Tursiops* throughout these regions.

6.1.2 Standardisation, guidelines and future studies

The Workshop **recommended** the guidelines in Reeves *et al*. (2004) for the assessment of species status, in Taylor *et al*. (2017b) for the assessment of subspecies and in Martien *et al*. (2015) for DIPs. Participants **strongly emphasised** that future taxonomic questions be examined within an appropriately wide and inclusive geographic context and that multiple lines of evidence are necessary when positing taxonomic changes.

6.1.3 Recommendations for future research

As described above, several important taxonomic questions remain unresolved at this time and the Workshop participants provided a series of recommendations for addressing these outstanding issues. These recommendations are:

(1) Collect additional nuclear DNA data to more fully characterise the degree of divergence between coastal and offshore forms in the western South Atlantic Ocean to aid in determining whether *T. t. gephyreus* might more accurately be elevated to species status.

(2) Extend the geographic coverage, especially including eastern Africa, the region between Pakistan and Indonesia, and the region between Australia and China to more fully investigate *T. aduncus* lineages in the Indian Ocean and western South Pacific Ocean using genetic and morphological data. This should build on already available data suggesting multiple distinct lineages and assess potential subspecies recognition. Participants also **encouraged** continued study of animals associated with the '*T. australis'* mtDNA lineage in the context of both *T. truncatus* and *T. aduncus*.

(3) Examine the level of male-mediated gene flow between the coastal and offshore forms in the western North Atlantic Ocean and determine whether the coastal form should be elevated to species or subspecies status.

(4) Conduct comprehensive morphometric analyses integrated with extensive existing molecular data comparing *Tursiops truncatus* throughout the Mediterranean to those in the Black Sea and those in the eastern Atlantic to evaluate whether any regions apart from the Black Sea may also harbour a taxonomic unit above the level of population.

(5) Conduct further morphometric analyses of coastal and offshore *Tursiops truncatus* in the eastern North Atlantic Ocean and compare results to those from western North Atlantic, integrating existing genetic data with the morphological data.

(6) Perform morphometric analyses of coastal and offshore dolphins throughout Mexican waters compare data to those from California and the eastern tropical Pacific, with a particular focus on the relationship between coastal dolphins in the upper Gulf of California with other areas.

(7) Collect additional genetic and morphological data throughout the eastern South Pacific Ocean to augment those in hand and conduct studies addressing taxonomic hypothesis concerning the relationship between costal and offshore dolphins throughout the region. This work should include coastal and offshore waters from Central America to Mexico and extend if possible around the southern tip of South America to Argentina.

7. ADOPTION OF REPORT

The report was adopted by emailed consensus on 21 April 2018.

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See Annex C for references.

Annex A

List of Participants

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Annex B

Agenda[1]

1. Introductory remarks
    - 1.1.1 Convenor's opening remarks
    - 1.1.2 Election of Chair
    - 1.1.3 Appointment of Rapporteurs
    - 1.1.4 Adoption of Agenda
2. Discuss terms and a strategy for taxonomic and population-level distinctions for this genus
    - 2.1.1 Review of existing proposed classifications of *Tursiops*: context and motivation for the 2018 Workshop on resolving *Tursiops* taxonomy worldwide
    - 2.1.2 Review of a practical example of approaches for 'stock' delineation used by US government agencies
    - 2.1.3 The use of morphology for understanding odontocete diversity
    - 2.1.4 Review of species and subspecies concepts
    - 2.1.5 Distribution-related terminology
3. Review of new available documents
    - 3.1.1 Overview: WP on the RAD phylogeny worldwide
    - 3.1.2 Area IO: Gray *et al.*, 2018. Cryptic lineage differentiation among Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in the Northwest Indian Ocean
    - 3.1.3 Area IO: WP on the morphometrics of the Pakistan lineage
    - 3.1.4 Area ENP: Segura-García *et al.*, 2018. Eco-evolutionary processes generating diversity among bottlenose dolphin (*Tursiops truncatus*) populations off Baja California, Mexico.
    - 3.1.5 Relevant WPs presented to the IWC meetings (each presented by the author/regional responsible).
4. Discuss summary data available from intersessional activities and earlier SC SM sub-committee sessions
    - 4.1.1 Review Intersessional table providing data summary
    - 4.1.2 IO/WSP (Australia)
    - 4.1.3 ENA
    - 4.1.4 MED & BLACK SEA
    - 4.1.5 ESA
    - 4.1.6 WNA
    - 4.1.7 WSA
    - 4.1.8 ENP
    - 4.1.9 ESP
    - 4.1.10 WNP
5. Evaluate the strength of evidence for taxonomic and population-level distinctions of *Tursiops* in each geographic region
    - 5.1.1 Consider types of evidence and relative value
    - 5.1.2 Build consensus taxonomy for the genus (or higher level classification as appropriate) based on available data and highlight areas of poor resolution or uncertainty
    - 5.1.3 Discuss life history, environmental and evolutionary history characteristics in the context of what is known about other delphinid genera and consider inference
6. Important outstanding areas for further research and poorly known regional populations that are data deficient
    - 6.1.1 Geographic regions
    - 6.1.1 Morphological data deficiencies
    - 6.1.3 Genetic data deficiencies
    - 6.1.4 Inventory of available samples and other resources: review and update of the underrepresented area database
7. Standardisation of genetic and morphological data and analyses for *Tursiops* taxonomy
8. Future work and recommendations
9. Adoption of report

[1] This agenda was followed during the Workshop, but discussions during the Workshop led to rewording of some items relative to the original agenda in the Workshop proposal and including agenda Items 3, 4, 5, 6 for each regional summary (Section 3 of the report) so that each regional summary was complete.

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Annex C

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Annex D

Tursiops Summary Table

This table is available online only, from the link to Supplements at *https://iwc.int/jcrm* (see Supplement 20).

Annex E

Outstanding Areas for Further Research and Poorly Known Regional Populations that are Data Deficient

Geographic regions	Location	Species/form reported	Background information	Contact availability	Samples available/ type of samples	Notes
EIO	Mozambique	*T. truncatus* & *aduncus*?	*aduncus* is known in coastal waters whereas *truncatus* offshore is not everywhere confirmed	Contact		
	Madagascar			Contact	A handful of samples and some teeth from Madagascar (north and south). Sequences from Mayotte.	Working on different manuscripts on the genetic population structure of *T. aduncus* in the western Indian Ocean region, including samples from Zanzibar, Oman, Madagascar, Mayotte, La Réunion and Mauritius
	Tanzania	*T. aduncus* and *truncatus* confirmed		Contact	4 *aduncus* skulls and 14 *truncatus* skulls	
	Kenya			Contact		
	Somalia					
	Yemen					
	Oman			Contact	Published	
	Djibuti					
	Pakistan	*T. aduncus* and *truncatus*?		Contact	5-7 skulls plus some samples in University	
	India			Contact	Two skulls	Checked two universities and Museum of Chennai, Bhubhaneswar and Mumbai
	Sri Lanka			Contact	None	
EIO (Red Sea)	Eritrea	*T. aduncus* and *truncatus*?				
	Egypt			Contact		
	Saudi Arabia					
EIO (Arabian/Persian Gulf)	United Arab Emirates	*T. aduncus*	Unconfirmed *truncatus* offshore	Contact	Skin samples, two skulls	
	Saudi Arabia					
	Qatar					
	Kuwait			Contact	No samples available	
	Iraq			Contact	No samples or information available	
	Iran			Contact		
WIO	Myanmar	*T. aduncus* and *truncatus*?				
	Malaysia					
	Indonesia					
WSP	Eastern Australia	*T.aduncus* and *truncatus*?				
	Indonesia					
	Papua New Guinea					
	Polynesia					
	Melanesia					
	Micronesia					
WNP	Vietnam	*T. aduncus* and *truncatus*?				
	Philippines			Contact		
	China (north)					
	Japan					
	South Korea			Contact		

Geographic regions	Location	Species/form reported	Background information	Contact availability	Samples available/ type of samples	Notes
ENP	Oregon USA	*T. truncatus* inshore/ offshore?				
	Mexico		Limited information in Gulf of California only	Contact	Genetic samples and skulls	
	Guatemala					
	El Salvador					
	Costa Rica					
	Nicaragua					
	Panama					
	Colombia			Contact	No samples available	
ESP	Equador	*T. truncatus* inshore/ offshore?		Contact	Submitted	
	Peru			Contact	Several dozen + few tissues samples left	Skulls in two private collections (CEPEC) and (Acorema)
	Chile			Contact	Very few specimens, scattered geographically and all held in private hands	
WNA	Throughout the Caribbean	*T. t. truncatus*	Need skulls	Contact		
	Colombia			Contact		
	Venezuela					
	Guyana					
	Suriname					
WSA	Brazil & Argentina	*T. t. truncatus* and *T. t. gephyreus*	Need to better define limits to distribution of *T. t. gephyreus* by sampling in Argentina and in Brazil in north Santa Catarina and Parana states. Coastal and offshore waters should be sampled (Fruet *el al*., 2017 workshop report)	Contact		
ENA	Morocco	*T. truncatus*				
	Mauritania			Contact	Skulls are available in Nouadhibou, Mauritania at the Institut Mauritanien de recherche océanographique et des Pêches (IMROP), 1 skull with Aguilar	
	Senegal			Contact	Senegal Stranding Network, periodic surveys, genetic samples collected, collaborations with Smithsonian Institute and prior 2017 University of Western Brittany. If skulls in good condition stored at the museum of Cheikh Anta Diop University in Dakar.	
	Gambia					
	Guinea Bissau			Contact		
	Liberia					
	Cote D' Ivoire					
	Ghana			Contact		
	Nigeria			Contact		
	Guinea					
	Camerooon			Contact		
ESA	Gabon	*T. truncatus*		Contact		
	Angola			Contact		
	Namibia			Contact		
	South Africa (Atlantic)					

Geographic regions	Location	Species/form reported	Background information	Contact availability	Samples available/ type of samples	Notes
MED/BS	Georgia	*T. truncatus ponticus*	Information is limited to the analysis of samples from Azov Sea. Indications of offshore/inshore populations and other areas of BS would help	Contact	31 + 5 skulls	31 samples from BS + 45 from other eastern MED regions in process for mtDNA. Intention to run ddRAD. Skull number to determined.
	Ukraina					
	Russia					
	Georgia					
	Romania			ACCOBAMS has created a network across the Mediterranean, contacts may be available through them		
	Bulgaria					
	Turkey	*T. truncatus ponticus*/ *T. truncatus*				
	Morocco	*T. truncatus*				
	Algeria					
	Tunisia					
	Libia					
	Egypt					
	Israel					
	Lebanon					
	Cyprus					
	Greece (Aegean)					

Report of the Workshop on Western North Pacific Common Minke Whale Stock Structure in Preparation for the Start of the *Implementation Review* in April 2018

Report of the Workshop on Western North Pacific Common Minke Whale Stock Structure in Preparation for the Start of the *Implementation Review* in April 2018[1]

The Workshop was held at the Crew House (*Senin Tsumesho*) of the Fisheries Agency of Japan, Tokyo from 12-13 February 2018. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants and thanked the Japanese Government for hosting the Workshop. He noted that the *Implementation Review* for western North Pacific common minke whales was scheduled to begin at the next Annual Meeting, with the first substantive discussions to take place at the 'First Intersessional Workshop' (probably to be held in late-2018, early-2019) in accordance with the Committee's Requirements and Guidelines for *Implementations* under the RMP (IWC, 2012a). The issue of stock structure was a particularly complex one during the past *Implementation Review* and the objective of this Workshop was to provide a preliminary opportunity to review work undertaken since the last *Implementation Review* and to develop, if necessary and possible, consensus advice on further analyses that will assist in the forthcoming *Implementation Review.* He hoped that this opportunity to discuss these issues outside the pressure of the formal review would prove valuable assistance to the review when it starts.

1.2 Election of Chair and appointment of Rapporteurs

Donovan was elected Chair and Hoelzel, Tiedemann and Butterworth acted as rapporteurs, assisted by the Chair.

1.3 Adoption of Agenda

The adopted Agenda is given as Annex B

[1] Presented to the meeting as SC/67b/Rep05.

1.4 Documents available

The list of documents is given as Annex C.

2. SUMMARY OF THE STOCK STRUCTURE HYPOTHESES USED IN THE PREVIOUS *IMPLEMENTATION REVIEW*

The following three stock structure hypotheses were used in the previous *Implementation Review* (IWC, 2012b, p.103):

> Hypothesis A: a single J stock distributed in the Yellow Sea, Sea of Japan and Pacific coast of Japan, and a single O stock in sub-areas 7, 8 and 9. The O stock migrates in summer mainly to the Okhotsk Sea (sub-areas 12SW and 12NE). Both J and O stocks overlap temporally along the Pacific coast (subareas 7CS and 7CN) and the southern part of the Okhotsk Sea (sub-areas 11 and 12SW);
>
> Hypothesis B: as for hypothesis A, but a different stock (Ystock) which resides in the Yellow Sea and overlaps with J stock in the southern part of sub-area 6; and
>
> Hypothesis C: five stocks, referred to as Y, JW, JE, OW and OE, two of which (Y and JW) occur in the Sea of Japan and three of which (JE, OW and OE) are found to the east of Japan.

The rationale for Hypotheses A and B (at that time called I and II) is provided in Pastene, Kanda and Hatanaka (IWC, 2012a, pp.435-39), and that for Hypothesis C (then called Hypothesis III) in Wade and Baker (IWC, 2012a pp. 439-45). The hypotheses are expressed by time period (month or group of months), reproductive class and sub-area in the mixing matrices.

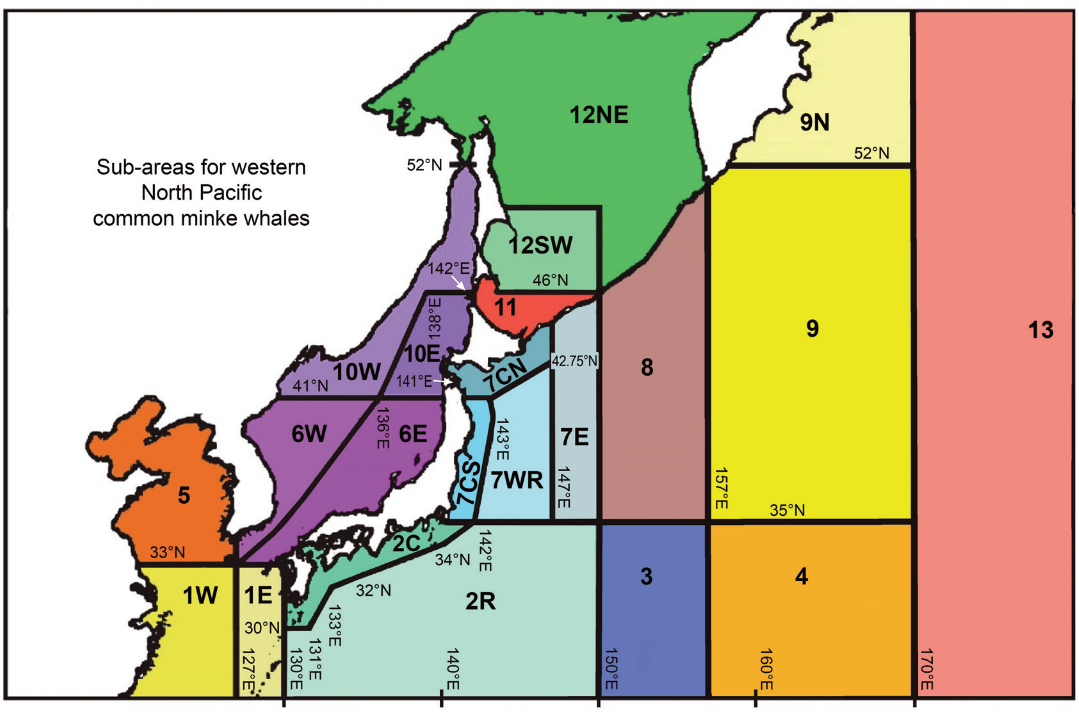

Fig. 1. Sub-areas used for the western North Pacific common minke whales.

There was no agreement within the Committee at the time regarding the plausibility category for these hypotheses and so all were treated as 'medium' plausibility for the purposes of the *Implementation Review.* Stock structure hypothesis is perhaps the major factor in determining the acceptability of management variants.

3. SUMMARY OF WORK ON WNP STOCK STRUCTURE UNDERTAKEN SINCE THE PREVIOUS *IMPLEMENTATION REVIEW*

3.1 Work presented at the JARPN II review and updated at the NEWREP-NP review

Pastene presented SC/F18/MI3, which summarised the outputs of the main genetic and non-genetic analyses on stock structure of North Pacific common minke whale conducted by Japanese scientists after the last RMP *Implementation Review* in 2013. Around 2,000 genetic samples were collected between the last *Implementation Review* and 2015 (Table 1). The source of the samples was JARPN II surveys and by-catches. Samples collected between 1994 and 2015 were examined by Japanese scientists with the main aim of evaluating the plausibility of additional structure in the O stock on the Pacific side of Japan, as postulated in Hypothesis C. The most recent analyses were conducted following recommendations from the JARPN II review workshops and the Scientific Committee (see the appendix of SC/F18/MI3 for a list of recommendations and responses). The new analyses involved hypothesis testing including an estimation of the power of the analysis (SC/F16/JR38; 40), Discriminant Analysis of Principal Components (SC/F16/JR40), catch-at-age (SC/F18/JR43; 52; 53), morphometrics (SC/F16/JR41) and kinship (Tiedemann *et al*., 2017). Furthermore, laboratory work and analyses were conducted to investigate the unassigned (to J or O stock) individuals from the STRUCTURE analysis (Taguchi *et al*., 2017). Preliminary results suggested that the unassigned individuals reflect a lack in the power of the analysis rather than heterogeneity associated with additional structure within the O stock. The authors of SC/F18/MI3 concluded that the output of the different analyses pointed to a single O stock distributed from the Japanese coast out to approximately 170°E (apart from the additional occurrence of the J stock in areas near the coast). SC/F18/MI3 had also summarised the views of Scientific Committee members on the results and interpretation of the analyses, where opinions were divided.

The Workshop thanked Pastene for his presentation and highlighted several issues for further discussion:

Table 1

Current number of genetic samples in comparison with those examined by the previous *Implementation Review* in 2013 (1994-2007). The final column shows the numbers obtained since 2007.

Sub-area	1994-2007	1994-2015	2008-2015
1E	22	69	47
2C	180	338	158
6E	392	916	524
7CS	437	925	488
7CN	598	1,178	580
7WR	70	89	19
7E	48	49	1
8	224	252	28
9	466	541	75
10E	9	15	6
11	96	129	33
Total	2,542	4,501	1,959

(1) treatment of unassigned (i.e. to J or O stock) samples and the implications of this;
(2) results from updated kinship analyses and the implications of this; and
(3) additional or revised analyses that will assist the *Implementation Review.*

Regarding the kinship analysis, it was noted that the observed false discovery rate was considerably higher than the estimated one. This was revealed when the inferred Parent-Offspring (PO) pairs based on 16 microsatellite loci, were reassessed by typing 10 additional microsatellite loci and by considering further biological data. The final set of putative parent-offspring pairs based on 26 loci has a significantly lower probability for false positives (based on likelihood calculations for a random match at any locus) and is consistent with biological data, both with regard to mitochondrial DNA data and in the context of earlier work indicating the distribution of adults offshore and juvenile animals along the coast east of Japan. In response to the conclusion that a single O stock occurs from the Japanese coast until at least approximately 170˚E, the importance of including analyses of the samples unassigned in STRUCTURE was mentioned (see Item 3.2.1 below). While it was agreed at the 2017 Scientific Committee meeting that the kinship analyses are inconsistent with the current mixing matrix associated with the implementation of Hypothesis C, it was proposed that implementation trials should maintain consideration of more than one O-stock among the scenarios tested.

3.2 Genetic data

The number of additional genetic samples available since the last *Implementation Review* is 1,959, bringing the total available to 4,501 (see Table 1). In discussion, it was noted that it is not known how many, if any, new Korean samples are available and no new analyses of stock structure in Korean waters (including the region in which the putative Y stock is found) have been presented. The Workshop also noted there is no genetic information available from the Okhotsk Sea (sub-areas 12NE and 12SW), the area of highest abundance of North Pacific common minke whales.

3.2.1 Treatment of unassigned samples

The occurrence of unassigned (to J or O stock) samples and the implications of how these are treated in analyses of stock structure (e.g. the use of 'purged' datasets versus total datasets) has been discussed several times within the Committee. At this Workshop, the importance and nature of the unassigned samples were discussed, including consideration of possible reasons for lack of assignment ranging from lack of resolution to admixture[2]. With regards to admixture, it was noted that even a small amount of genetic exchange among stocks may result in a persistent admixture signal in subsequent generations. However, there is also a quantifiable relationship between the degree of admixture and degree of differentiation (in the context of factors such as effective population size). The potential for alternative methods to STRUCTURE to assign samples and improve resolution, such as BayesAss (Rannala and Mountain, 1997), BAPS (e.g. Corander *et al*., 2008), TESS (Caye *et al*., 2016), or Geneland (Guillot *et al*., 2012) or a further analysis of PCA results was also discussed. It was suggested that analyses based only on area and temporal differences (independent of STRUCTURE) may be useful.

[2] Genetic admixture is the shared ancestry resulting from interbreeding between populations.

Proposals were made to explore the unassigned samples further, including testing the assignment potential at 16 loci of those unassigned by typing 10 additional microsatellite loci. From the total of 26 loci, an operating curve will be calculated to determine the assignment threshold that increases assignment percentages at 16 loci, while keeping the total number of erroneous assignments low.

In response to previous recommendations from the Committee on the additional microsatellite analyses to investigate the unassigned individuals, SC/67a/SDDNA5 had been presented to the 2017 meeting of the Scientific Committee. That study examined samples from sub-areas 6E (n=100) and 7CS (n=117) using 26 microsatellite loci rather than the usual 16 loci. The proportion of unassigned individuals at each assignment probability (70%, 80% and 90%) was found to decrease as the number of loci increased. The Committee had suggested an analysis in which the additional loci were genotyped for samples collected from a broader region (IWC, 2018).

Taguchi reported on the ongoing work being undertaken in response. She explained that, as shown in Table 2, around 25 individual whales in each sub-area had been genotyped with 26 microsatellite loci (except sub-area 10 where the sample size is 15 due to the limited number of samples from that sub-area). The results are being analysed with a view to presenting a paper to the 2018 Scientific Committee meeting. Taguchi reported that at least the preliminary findings were similar to those of Taguchi (2017) i.e. that the number of unassigned individuals decreases with an increase in the number loci.

In discussion, it was noted that the results illustrated in fig. 2 of Taguchi (2017) may reflect variation among microsatellite DNA loci with respect to diversity (reflected in power for assignment) and that there was little evident change in discrimination beyond ~17 loci. It was suggested that unassigned samples may be unassigned for different reasons in different sub-areas, and that 26 samples per area may not be sufficient to adequately capture this. Recognising the logistical and financial implications of additional genotyping, a recommendation to increase the sample size (and for further genetic analyses) is given under Item 5.1 below.

3.2.2 Kinship analyses

SC/F18/MI/02 reports an analysis of the spatial distribution of Parent Offspring (PO) pairs. Specifically, the spatial occurrence of the 49 PO-pairs from North Pacific common minke whales (foetuses excluded) reported in Tiedemann *et al.* (2017) was compared to random expectations. PO-pairs occurred generally at random within and across areas and subareas, except that more PO-pairs were observed than expected within sub-area 7CS as well as among sub-areas 7 and 9. The author found that these differences disappeared if animals assigned to the J stock were excluded (leaving 40 pairs), such that only animals assigned to O stock and unassigned specimens were examined (SC/F18/MI04). Then, there was no evidence to suggest that the PO pairs were not spatially distributed at random if this stock assignment was taken into account.

Hoelzel noted that under the assumption that some proportion of these parental matches between OW and OE regions may reflect gene flow between stocks, this may not be sufficient to prevent those stocks from genetic differentiation and some level of evolutionary independence. The relevant theory is as proposed in Wright (1931) in relation to the impact of genetic migration when the assumptions of his island model do and do not hold. In particular, the island model assumptions of equivalent, very large effective population size and equivalent rates of migration among all demes are unlikely to hold in this case, meaning that even fairly substantial gene flow may not necessarily prevent differentiation by genetic drift. Further discussion considered the distinction between genetic stock concepts, the various alternative interpretations of the kinship data (e.g. taking into account various migration and distribution scenarios), and the implications for operating models on which future *Implementation Simulation Trials* might be based. The Workshop **agreed** that the PO analysis, whilst not conclusive on its own, provided valuable input into the discussion of stock structure for consideration during the *Implementation Review.*

3.3 Other data

The importance of using data from a suite of techniques, including use of morphological and biological data to inform discussions of stock structure and plausibility was **reiterated**.

Kitakado introduced SC/F18/MI/03, which responded to requests from the 2017 Scientific Committee meeting for further information in relation to paper SC/67a/SCSP/13. That paper had used information on the trend over time in the J:O stock ratio for common minke whale bycatches around Japan to draw various inferences, in particular about the value of the MSYR. Although this trend was consistent with stock structure Hypothesis A in certain circumstances, this was not the case for each sub-area when these sub-areas were considered separately. The Workshop **agreed** that this matter will require attention when formulating stock distribution assumptions for the process of conditioning *IST*s in the coming *Implementation Review*.

In discussion, some questions were raised about the assumptions on which these analyses were based, but major discussion on those was outside the focus of this Workshop and was deferred to the 2018 Scientific Committee meeting when it was noted that this paper (possibly extended) would be re-tabled. Instead, having agreed that the information presented had potential utility for the *Implementation Review*, the Workshop focussed on the matter of provision of further information which could assist that process.

It was pointed out that the basis used to provide J:O bycatch ratios in SC/F18/MI/03 differed from that used to generate estimates of these ratios for the existing *IST*s, whose results had been used for the comparisons reported in SC/F18/MI/03. The former estimates were developed from applications of STRUCTURE to assign whales to the J or the O stock where possible. In contrast, the latter were inferred from model fits to mtDNA and microsatellite data in each sub-area by month under input of haplotype frequency distributions obtained from regions assumed to contain ‘pure’ stocks. Requests for further work are given under Item 5.2.

4. SUMMARY OF THE COMMITTEE’S COMMENTS ON WORK ON STOCK STRUCTURE UNDERTAKEN SINCE THE PREVIOUS *IMPLEMENTATION REVIEW*

The Workshop took note of the discussions on stock structure undertaken at the JARPN II and NEWREP-NP reviews, and the discussions and recommendations resulting out of those and in discussions of them by the Scientific Committee. A summary of those recommendations and the progress made in meeting those was provided in the appendix to SC/F18/MI3.

5. ADDITIONAL ANALYSES TO ASSIST THE DISCUSSION OF STOCK STRUCTURE DURING THE *IMPLEMENTATION REVIEW*

5.1 Genetic data

5.1.1. Analysis 1

The Workshop **agreed** that it is valuable to extend the sample size for the proposed study by Taguchi on unassigned whales, taking into account logistical considerations (see Item 3.2 and Table 2). It noted that the PO analysis presented in SC/67a/SDDNA01 contained all the available samples already genotyped for 26 loci animals. It **recommends** that these (while avoiding putative first-order relatives from the parent-offspring analyses) should be used to supplement the sample size. The following rules should be followed to balance representation among areas:

(1) take all mothers from mother-foetus pairs;
(2) if one sample of a PO pair is from any sub-area that is not 7CS, 7CN or 9, use that sample (because those three areas are over-represented for samples from the kinship analysis);
(3) if both of a PO pair are from sub-areas 7CS, 7CN, or 9, take samples preferentially in this order – if available, take a sample from 9, if not, take a sample from 7CN, if both samples are from 7CS, take one of the samples from 7CS; and
(4) if both of a PO pair are from the same sub-area, 'randomly' take one of the samples (can be done by sequentially alternating columns in the sample list).

STRUCTURE analyses should be run on two datasets (Table 2), i.e. with sample sizes that are balanced but not necessarily equivalent among sub-areas (dataset 1) and the entire dataset (dataset 2). The same samples that have been genotyped at 26 loci should also be run for 16 loci, comparing the assignment probability for each at these two levels of resolution. The final comparison of assignment probability for each of these samples should be for 16 loci for the full dataset (already available), for 16 loci for the subset of samples (to be undertaken), and for 26 loci (already available). The Workshop noted that while assignment probability may have increased in the 26 locus dataset for some samples, others may remain unassigned. This study will quantify the pattern across samples in order to determine a threshold for 16 locus analyses above or below which the majority of samples routinely reached >90% assignment when run with 26 loci. This threshold will be applied on the full dataset for 16 loci to be used in analysis 2.

5.1.2 Analysis 2

The Workshop **agreed** on the importance of trying to better understand the nature of unassigned individuals. Whilst unassigned individuals occur mostly in random proportions across sub-areas, there is a higher proportion of unassigned samples in sub-area 7CS and a tendency towards lower proportion in sub-area 6 (Table 3). Unassigned samples may reflect admixture between J and O stocks, or admixture between either J or O stock and one or more unidentified additional stocks (e.g. the putative OW stock). The recommended analyses below consider two potential starting sample sets. The first will include O-stock together with the unassigned individuals (remaining after Analysis 1 above). The second will not be based on the STRUCTURE results but rather will include only the relevant geographic areas that are not dominated by J-stock (i.e. sub-areas 7, 8 and 9). As discussed under Item 3.2.1, all analyses should consider temporal comparisons (both seasonal and across years) in addition to the spatial comparisons. Comparisons should be based on summary statistics (e.g. F_{ST}), PCA (or FCA) analyses, including partitioning based on multiple components, and DAPC (Jombart *et al.*, 2010). Clustering in the DAPC analysis may identify putative J-stock individuals as a strongly supported cluster that could be excluded in further analyses if this facilitated the resolution of more weakly differentiated clusters. The objective is to diminish or eliminate the strong signal identifying the distinction between O and J stocks to increase the potential to identify

Table 2

Number of samples by sub-area to be used for new 26-loci STRUCTURE analyses (Analysis 1). The originally proposed sample size was given by Taguchi. The additional samples to be used for Analysis 1 are to be taken from the PO study of Tiedemann *et al.* (2017) according to the rules specified above. The additional samples for Analysis 2 are from the analysis reported in Taguchi *et al*. (2017).

Sub-area	1E	2C	6E	7CN	7CS	7E	7WR	8	9	10	11	Total
Originally proposed sample size	25	26	22	26	20	24	26	25	24	15	24	257
Additional samples from PO	1	1	5	16	11	3	2	9	14		1	63
Total Dataset 1	26	27	27	42	31	27	28	34	38	15	25	320
Additional samples A-2			100		117							217
Total Dataset 2	26	27	127	42	148	27	28	34	38	15	25	537

Table 3

Expected and observed distribution of unassigned specimens across areas.

Sub-area	Expected	Observed	Chi^2	Bonferroni	
1	6.48455899	4	0.30534524	ns	ns
2	31.7649411	27	0.37442918	ns	ns
6	86.08487	69	0.05304598	(*)	ns
7CN	110.707398	100	0.28501551	ns	ns
7CS	86.9306821	115	0.00156242	**	*
7E	4.60497667	4	0.76709258	ns	ns
7WR	8.3641413	7	0.6202183	ns	ns
8	23.6827372	28	0.35132818	ns	ns
9	50.8427016	52	0.86460534	ns	ns
10	1.40968674	3	0.15937151	ns	ns
11	12.1233059	14	0.57121886	ns	ns

**p<0.01;*p<0.05; (*)p<0.1;ns p>0.1

a weakly differentiated stock. However, the priority should be to resolve local patterns by the selection of geographic samples without post-hoc purging if possible.

The Workshop **recommends** that Analysis 1 is completed before the upcoming Scientific Committee meeting to enable the possibility of reassessing assignment thresholds at that meeting before recommending any future genetic analyses.

The Workshop **recommends** that the series of analyses incorporated in Analysis 2 above should be undertaken in advance of the First *Implementation Review* Workshop. These analyses would include the inclusion of unassigned individuals (based on revised proportions arising out of Analysis 1 as appropriate) together with sub-areas representing O-stock and excluding sub-areas representing J-stock for a DAPC analysis. The unassigned individuals should also be included in a replication of F_{ST} analyses previously undertaken.

As discussed under Item 3.2, the Workshop also **recommends** that methods more powerful than STRUCTURE (or incorporating alternative methods) should be used (e.g. BayesAss, BAPS, TESS and especially Geneland – the Advisory Group will provide advice on this) to provide an alternative to STRUCTURE based assignments. Further analyses should be based on samples partitioned temporally and spatially independent of STRUCTURE assignment. Finally, it was suggested that it would valuable if putative stocks defined by this series of analyses could be included in an ABC analysis (Beamont *et al.*, 2009) to distinguish among potential stock hypotheses as described in Waples, Hoelzel and Gaggiotti (IWC, 2012, Appendix N).

The Workshop also **agreed** that the Wahlund analyses undertaken by Waples in 2011 (Tiedemann, 2014), which based inference on mixing populations and therefore do not require the specific identification of putative stocks *a priori*, were preliminary and will require the testing of further mixing scenarios before the strength of inference from this method can be assessed.

5.2 Other work

As discussed under Item 3.3, the Workshop **requests** that any future analyses using information on the trend over time in the J:O stock ratio for common minke whale bycatches around Japan to draw inferences on MSYR and stock structure should be undertaken comparing the outputs from the two approaches to obtain the ratio (i.e. in SC/F18/MI03 and that used in the existing *IST*s). The authors should also investigate the sensitivity of results for the former of differing allocations to stock of 'unassigned' whales, taking into account the results of the work recommended under Item 5.1 on assignment.

Related to this, the Workshop noted that the Secretariat holds data on the set nets in which bycatches occur that extend only to 2009, whereas the analyses in SC/F18/MI/03 extend to 2014. These set net data are used to provide measures of fishing effort for use when the conditioning of *IST*s. The Workshop **requests** that Japan provide updated information on fishing effort to the Secretariat for use in the coming *Implementation Review* process.

Finally, the Workshop noted that the conditioning process for modelling bycatches in the current *IST*s differs from that on which sex ratio data are used in more recent *IST*s for North Atlantic common minke whales (REF). The Workshop **agreed** that the J:O ratios from bycatch should be included more formally in the conditioning process using a similar approach to that for sex ratio in the North Atlantic.

6. CONCLUSIONS AND WORK PLAN

The Workshop **agreed** that the opportunity to consider issues surrounding the stock structure prior to the start of the *Implementation Review* had proved valuable. In particular, good progress had been made on the issue of assignment that is fundamental to additional and updated genetic analyses. Given this, the Workshop **requests** that Analysis 1 under Item 5.1 be given priority during the early intersessional period. If that work can be completed quickly enough then it may be possible to have the results of both analyses presented to the Scientific Committee meeting in Bled which will greatly facilitate discussion at that meeting of additional analyses to be presented to the 'First Intersessional Workshop'.

Recognising the importance of this work, the Workshop established a small Advisory Group comprising, Tiedemann (convenor), Goto, Hoelzel, Pastene and Wade to assist Takaguchi as necessary. Once Analysis 1 is completed it should be circulated to participants at the Workshop and uploaded as a Primary Paper for the Scientific Committee meeting.

Donovan thanked all the participants for their positive and co-operative contributions to the Workshop. Recognising the complexity of the issue and the sometimes strong differences of opinion that have characterised previous discussions during past *Implementation Reviews*, he hoped that this Workshop will help to set a similar positive tone to discussions when the full *Implementation Review* begins. He also thanked the rapporteurs and interpreters for their hard work. Finally, he thanked the Government of Japan and ICR for hosting the Workshop in such excellent facilities. The Workshop participants thanked Donovan for his usual efficient and fair chairing of the Workshop.

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Annex A

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Annex B

Agenda

1. Introductory items
   1.1 Convenor's opening remarks and objectives of the Workshop
   1.2 Election of Chair and appointment of Rapporteurs
   1.3 Adoption of Agenda
   1.4 Documents available
2. Summary of the stock structure hypotheses used in the previous *Implementation Review*
3. Summary of work on WNP stock structure undertaken since the previous *Implementation Review*
   3.1 Work reviewed at the JARPN II review and updated at the NEWREP-NP review
   3.2 Genetic data
   3.3 Other data
4. Summary of Committee's comments on work on stock structure since the previous *Implementation Review*
5. Discussion of ANY additional analyses/approaches that will assist discussion of stock structure during the *Implementation Review* starting in 2018
   5.1. Genetic
   5.2. Other
6. Conclusions and recommendations

Annex C

List of Documents

SC/F18/MI

01. Goto, M., Taguchi, M. and Pastene, L.A. Recent genetic analyses following recommendations from the IWC Scientific Committee confirm no sub-structure of the 'O stock' common minke whale in the western North Pacific.
02. Tiedemann, R., Taguchi, M. and Pastene, L. Expected and observed PO pairs among NP minke whales.
03. Kitakado, T. Responses to requests by the Scientific Committee for more detailed explanation for Section 4 of SC/67a/SCSP/13.

Report of the Second *Implementation Review* Workshop on Western North Pacific Bryde's Whales

Report of the Second *Implementation Review* Workshop on Western North Pacific Bryde's Whales[1]

The Workshop was held at the Crew House (*Senin Tsumesho*) of the Fisheries Agency of Japan, Tokyo from 14-16 February 2018. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants and thanked the Japanese Government for hosting the Workshop. He noted that the *Implementation Review* for western North Pacific Bryde's whales was scheduled to finish at the 2018 Scientific Committee meeting. The objective of this Workshop was to facilitate this, and in particular to resolve any outstanding issues and complete the conditioning of the trials. This would enable the final results to be developed during the intersessional period.

1.2 Election of Chair and appointment of Rapporteurs

Donovan was elected Chair and Allison, Butterworth and Palka acted as rapporteurs with assistance from the Chair.

1.3 Adoption of Agenda

The adopted Agenda is given as Annex B.

1.4 Documents available

The list of documents is given as Annex C.

2. SUMMARY OF PROGRESS SINCE THE 2017 ANNUAL MEETING

Allison reported on the progress made since the 2017 Annual Meeting. The focus had been on updating the trials with the updated stock structure hypotheses and new *Implementation Simulation Trials* agreed at the March 2017 intersessional workshop. Additional work remaining included finalisation of future survey plans and inclusion of density-dependent *M* in the trials (IWC, 2017).

3. COMPLETION OF OUTSTANDING TRIAL SPECIFICATIONS

Allison provided the most recent version of the trial specifications as a working paper and highlighted several issues that required action or confirmation by the Workshop.

3.1 Confirmation of mixing matrices

The Workshop confirmed that the approach documented in the draft trial specifications was appropriate and that in particular:

(a) for Hypothesis 2 Baseline, the ratio of the number of Stock 1 whales in subarea 1W to that in 1E should be estimated during conditioning using the relative abundance in the two sub-areas;
(b) in Trial 6, the boundary between the two stocks changes from 180° to 175°E. The proportion of stock 2 in component area 1Ec (=Y) is calculated using the ratio of the number of degrees of latitude covered by component areas 1Ec and 2a, i.e. Y=33/18; and
(c) for Hypothesis 5, the density of each stock is assumed to be uniform across the mixing area band. The proportion of each stock in the mixing band is given in Table 1, (IWC, 2018, p.589) i.e. gamma values are estimated during conditioning by fitting to the abundances (see Item 3.2 below for discussion of these) and the mixing proportions provided in Table 5 (IWC, 2018, p.592).

3.2 Updated abundance estimates – g(0) and additional variance

3.2.1 Review SC/F18/Br01

Hakamada presented SC/F18/Br/01, which obtained *g*(0) estimates for Bryde's whales by applying mark-recapture distance sampling methods to sighting data from Independent Observer (IO) mode conducted during the IWC-POWER surveys in 2015 and 2016. Sea state (using the Beaufort scale) was used as a covariate. For the analysis, *g*(0) for the top barrel and for the IO platform were assumed to be the same because data were limited. The *g*(0) for the top barrel was estimated to be 0.672 (SE=0.168) and the probability that the observers on either the top barrel or the IO platform detect a school on the trackline was estimated as 0.863 (SE=0.135). Estimates for the top barrel were 0.899 in good (sea state 0-3) and 0.543 in bad (sea state 4-5) conditions.

The Workshop examined diagnostic plots for the model selected in SC/F18/Br01 and found these to be satisfactory. The assumption that *g*(0) on the IWC-POWER surveys was the same for the top barrel and the IO platform was tested by applying a model including an interaction term between the two platforms. This hardly improved the fit to the data and the point estimates of *g*(0) for each platform showed little difference, so the Workshop **agrees** that the assumption of platform-independence of *g*(0) was acceptable, and thus accepts the estimates provided in SC/F18/Br/01 as detailed above, recognising that the updated abundance estimates must be agreed by the Scientific Committee at the 2018 Annual Meeting.

The Workshop noted that the intent of this analysis was to provide estimates of *g*(0) that could be used to adjust all of the existing Bryde's whale estimates (up to now based on *g*(0)=1) to be used in conditioning the *IST*s. The Workshop examined whether the vessels and procedures used for the non-POWER surveys were sufficiently comparable to those for the 2015-2016 IWC-POWER surveys. The non-POWER surveys had observers in the top barrel only – there was no IO platform. Thus, any estimates of *g*(0) from the POWER surveys applied to other surveys must be for the top barrel only. In both sets of surveys there were two observers in the top barrel and furthermore the eye-level heights above sea level of these observers covered similar ranges on the vessels used (17.5 to 20.5m). The Workshop **agrees** that the similarity between the two sets of surveys was sufficient to allow application of the IWC-POWER survey estimates of *g*(0) for the top barrel to the Bryde's surveys.

Given the dependence of the estimate for *g*(0) for the top barrel on sea state, the Workshop noted that applying the composite estimate for g(0) of 0.672 for the upper barrel from the POWER surveys to the Bryde's whale surveys would tacitly assume that the ratio of good:bad sea states on both sets of surveys had been the same. Inspection of these ratios for some of these surveys did, however, indicate some fairly large differences in these ratios. The Workshop therefore **agrees** that the *g*(0)-corrected survey estimates of abundance for the non-POWER surveys needed to take sea

[1] Presented to the meeting as SC/67b/Rep02.

state into account. Japan is therefore **requested** to revise the existing estimates of abundances for the Bryde's surveys to incorporate the Beaufort-specific estimates of $g(0)$ following the method given in Annex D. This should be completed before the Scientific Committee meeting. Given the relatively large estimates of additional variance, the Workshop **agrees** that it is adequate to adjust existing CVs for these abundance estimates in a simple way by using the CV of the composite estimate for the POWER surveys of 0.168/0/672=0.25.

For conditioning and the trials the Workshop **agrees** to apply the POWER surveys estimate of $g(0)$=0.672 with a CV of 0.25 to all of the Bryde's whale surveys.

3.2.2 Abundance estimates for conditioning

For conditioning, abundance estimates for the entire area for the entire historical time series are required. The entire area is defined as the sub-areas 1W, 1E and 2, less the hatched region between 165°E and 165°W in the northeast (Fig. 1). The time series consists of three sets of abundance surveys where the abundance estimates are centred on, and therefore time stamped 1995 (1988-1996: Shimada *et al.,* 2008; Figs 2-3), 2000 (1998-2002: Kitakado *et al.,* 2008; Fig. 4) and 2011 (2008-2015: SC/M17/RMP02; Fig. 5). The Scientific Committee has agreed that although all three estimates are suitable for conditioning, only those for 2000 and 2011 are suitable for use in the RMP since the 1995 set was not carried out with IWC oversight (IWC, 2010).

The abundance for the entire area has already been estimated (and agreed by the Scientific Committee) for the first two sets of surveys. However, the set of surveys time stamped 2011 did not cover the whole of sub-area 1W (see Fig.1), thus the abundance estimate reported previously (15,422 CV=0.289; SC/M17/RMP02) for sub-area 1W for 2011 represents only a partial estimate. Therefore, to make the abundance estimate for sub-area 1W from the 2011 set of surveys comparable to the earlier two sets of surveys for conditioning purposes, the partial estimate must be expanded by adding an approximate estimate of the abundance in the unsurveyed areas. The approach to achieve this is given in Annex E. It assumes that for each set of surveys, the ratios of the abundance in the 2011 unsurveyed areas of sub-area 1W to the abundance surveyed sub-areas in 2011 were similar.

The Workshop **agrees** that for conditioning, the value for the 2011 abundance estimate for the whole survey is 18,035 (CV=0.476; Annex E, table 1).

3.2.3 Value for CVadd (high)

Additional variance CV_{add}, is incorporated into the estimates of future abundance in the trials (see Equation G.6 of the trial specifications). For the baseline trials CV_{add} = 0.335 (SC/67a/RMP04), but an upper value for CV_{add} in trials Br5-1 and 5-4 is required.

Kitakado advised that since his code was written in ADMB-RE to integrate out random effects and regression parameters (for a REML treatment), he was not able to use the profile likelihood option to obtain an upper percentile for the distribution of the estimate of CV_{add}. Instead he had assumed log-normality of this estimate, leading to an estimate of the upper 5th-percentile of 0.737. The Workshop **agrees** to the use of this value in trials Br5-1 and Br5-4.

3.3 Confirmation of sighting survey plan

The Workshop considered possible sighting survey options for future surveys involving effort spread evenly across years or increased effort in single years.

After lengthy discussion about the advantages and disadvantages of different options, Japan provided a revised set of options for future surveys that are set out in Annex F. Note that overall this includes a 2x2 set of options: the two options for timings as set out in Annex F, and whether future surveys will extend south to 10°N or to 20°N. Japan advised that they wished to see the trade-offs in performance amongst these options before deciding on their final plan.

The Workshop noted that option 2 will require recalculation of additional variance as the regions covered by some surveys are on a smaller scale than the sub-area level upon which previous additional variance computations have been based. Japanese scientists were requested to get this alternative CV_{add} value to Allison within three weeks so as not to delay progress in finalising the trial result computations, so that these would be ready for the start of the 2018 Scientific Committee annual meeting.

3.4 Confirmation of management options (including whether catch spread across whole area)

The Workshop confirmed that all future catches from sub-area 1W will be simulated to be taken in component area 1Wa (closest to the coast of Japan) only. 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*;

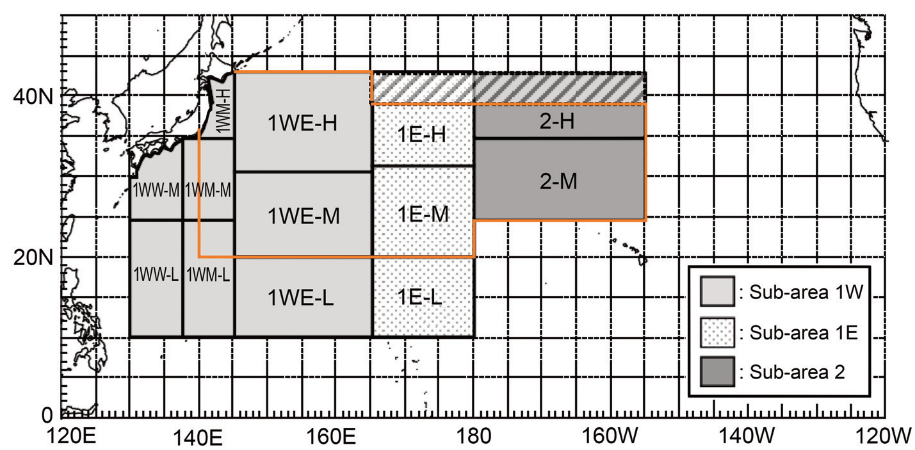

Fig. 1. Sub-areas and blocks used for the abundance estimation. H, M and L mean high, middle and low latitudes. The northern parts (shaded) in the two blocks, 1E-H and 2-H, were excluded from the previous estimation of abundances, which means any detections and effort in those parts were not included in the analyses, and the abundance estimates in those blocks were calculated for the southern parts of 1E-H and 2-H. A more detailed explanation is given in Shimada *et al.* (2008). The orange line shows the area covered in the 2011 set of surveys (see text).

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; and

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.

3.5 Other issues

3.5.1 Specification of density dependent M

The Workshop confirmed the specifications for trials with density dependent mortality (trials Br9 and Br10) as given in section D of the specifications.

3.5.2 Confirmation of the date corresponding to the commercial samples used to set the proportions in Table 5

The Workshop confirmed that the commercial samples used to set the proportions in Table 5 of the trial specifications are from year 1979 only (see IWC, 2018, p.592).

4. REVIEW CONDITIONING RESULTS

The Workshop reviewed the preliminary conditioning results for all trials other than Br3 and Br4 and **agreed** that these were satisfactory. The conditioning plots are available from the Secretariat.

5. WORKPLAN

The Workshop **agreed** that the remaining work should be undertaken intersessionally with the intention of completing the *Implementation Review* at the 2018 Annual Meeting. Kitakado agreed to provide Allison with the CV_{add} values for the future surveys within three weeks of the close of the Workshop. The final trial specifications will be presented at SC67b.

6. ADOPTION OF REPORT

The report was adopted, apart from updating some factual sections, at the Workshop. Donovan thanked Japan for hosting the Workshop in such an efficient manner, the rapporteurs for their work and Allison, de Moor and Punt for computing and all participants for their hard work. The participants thanked the Chair for his usual fair and efficient Chairing.

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Annex A

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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 Available documents
2. Summary of progress since the 2017 annual meeting
3. Completion of outstanding trial specifications
   3.1 Confirmation of mixing matrices
   3.2 Updated abundance estimates – g(0) and additional variance
      3.2.1 Review SC/F18/Br01
      3.2.2 Value for CVadd (high)
   3.3 Confirmation of sighting survey plan
   3.4 Confirmation of management options (including whether catch spread across whole area)
   3.5 Other issues
      3.5.1 Specification of density dependent *M*
      3.5.2 Confirmation that the commercial samples used to set the proportions in Table 5 are from year 1978 only
4. Review conditioning results
5. Workplan
6. Adoption of report

Annex C

List of Documents

SC/F18/BR01. HAKAMADA, T. *g*(0) estimation for Bryde's whales from the POWER surveys during 2015-2016

Annex D

Method for Adjusting Existing Abundance Estimates for Beaufort-Specific Estimates of *g*(0) for the Top Barrel

If *N* is the original estimate of abundance for the stratum of concern (based on *g*(0)=1) then the estimate for the stratum of concerned adjusted for *g*(0), *N**, is given by equation 1:

$$N^* = N \cdot \left[\frac{\frac{n_G}{g_G(0)} + \frac{n_p}{g_p(0)}}{n_g + n_p} \right] \tag{1}$$

where for the stratum of concern:

n_G is the number of primary sightings detected under good Beaufort conditions (Beaufort =0–3);
n_p is the number of primary sightings detected under poor Beaufort conditions (Beaufort =4–5);
$g_G(0)$ is the g(0) for the top barrel under good Beaufort conditions = 0.899; and
$g_G(0)$ is the g(0) for the top barrel under poor Beaufort conditions = 0.543.

Justification
Using equation 1, *N**, the abundance estimate adjusted for the Beaufort-specific *g*(0), corrects the original abundance estimate *N* simply using a sightings-weighted (inverse) *g*(0). On first principles it is reasonable that *N* should be corrected using an effort-weighted *g*(0), rather than a sightings-weighted *g*(0). However, it can be shown that equation 1 is equivalent to using an effort-corrected *g*(0).

Consider the simple abundance estimate formula with *g*(0)=1:

$$N = \frac{A\bar{s}n}{2Lw}$$

where A=Area, $\bar{s}$=expected value of the group size, n=total number of sightings, L=total trackline length and w=effective half-strip width.

If, in a general sense, there are two spatial strata (denoted as areas 1 and 2), and the sighting rate estimates for each area ($\frac{n_1}{L_1}$ and $\frac{n_2}{L_2}$) are effort-weighted by trackline length, L=L_1+L_2 and n=n_1+n_2 then the abundance estimate is given by:

$$
\begin{aligned}
N &= \frac{A\bar{s}}{2w}\left(\frac{L_1}{L_1+L_2}\cdot\frac{n_1}{L_1}+\frac{L_2}{L_1+L_2}\cdot\frac{n2}{L_2}\right)\\
&= \frac{A\bar{s}}{2w}\left(\frac{n_1+n_2}{L_1+L_2}\right)\\
&= \frac{A\bar{s}}{2w}\left(\frac{n_1+n_2}{L}\right)
\end{aligned}
$$

Extending from two spatial strata to stratifying by effort conducted under two Beaufort categories, and including a Beaufort-specific $g(0)$, we have a $g(0)$ adjusted abundance estimate:

$$
\begin{aligned}
N^* &= \frac{A\bar{s}}{2w}\left(\frac{LG}{L_G+L_p}\cdot\frac{nG}{g_G(0)\cdot L_G}+\frac{Lp}{L_G+L_p}\cdot\frac{np}{g_p(0)\cdot L_p}\right)\\
&= \frac{A\bar{s}}{2w}\cdot\frac{1}{L_G+L_p}\cdot\left(\frac{n_G}{g_G(0)}+\frac{n_p}{g_p(0)}\right)\\
&= \frac{A\bar{s}}{2wL}\left(\frac{n_G}{g_G(0)}+\frac{n_p}{g_p(0)}\right)\\
&= \frac{N}{n}\left(\frac{n_G}{g_G(0)}+\frac{n_p}{g_p(0)}\right)
\end{aligned}
\tag{2}
$$

Note that equation 2 is identical to equation 1. This approximation assumes that the values of $\bar{s}$ and w are independent of the Beaufort categorisation. Practically this often has to be assumed due to small sample sizes.

Annex E

Method to Estimate Abundance for Conditioning

For conditioning, abundance estimates for the entire area for the entire historical time series are required. The entire area is defined as the sub-areas 1W, 1E and 2, less the hatched region between 165°E and 165°W in the northeast (see Fig. 1 in the main report). The time series consists of three sets of abundance surveys where the abundance estimates are centred on, and therefore time stamped 1995 (1988-1996: Shimada *et al.,* 2008; Figs 1-2), 2000 (1998-2002: Kitakado *et al.,* 2008; Fig. 3) and 2011 (2008-2015: SC/M17/RMP02; Fig. 4).

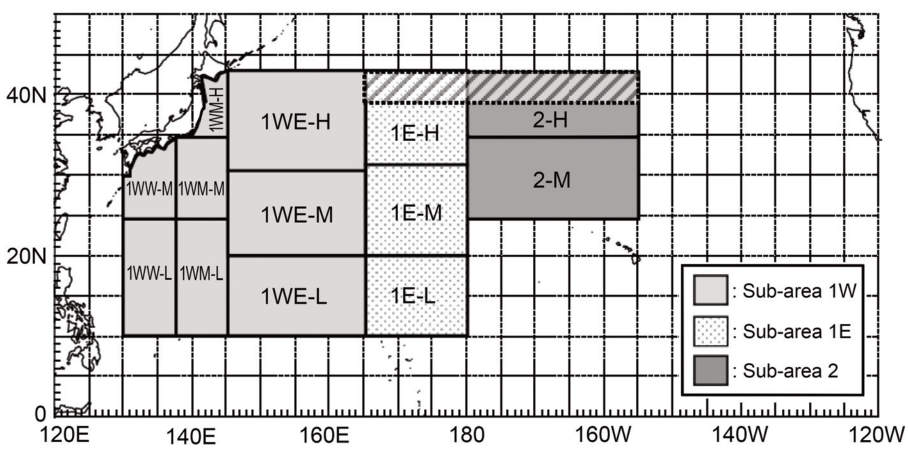

Fig. 1. Sub-areas and blocks used for the abundance estimation. H, M and L mean high, middle and low latitudes. The northern parts (shaded) in the two blocks, 1E-H and 2-H, were excluded from the estimation of abundances, which means any detections and effort in those parts were not included in the analyses, and the abundance estimates in those blocks were calculated for the southern parts of 1E-H and 2-H. A more detailed explanation is given in Shimada *et al.* (2008).

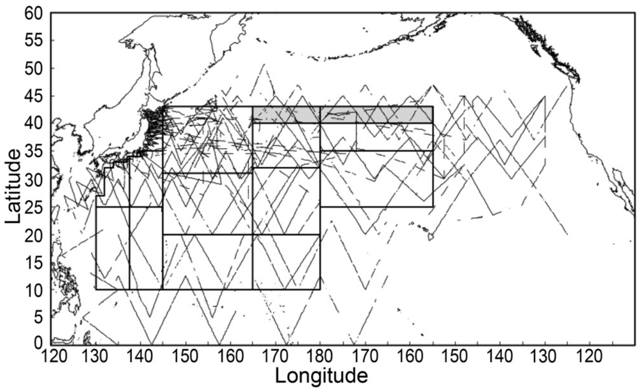

Fig. 2. Pre-determined cruise tracklines on effort during the past sightings surveys in August and September,1988-1996. The northern part (North of 39° N) of 1E-H and 2-H block excluded this abundance estimation to keep consistency of estimation in the recent surveys that were not covered enough, shown as grey colour.

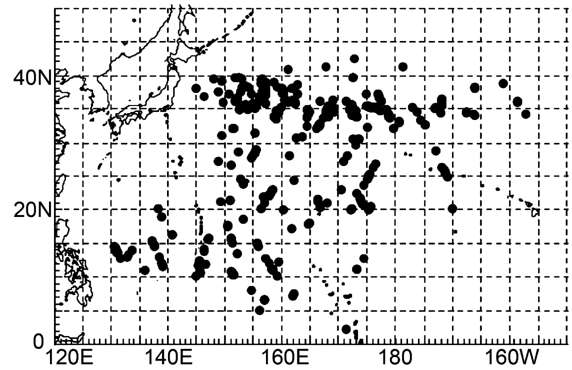

Fig. 3. Primary sighting positions of Bryde's whale during the past sighting surveys in August and September, 1988-1996.

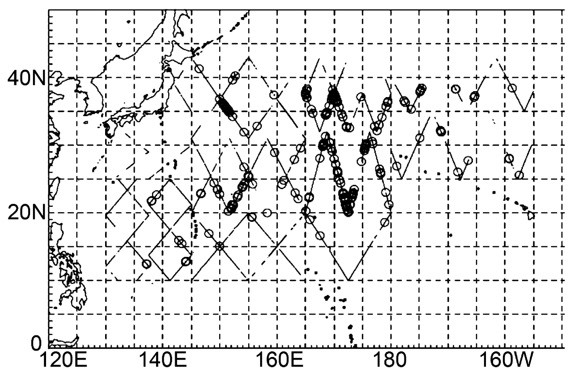

Fig. 4. Primary sighting positions of Bryde's whale and tracklines on effort for surveys in August and September, 1998-2002.

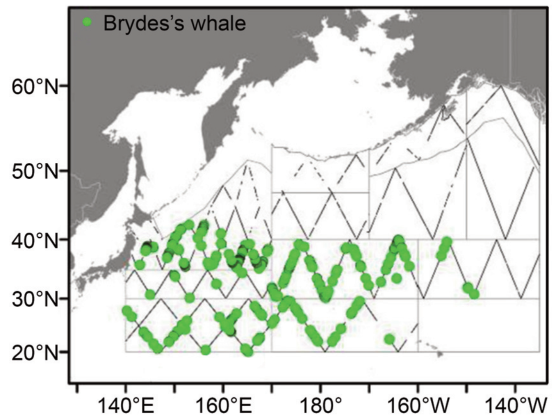

Fig. 5. Plot of primary sightings for Bryde's whales (green circles) and tracklines actually surveyed during 2008-2015.

The abundance for the entire area has already been estimated (and agreed by the Committee) for the first two sets of surveys that were time stamped 1995 and 2000. However, the set of surveys time stamped 2011 did not cover the whole of the 1W sub-area. The previously reported abundance estimates for 1W for the 2011 set of surveys represents thus only a partial estimate for the 1W sub-area. Therefore, to make the 1W abundance estimate from the 2011 set of surveys comparable to the earlier two sets of surveys, the partial 1W abundance estimate from the 2011 set of surveys must be expanded by adding an approximate estimate of the abundance in the unsurveyed areas. The 1W sub-areas not surveyed during the 2011 set of surveys and where there were Bryde's whales are between 130°-140°E (sub-areas 1WW-L and 1WM-L) and between 10°-20°N (sub-areas 1WE-L and 1E-L). Sub-areas 1WW-M, 1WM-M and 1WM-H were also not surveyed in 2011, but there were no Bryde's whales detected in the earlier two set of surveys (Figs 2 and 3), so it is assumed there were no Bryde's whales in these sub-areas during the 2011 set of surveys.

The best abundance estimate for the unsurveyed 1W sub-areas for the 2011 set of surveys was derived from the abundance estimates for these sub-areas as calculated from the 1995 and 2000 sets of surveys. It was assumed that for each set of surveys, the ratio of the abundance in the 2011 unsurveyed 1W areas (sub-areas 1WW-L, 1WM-L, 1WE-L and 1E-L) to the abundance in the 2011 1W surveyed sub-areas (1WE-H, 1E-H, 1WE-M and 1E-M) were similar. Since there are two sets of previous surveys, the average ratio from the two previous sets of surveys was assumed to be the most representative number to use to expand the 1W partial abundance estimate from the 2011 set of surveys ($N_{part2011}$=15,422 CV=0.289; Hakamada *et al.,* 2018). Thus, the expanded estimate for the total abundance of 1W for the 2011 set of surveys ($N_{tot2011}$) was estimated by:

$$N_{tot2011} = N_{part2011} + \left(N_{part2011} \cdot Average\left[\frac{N_{unsurv.i}}{N_{surv.i}} \right] \right)$$

where $N_{unsurv.i}$ is the abundance in the unsurveyed sub-areas from the i[th] set of surveys;
$N_{surv.i}$ is the abundance in the surveyed sub-areas from the i[th] set of surveys; and
i is the set of surveys time stamped either 1995 or 2000.

The CV of $N_{tot2011}$ was estimated using the delta method. $N_{tot2011}$ was estimated to be 18,035 (CV=.476; Table 1).

Table 1

Estimate of abundance for the entire 1W sub-area for the 2011 set of surveys ($N_{tot2011}$) and abundances used to estimate it. Estimates from the 1995 set of surveys were taken from the base case in Shimada et al. 2008 (SC60/PFI2) (Table 8a). Estimates from the 2000 set of surveys were taken from run 1, Model 4 in Kitakado et al. 2008 (SC60/PFI3) (Table 3).

		Unsurveyed sub-areas in 2011 set of surveys				Surveyed sub-areas in 2011 set of surveys				Abundance				
		130°-140°E		10°-20°N										
Year		1WW-L	1WM-L	1WE-L	1E-L	1WE-H	1E-H	1WE-M	1E-M	$N_{surv.i}$	$N_{unsurv.i}$	$N_{part2011}$	2011 Unsurv	$N_{tot2011}$
1995	n	2132	792	3002	622	3531	13634	3450	7132	27747	6548	15422	2613	18035
	CV	0.5812	0.5627	0.7114	0.7428	1.2805	0.7427	0.5348	1.3087	0.5429	0.4755	0.289	0.7031	0.4755
2000	n	348	439	407	315	1238	3480	2525	7418	14661	1509			
	CV	1.0632	0.784	0.7379	0.7646	0.6371	0.5967	0.6149	0.6628	0.4755	0.4581			

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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].

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 F

Options for Future Sighting Surveys for Use in the Trials

Takashi Hakamada and Koji Matsuoka

This Annex provides possible future survey options including information the survey area and survey month when sighting surveys are to be conducted in each sub-area.

Table 1 provides possible plans for sub-areas 1W, 1E and 2. It is planned to cover either (a) the whole of the sub-areas 1W, 1E and 2, or (b) only North of 20°N within in these sub-areas. These survey areas are shown in Fig.1.

There are two options for these future survey plans. One is that sub-areas 1W, 1E and 2 are surveyed within a single year. Sighting surveys are to be conducted every two years. When sub-area 1W is surveyed, survey effort is doubled.

Another is that sub-area 1W is divided into three sub-regions (130°E-140°E, 140°E-152°30'E and 152°30'E-165°E) because sub-area 1W is too wide to be able to cover the whole of this sub-area in one year with a single vessel. Each sub-region is planned to be surveyed in a single year.

For both options, sighting surveys are conducted in July-August. The set of surveys is repeated every six years.

Table 1

Future survey options for use in *IST*s.

Option 1

		Sub-area		
		1W	1E	2
Year	2019			
	2020	Jul-Aug*		
	2021			
	2022		Jul-Aug	
	2023			
	2024			Jul-Aug
	2025			
	2026	Jul-Aug*		
	2027			
	2028		Jul-Aug	
	2029			
	2030			Jul-Aug
	2031			

*: Double effort is to be allocated.

Option 2

		Sub-area			
		1W		1E	2
Year	2019				
	2020	Jul-Aug	130-140˚E		
	2021	Jul-Aug	140-152.5˚E		
	2022	Jul-Aug	152.5-165˚E		
	2023			Jul-Aug	
	2024				Jul-Aug
	2025				
	2026	Jul-Aug	130-140˚E		
	2027	Jul-Aug	140-152.5˚E		
	2028	Jul-Aug	152.5-165˚E		
	2029			Jul-Aug	
	2030				Jul-Aug
	2031				

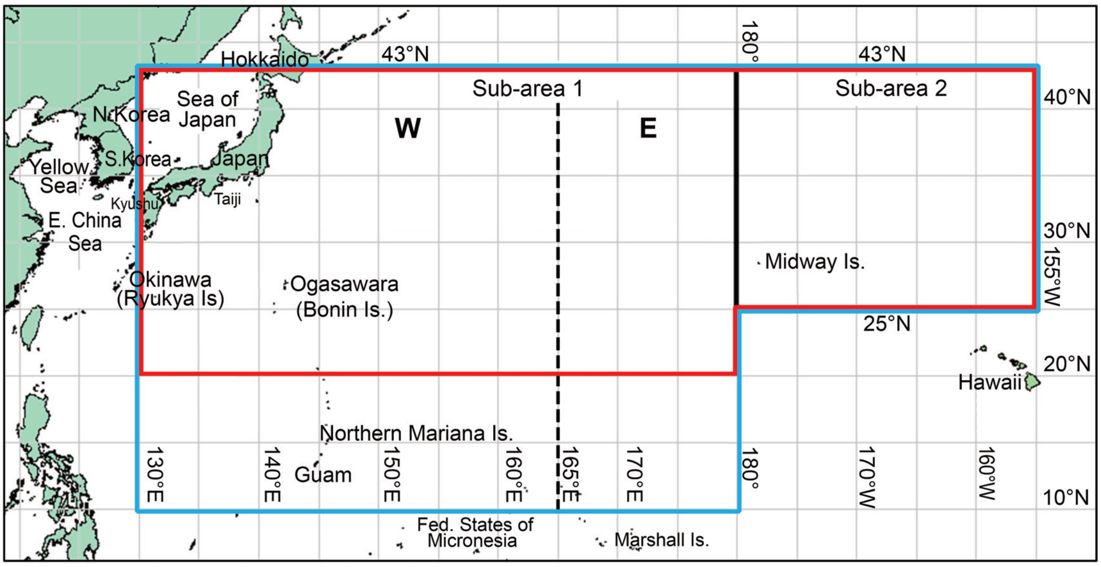

Fig. 1. Survey area planned to be covered by the future survey options to be considered in ISTs. The area surrounded by blue lines is the survey area considered in (a) and that surrounded by red lines is the survey area considered in (b).

Annex G

The Specifications for the *Implementation Simulation Trials* for Western North Pacific Bryde's Whales

For the Specifications, see main Scientific Committee Report, Annex D, Appendix 3 published in this volume.

Report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales

Report of the Fifth Rangewide Workshop on the Status of North Pacific Gray Whales[1]

1. INTRODUCTORY ITEMS

The Workshop was held at the Granite Canyon Laboratory of the Southwest Fisheries Science Center (Big Sur, California) from 28-31 March 2018. The list of participants is given as Annex A.

1.1 Convenors' opening remarks

Brownell welcomed the participants and explained the history of the facility, which has been used for almost five decades to census gray whales during their southbound migration. Donovan and Punt (co-convenors) noted that the primary tasks of the workshop were to review the results of the modelling work identified at the Fourth Workshop and SC67a, to examine the new proposed Makah Management Plan (submitted by the USA) for gray whaling off Washington state and to update as possible (and develop a workplan for) updating the scientific components of the Conservation Management Plan (CMP) for western gray whales.

1.2 Election of Chair

Donovan and Punt were elected Chairs (Donovan chaired from the 28-30 March and Punt on 31 March).

1.3 Appointment of Rapporteurs

Calambokidis, Cooke, Lang, Punt, Reeves, Scordino and Weller served as rapporteurs.

1.4 Adoption of Agenda

The adopted Agenda is given as Annex B.

1.5 Documents and data available

The documents available to the meeting are listed in Annex C. Annex D summarises the terminology used to designate breeding stocks and feeding aggregations.

2. PROGRESS ON 'NON-MODELLING' RECOMMENDATIONS AND NEW DATA

2.1 Updated information from co-operative genetics studies

Bickham presented the results of a multi-authored study of SNPs using samples from approximately 50 whales feeding off Sakhalin Island ('western' gray whales) and approximately 100 whales from the Mexican wintering grounds (assumed 'eastern' gray whales); the full study will be presented at SC67b [see SC/67b/SDDNA03]. The methods used are described in DeWoody *et al*. (2017). The authors believe that the results will have implications for prioritising the various stock structure hypotheses being modelled in the Rangewide Review (see below).

Multiple duplicate biopsies were found within both the Sakhalin and Mexico sample sets, but none were shared between the two localities. SNP genotypes were also presented for two mitochondrial and two sex-linked loci (Zfx and Zfy). One of the sex-linked SNPs (ZFY_342) had an apparent fixed heterozygosity in the Mexican whales and thus only the second locus could be used for determining the sex of the whales. The Workshop noted that whilst there is no single explanation of this, one possibility is that there was a translocation (duplication) of the Y-linked SNP to the X or to an autosome.

Bickham also presented the results of the STRUCTURE analyses for the SNPs. In the cases with locality as a prior and without locality as a prior, K=2 genomes (or populations) was the best solution; the plot with geography as a prior showed better differentiation with one predominating in the east (Mexico) and the other predominated in the west (Sakhalin). All eastern samples showed admixed ancestry (including some with predominantly the 'western' genome) but the western samples showed a much higher proportion of admixture including individuals of nearly 'pure' eastern and western genomes. He also presented results for an analytical approach called Landscape and Ecological Associations (LEA)[2]. The LEA analysis also identified K=2 genomes but with greater separation. In the Sakhalin sample set the western genome still predominated but there were both individuals with pure western and others with pure eastern genomes as well as admixed individuals. The more equal proportions of western and eastern genomes in the Sakhalin samples was consistent with an Mxy estimate of genetic similarity (the Sakhalin sample set had a notably higher variance for genetic relatedness between paired samples than was observed in the Mexican sample set).

The authors concluded that the Sakhalin population might be comprised of two types of individuals representing two breeding stocks (i.e. two different genomes), along with individuals of mixed ancestry (admixture). The proportions of the two genomes are vastly different in the two sample sets.

The Workshop **agreed** that incorporating photo-ID data into the genetic results will greatly improve interpretation of stock structure and movements and **recommended** that the genetic dataset should be examined comparing whales seen only once off Sakhalin with those whales seen in multiple years.

Lang gave a brief update of her work on SNPs, using the next-generation sequencing approach ddRAD. She is analysing approximately 200 gray whales representing approximately equal sample sizes of PCFG (Pacific Coast Feeding Group), western gray whales, and Northern Feeding Group whales. She expects to present the results of at the 2019 gray whale *Implementation Review*.

The Workshop **welcomed** news from Bickham that a request to the Government of Japan to obtain gray whale samples for genetics studies (including of the possible extant western breeding stock) had been granted.

It was noted that the extent of mixing of gray whales in the past had probably fluctuated in response to changes in sea ice (glacial versus interglacial periods). Bickham responded that additional genome sequencing was planned and that the reconstruction of the historical demography of western and eastern gray whales is one goal of that study. Analyses may reveal associations with the climate cycles of the Pleistocene.

2.2 Updated information from photo-identification studies including consolidation of WGW catalogues

SC/M18/CMP/02 reviewed the results of long-term photo-identification studies conducted between 2002-2017 off northeast Sakhalin Island by the Joint Monitoring Program of two oil and gas companies[3]. The photo-identification catalogue resulting from this work contains 283 identified individual gray whales, including: (a) 175 whales that use

[1] Presented to the meeting as SC/67b/Rep07.

[2] *http://membres-timc.imag.fr/Olivier.Francois/LEA/tutorial.htm.*

[3] Exxon Neftegas Limited (ENL) and Sakhalin Energy Investment Company (SEIC)

the Sakhalin Island feeding area on a regular annual basis, (b) 27 occasionally-sighted whales (recorded at intervals greater than three years), and (c) 71 individuals that have been recorded only once. Forty-eight of the one-time visitors were recorded as calves, excluding the nine calves first identified in 2017. There are 29 identified mothers and 127 whales first identified as calves in the catalogue. Six mother-calf pairs were identified in 2017, along with three unpaired calves. Whale no. KOGW127 (aka 'Agent'), was identified as a calf in 2005 and was first recorded as a mother in 2017 at the age of 12 years. Agent was satellite tagged in 2011 and her winter migration was tracked to the Gulf of Alaska before the transponder stopped working (Mate *et al.*, 2015).

Drone-based photography was incorporated into the joint-programme field program in 2017. In most cases, the drone was used at an average distance of about 800m from shore with a standard altitude of 8 meters. The range of the drone presently in use is 2.5km from the shore. With the collection of aerial photographs from drones, a new body aspect ('back') was added to the photo-identification catalogue. Also, a new supplemental catalogue of drone-collected video was created for 35 individuals.

The catalogues of the ENL-SEIC joint programme and the Russian Gray Whale Programme (previously the Russia-US programme) were last cross-matched using data available through 2011. At that time, the two Sakhalin photo-identification catalogues contained a total of 222 whales, of which 186 were common to both. Seventeen whales were found only in the Russian Gray Whale Programme catalogue and 19 only in the ENL-SEIC catalogue (IUCN, 2013). An updated catalogue comparison, under the auspices of the IWC, is being discussed, as is the concept of a common shared catalogue and database.

In discussion, the Workshop **agreed** on the importance of the long-term nature of the research programmes being conducted off Sakhalin. The concept of a common catalogue and database was welcomed and several measures to ensure data compatibility were mentioned, including the important step to standardise reporting of effort and protocols used to designate calves versus yearlings. It was further mentioned that sighting histories of whales photo-identified off Kamchatka should be evaluated to determine patterns of annual occurrence. Finally, the availability of a shared catalogue and regular updating of such was highlighted with respect to the research component of the hunt management plan proposed for the Makah hunt.

2.3 Gray whales off Korea

SC/M18/CMP/04 reported the possible occurrence of a gray whale off Korea in 2015. Video footage of what appears to be a gray whale was uploaded on YouTube in 2015[4]. The whale was swimming near a port facility in Samcheok, on the east coast of Korea. While the poor quality of the video prevented positive identification to species, some features of the whale suggest that it was a gray whale. Additional information is being sought to confirm the species identification. If this sighting was indeed of a gray whale, it would be the first record from Korea since 1977. The Workshop thanked Dr. Yasutaka Imai for alerting Kim to the existence of this video.

3. UPDATING SCIENTIFIC ASPECTS OF THE CMP

Donovan reported recent progress on the 'Rangewide Review of the Status of North Pacific Gray Whales' and the 'Western Gray Whale Conservation Management Plan' (CMP). Since 2004, the IUCN and the IWC have emphasised the need for a comprehensive international CMP to mitigate anthropogenic threats facing gray whales throughout their range in the western North Pacific. This CMP was initiated at an IUCN-convened international workshop in Tokyo in summer 2008 (IUCN, 2009). A draft of the CMP was completed in 2010 (Brownell *et al.,* 2010), and this was endorsed by both the IWC and the IUCN. The first successes of the CMP included completion of a telemetry project conducted off Sakhalin and a Pacific-wide photo-identification catalogue comparison. The results of these projects showed that some of the whales sighted off Sakhalin in the summer migrate east, across the Pacific, reaching portions of the North American coast between British Columbia, Canada and the wintering lagoons off Baja California, Mexico. In light of this new information, the IWC has been engaged in the present rangewide review.

In support of the CMP initiative, in 2014 a 'Memorandum of Cooperation Concerning Conservation Measures for the Western Gray Whale Population' (the MoC), was signed by Japan, Russian Federation and the USA. In 2016, the memorandum was signed by Mexico and the Republic of Korea, and Prof. Hidehiro Kato of the Tokyo University of Marine Science and Technology was appointed as coordinator of the memorandum. It is hoped that in time the other remaining range states will also sign the memorandum.

3.1 Review of existing sections

The Workshop noted that the work to complete the model specifications, especially taking into account the new Makah Management Plan, meant that there was insufficient time to update the CMP sections, also recognising that this could best be completed after the modelling results became available, ideally at SC67b. Attention was drawn to the updated seasonal maps[5], and participants were asked to send any comments or suggestion for modification to Donovan and Reeves.

The Workshop **recommended** that the Scientific Committee considers establishing a small drafting group comprised of at least the national co-ordinators of the MoC, Reeves (IUCN) and Donovan be convened to meet intersessionally (e.g. at IUCN headquarters) to provide an updated version of the plan after SC67b.

3.2 Consideration of future stakeholder workshop

An important component of the CMP effort is the need for a stakeholder workshop (tentatively forecast to occur in 2019) that helps to finalise the CMP and develops a strategy for its implementation. The workshop, which would be co-sponsored by IWC, IUCN and the signatories to the Memorandum of Cooperation, should be broad-based and include representatives of national and local governments, industry (e.g. oil and gas, fishing, shipping and tourism), IGOs and NGOs. Objectives of this meeting should include: (1) review and updating of the CMP taking into account any new scientific results from the rangewide workshops; (2) establish a stakeholder Steering Group to monitor CMP implementation; (3) arrange for a coordinator of the CMP; and (4) establish a work plan and consider funding mechanisms to implement the actions of the plan. The IWC has a Voluntary Fund for Conservation, to which donations can be specifically directed towards the gray whale CMP and related work. It is expected, however, that after the first year of CMP implementation, range states will contribute the necessary funds to advance the conservation actions listed in the plan. The Workshop welcomed the support offered by IUCN with respect to organising the stakeholder workshop.

[4] *https://www.youtube.com/watch?v=dJ4J7luGgcE.*

[5] *https://iwc.int/western-gray-whale-cmp*

4 UPDATE ON MODELLING FRAMEWORK AND RUNS

4.1 Progress of modelling since SC67a including validation

4.1.1 General progress, including validation

Punt informed the Workshop that code implementing the specifications agreed at the 4th Rangewide Workshop and modified during SC67a had been written and used to condition the reference trials based on stock hypotheses 3a, 3e and 5a, along with the sensitivity tests that implement stock hypotheses 3b and 6b.

Brandon summarised progress on validating the code implementing the operating model and the conditioning process. SC/M18/CMP/03 provides an update on code validation, including a brief overview of the code and input files, and a list of verification steps taken to date. The main focus of the validation process has been on the FORTRAN procedures necessary for the conditioning phase. Conditioning the operating model is the first and most computationally expensive phase of the Rangewide modelling effort because this code involves the bulk of calls to numerical methods to estimate parameters given model fits to the data. To this end, the conditioning code has been checked against the mathematical and statistical model specifications, to ensure that the procedures as implemented are consistent with the specifications (see Annex D for the specifications of the Rangewide model). Likewise, diagnostic output from the code has been checked against expected values. No errors in the coding were identified.

4.1.2 Modelling related to the proposed Makah Management Plan

Punt informed the Workshop that code implementing the Makah Management Plan had been developed and initial results presented to the March 2018 AWMP meeting. However, Brandon has yet to validate this code. The code implementing the Makah Management Plan needs to be validated prior to SC67b.

During the Workshop, the Makah Management Plan was clarified/updated as shown below.

(1) It was clarified that the hunt will be stopped if the PCFG 10-yr strike limit less the number of PCFG-designated animals drops below 1 or if the PCFG 10-yr female strike limit less the number of PCFG-designated females drops below 1. The initial implementation stopped the hunt only when these differences were less or equal to zero.
(2) It was agreed to incorporate an 'unknown identity' component for landed whales because it may not be possible to obtain a useable photograph of landed as well as struck and lost whales (although at a lower probability).
(3) It was agreed to allowing for the fact that the amount that unidentified whales count towards the PCFG 10-year strike limit will be updated based on available data rather than always being assumed to be 0.4. The error associated with the estimate of the proportion of PCFG whales in even-year hunts needs to be accounted for (see Item 4.4.1).

4.2 Review of stock hypotheses

The Workshop reviewed how the three baseline stock hypotheses (3a, 3e and 5a) and the two stock hypotheses considered as tests of sensitivity (3b and 6b) had been implemented, noting that some of the 'limited' movements (light arrows in Annex E) had been omitted from the baseline hypotheses, but would be considered in tests of sensitivity (e.g. the PCFG in sub-area BSCS). The omission of the associated links was due to lack of mixing data to allow the links to be modelled. It was also noted that that there are no data (abundance estimates, mixing proportions, catches) for some of the sub-area (e.g. the OS sub-area), which implies that the results will be identical no matter how such regions are treated in the modelling.

The Workshop noted that the current implementation of hypothesis 5a did not include the WBS in the SKNK sub-area. This is because there was currently no basis to specify a mixing proportion for WBS vs WFG animals in the sub-area. Cooke provided abundance estimates by breeding stock/feeding group (see Item 4.3.1), which means that it is no longer necessary to specify mixing proportions for the SKNK sub-area.

The Workshop **agreed** that stock hypotheses 3a and 5a would form the references for the analyses as they appear to be most plausible, while trials would also be conducted for stock hypotheses 3b, 3c, 3e and 6b. Annex E shows the final stock hypotheses considered in the trials graphically, while Annex D, table 2 shows the resulting mixing matrices. The g values in Annex D, table 2 indicate parameters that are estimated during the model fitting process.

4.2.1 Plausibility of stock hypothesis 6b

SC/M18/CMP/01 aimed to reopen discussion on the plausibility of the stock hypotheses previously considered as high priority for modelling, with special emphasis on stock hypothesis 6b. Stock hypothesis 6b assumes that the WBS has no fidelity to wintering ground and uses both wintering grounds in both Asia and Mexico. SC/M18/CMP/01 argued that this hypothesis was elevated to high priority due to discussions regarding the movements of humpback whales and the social aggregating hypothesis of Clapham and Zerbini (2015). This hypothesis involves humpback whales learning of new wintering grounds, likely through hearing other humpback whales, and temporarily immigrating. SC/M18/CMP/01 argued that this hypothesis does not apply well to gray whales because they are much quieter than humpback whales and there is a large distance between the distribution of WBS and eastern breeding stock whales (as portrayed by hypothesis 6b) preventing communication between whales. Furthermore, humpback whales and gray whales have very different breeding behaviour, with humpback whales aggregating on modified leks (Clapham and Zerbini, 2015). There does not appear to be a functional benefit for WGW to justify shifting their migration to go to wintering grounds in Mexico instead of Asia given the extra 4,000km of travel required (Villegas-Amtmann *et al*., 2015). Furthermore, it does not appear likely that the WBS used both wintering grounds without fidelity prior to commercial whaling given that whaling occurred off Japan and Korea during a period when the whales using the Mexican wintering grounds were depleted. Bickham *et al.* (2013) has also presented arguments based on genetics on why hypothesis 6b has low plausibility. SC/M18/CMP/01 also suggested that hypothesis 3e has low plausibility because it assumes that WBS whales occur in their historical feeding range but do not use the Piltun Lagoon area of Sakhalin Island, which has proved to be an important feeding area since the mid-1980s. It is more likely that if the WBS exists, that this breeding stock would spend at least some time feeding near Piltun Lagoon. SC/M18/CMP/01 concluded the trials based on stock hypotheses other than 3a and 5a should be sensitivity tests.

In discussion, it was noted that gray whales that feed off Sakhalin and traditionally used wintering grounds in the western North Pacific could be driven to occasionally use migratory routes and wintering areas in the Eastern North Pacific. While the Rangewide model does not explicitly account for breeding so does not incorporate information on when or where whales breed, this hypothesis could provide an explanation for the observations of Sakhalin whales in the eastern North Pacific. There is evidence showing that whales from the same feeding groups migrate together; both Sakhalin and PCFG whales have been photographically identified in the same groups and in localised areas while on migratory routes (Weller *et al.*, 2012, Calambokidis and Perez, 2017). This could provide a mechanism by which whales that feed together, but have traditionally used different wintering areas, could learn new migratory routes.

Although the possibility that gray whales use multiple wintering grounds could not be ruled out, the Workshop **agreed** that stock hypotheses 6b would be considered as a sensitivity test. It was also **agreed** that stock hypothesis 3e would be considered a sensitivity test.

4.3 Confirm final data sets

4.3.1 Removals (direct and incidental)

Nakamura *et al.* (2017, table 1), gave a listing of gray whale deaths from entanglement/entrapment, ship strike, and unknown causes in Japan from 1955 until the present. A small group (Scordino, Reeves, Brownell) met to confirm and update previous discussions on removals in Japan (and elsewhere), recalling that the adult that 'died off Hokkaido in 1996' was killed deliberately (Brownell, 1999).

The Workshop **endorsed** the conclusions of the small group as summarised below.

(1) Of the six gray whales reported as beached in Japan between 1990 and 2016 but with cause of death undetermined, some proportion should be assumed to have died from either entanglement/entrapment or ship strike. The under-reporting factor (usually x4 but with sensitivities of x10 and x20; Annex D, tables 8 and 9) used in the model to convert observed mortality to true mortality in the case of bycatch and ship strike would account for this.

(2) There was no reason to believe there had been any change in fishing effort (e.g. set net fishing) in Japan between 1930 and 1982. Therefore, the removal rate from 1982 to the present should be extended back to 1930 for modelling purposes.

(3) With respect to commercial set gillnet fishing in California prior to 1981, as noted last year (IWC, 2018), a seabass fishery operated in northern Mexico and southern California prior to the 1980s (e.g. landing 412,000 pounds of black seabass and 873,000 pounds of white seabass in 1953; Marine Fisheries Branch, 1956). In fact, this fishery was active and overall fishing effort 'fairly constant' from before 1930 until the early 1980s (Vojkovich and Reed, 1983). There was no observer effort in this fishery before 1981, nor was an official stranding record of cetaceans maintained in California before that time. However, a coordinated reporting system for stranding was established in the early 1960s under the auspices of the American Society of Mammalogists, and stranded gray whales were regularly reported. For example, 24 dead gray whales were reported as stranded in California between 1960 and 1968, of which seven were confirmed or suspected of having been either entangled in fishing gear or struck by a ship (Brownell, 1971). A gray whale that stranded at Ocean Beach, California, on 19 February 1953 was missing its flukes and bore 'several gashes' on the body – all suggestive of an entanglement death (Robert Orr, pers. comm. to R. Brownell, April 1964).

At last year's workshop, it was assumed that set gillnet fishing effort for halibut in California declined linearly from 1982 to no effort in 1975. To model the effect of this assumption, it was decided to assign all records of gray whales recorded as injured or killed in halibut or other set gillnet fisheries to a single fishery and modelled separately from all other California fisheries. It was also decided to examine both a low case that assigned no deaths to set gillnet fisheries and a high case that considered all bycatch reports related to gillnet, set gillnet, net, and halibut fisheries in California as if they came from a single fishery (IWC, 2018). A recently found publication (Bureau of Commercial Fisheries, 1936) reported that both set gillnets and trammel nets were used in the 1930s in California for halibut and white seabass fishing. Based on this new information, the Workshop **agreed** to drop the assumption that fishing effort declined linearly to zero from 1982 to 1975 and therefore there was no reason to evaluate high and low scenarios as a way of accounting for bycatch in California prior to 1975.

Set gillnetting effort off California changed markedly in 1991 due to regulations passed in November 1990 intended to eliminate gillnet fishing within 3 n.miles of the mainland and within 1 n.mile of any offshore island in southern California by 1994 (Barlow *et al.,* 1994). To address this, a second set gillnet fishery was added to the model starting in 1991, and the set gillnet fishery described in the preceding paragraph was modelled as having ended in 1990.

4.3.2 Abundance estimates

There were no updates to the estimates of abundance for the PCFG or the ENP stock. New abundance estimates for western gray whales had been presented to the last WGWAP meeting (Cooke *et al*., 2017), which will also be presented to the SC67b. Estimates for the WFG were extracted at the Workshop (Table 1), these correspond to the stock structure hypotheses listed in Annex E. The larger estimates for the WFG correspond to the hypothesis that all whales visiting SE Kamchatka and/or Sakhalin belong to the WFG, while the smaller ones correspond with the hypothesis that only whales that visit Sakhalin belong to the WFG (regardless of whether these individuals also visit Kamchatka).

For the hypotheses where a proportion of the WFG belongs to the western breeding stock (WBS), this proportion is highly uncertain (and could be zero) even though the estimate for the total WFG is reasonably precise. The estimates of the numbers of WFG animals in each of the two breeding stocks are, therefore, highly negatively correlated. In these cases, the multi-stock model uses as inputs the estimate of the total WFG abundance and the estimated proportion of this that belongs to the WBS.

4.3.3 Mixing proportions

Table 2 lists the updated mixing proportions. The mixing proportion for the EJPJ sub-area is unchanged from that specified at the 4th Rangewide Workshop because none of whales encountered recently in this sub-area had adequate photographs to allow for matching (Table 3).

New mixing proportions were calculated for PCFG whales by sub-area for the winter/spring (migrating) and summer/fall (feeding) seasons (Table 4). The sub-regions of the BCNC region used for the analysis were northern Oregon,

Table 1

Abundance estimates (1+) for the WFG feeding aggregation and the western breeding stock.

Year	Group	Hypothesis	Estimate	SD	CV
1995	WFG	3a/3c/3e/6b	75.1	3.8	0.051
1995	WBS	3b	25.8	7.3	0.282
1995	WFG	3b	75.5	3.3	0.043
1995	WBS	3e	30.0*	15.0	0.500
1995	WBS	5a	26.6	6.9	0.259
1995	WFG	5a	47.8	7.7	0.160
1995	WBS+WFG	5a	74.4	3.9	0.052
1995	WBS/(WBS+WFG)	5a	0.358	0.093	0.259
2015	WFG	3a/3c/3e/6b	199.8	5.4	0.027
2015	WBS	3b	63.8	15.8	0.248
2015	WFG	3b	198.9	5.7	0.029
2015	WBS	3e	30.0*	15.0	0.500
2015	WBS	5a	64.4	14.0	0.218
2015	WFG	5a	135.6	14.1	0.104
2015	WBS+WFG	5a	200.0	5.7	0.029
2015	WBS/(WBS+WFG)	5a	0.322	0.069	0.200

* Guesstimate because the WBS cannot be distinguished given the available information.

Table 2

Mixing proportions for use in the trials

Sub-area	Season	Stock/Feeding aggregation	Mixing proportion
EJPJ	All	WBS/NFG	0.33
SEA	Feeding	PCFG	0.57[1]
SEA	Migration	PCFG	0.1[2]
SEA	Migration	WGW	0.002[3]
BCNC	Feeding	PCFG	0.93
BCNC	Feeding	WGW	0
BCNC	Migration	PCFG	0.28
BCNC	Migration	WGW	0.002
CA	Feeding	PCFG	0.60
CA	Feeding	WGW	0
CA	Migration	PCFG	0.1
CA	Migration	WGW	0.002[3]

[1] Not used in the conditioning as no bycatch is recorded for the SEA sub-area during the feeding season.
[2] Assumed value owing to lack of data to estimate mixing proportions.
[3] Set to the value calculated for BCNC by Moore and Weller (2013)

Table 3

Updated information on matches between whales encountered off Japan and those photographed off Sakhalin (D. Weller, SWFSC).

Date	Location and source	Conclusion
April 2016	Shizuoka, beached	no useable photos/no match
February 2017	Kanagawa, sighting	poor quality video only/no match
April 2017	Chiba, sighting	poor quality video only/no match
March 2017	Aogashima, sighting	no useable photos/no match
February 2018	Aogashima, sighting	no useable photos/no match

Table 4

Proportion of PCFG whales by region and Month for cells with >10 IDs through complete through 2015 for OR-WA Jan to May (no Dec data).

Region	Jan	Feb	Mar	April	May
NWA	0.09		0.09	0.10	0.41
SWA			0.38	0.21	0.33
NOR					0.63

Mean of above cells for OR to WA: **Unweighted=28%**, Pooled=24%
Mean of above for just NWA: Unweighted=17%, Pooled=20%

southern Washington, and northern Washington because they were thought to have the least chance of bias in calculated mixing proportions. Updated data through 2015 based on matches to the PCFG catalogue were used. There was considerable discussion about how to calculate the mixing rate for the Oregon-Washington outer coast area due to a dramatic change in proportion of PCFG whales in northern Washington from surveys in early April 2015. Those surveys identified a large number of whales in a previously poorly sampled area that had very few PCFG whales. Identifications in spring 2015 (heavily influenced by these April surveys) reduced the overall proportion of PCFG whales based on pooled proportions through 2015 to 24% (it had been 36% based on data through 2014). To provide a value less influenced by these two days of surveys, the proportions of PCFG whales were averaged over sub-region and month to compute an overall average of 28% (an average of the eight values presented in Table 4).

The Workshop **agreed to** adopt 28% for the proportion of PCFG whales in the BCNC sub-area during the migrating season for the bulk of the trials, and that sensitivity would be evaluated to 17%. This value is obtained by restricting the analysis of mixing rates of PCFG whales during the winter/spring to just northern Washington where the hunt would occur (based on the unweighted average of the 4 months where there were at least 10 photo-IDs, table 4). Pooling all 622 photo-IDs for December to May would result in a rate of 20%, although this approach weights values towards periods with more photo-IDs.

Considering some of the uncertainty around the estimate for the portion of PCFG whales present in the spring off the Washington-Oregon coast and the variation by location, month, and year, the Workshop **agreed** the current best estimate of 28% to be +-20% (8-48%) for the true PCFG mixing rate. The rationale for the choice is that very different results would be obtained in different areas such as 1) the recently sampled zone north of Tatoosh Island in the early spring where migrating whales appear to gather in some years where recent efforts revealed almost no PCFG whales, compared to 2) areas along the Northern Washington Coast or for example in Barkley Sound that are feeding areas for PCFG whales and where their proportion compared to migrating whales would be highest.

4.4 Confirm final trial structure and conditioning

4.4.1 Changes to the trials specifications, including stock structure

Annex D lists the specifications for the model that will form the basis for drawing final conclusions regarding the implications of alternative stock structure hypotheses and of the implementation of the Makah Management Plan. The specifications (see also Annex D and Table 5 and 6) reflect changes to how the stock hypotheses are implemented as well as how the abundance estimates for the western Pacific are used in conditioning. The Workshop also agreed that the following additional changes will be made the trials specifications:

(1) the base-case survival rate for animals aged 1 and older would be assumed to be 0.98, which reflects the estimates obtained by Cooke (and Punt and Wade, 2012) – the value used in previous trials was 0.95;
(2) the SET1 and SET2 fleets (set gillnets off California in the feeding and migration seasons) would be split between 1990 and 1991 given the changes in regulations in the associated fisheries that appear to have changed bycatch rates;
(3) the survey plan for the California counts were updated to reflect the current plan (two surveys in every five-year block); and
(4) the periods used to calculate average bycatch rates to infer bycatch prior to the establish of monitoring networks into the future as generally but the earliest and most recent five years, but a longer period is specification for sub-areas (e.g. EJPJ and SI) with limited data (Annex D, table 3).

Evaluation of the Makah Management Plan requires specification of the probability of photographing a landed or struck and lost whale, as well as the probability of correctly deciding that such a whale is from the PCFG or the WFG. In addition, it is necessary to specify the probability of striking and losing a whale and assigning a sex to an animal for which a match has been made. These probabilities are specified as follows:

(1) *Probability of obtaining a photograph of sufficient quality to allow it to be matched to the catalogue*. For struck and lost whales, this probability is estimated to be a 0.6 for winter/spring and 0.8 for summer/fall (due less favourable light and weather in winter/spring compared to summer/fall). For landed whales, it is estimated to be 0.9 for all seasons.
(2) *Probability of struck and lost*. The review of the Makah whale *SLA* concluded in 2013 was based on a value for this probability of 0.5, which was informed by two strikes that occurred during the Makah 1999 hunt in which one strike resulted in a landing and the other contacted the whale but did not penetrate the skin. The Workshop **agreed** to retain the assumption of a 50% struck and lost rate for hunts during the winter and spring. It was decided that hunts occurring during the summer and fall were much less likely to have struck and lost due to better weather conditions and more predictive movement behaviours of whales in the normal feeding depths of PCFG whales. The Workshop therefore **agreed**

Table 5

Factors considered in the model scenarios. The bold values are the base-levels and the values in standard font form the basis for sensitivity analyses.

Factor	Levels
Model fitting related	
Stock hypothesis	**3a,** 3b, 3c, 3e, **5a,** 6b
$MSYR_{1+}$ (western)	As for WFG
$MSYR_{1+}$ (north)	**4.5%**, 5.5%, Estimated (common); estimate (separately)
$MSYR_{1+}$ (WFG)	**4.5%** Estimated (common); estimate (separately)
$MSYR_{1+}$ (PCFG)	2%, **4.5%**, 5.5%¸ Estimated (common); estimate (separately)
Mixing rate (migration season in BCBC	**0.28**, 0.17, 1.00
Immigration into the PCFG	0, 1, **2**, 4
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
Projection-related	
Additional catch off Sakhalin (mature female)	0, 1
Catastrophic events	**None**, once in years 0 – 49, and once in years 50-99
Northern need in final year (from 150 in 2014)	**340**
Struck and lost rate	**(0.1; odd-years; 0.5 even years),** 0.5 all years
Future effort	**Constant**, Increase by 100% over 100 years
Probability of a photo (struck and lost whales)	**0.8; odd-years; 0.6 even years**
Probability of a photo (landed whales)	**0.9**
Probability of false positive rate PCFG	**0.05**, 0.1
Probability of false negative rate PCFG	**0.25**
Probability of false positive rate WFG	**0.01**
Probability of false negative rate WFG	**0.041 (stock hypotheses 3a, 3c, 3e, 6b);** 0.040 (stock hypothesis 3b); **0.049 (stock hypothesis 5a)**
Probability of a sex assignment given a PCFG match	**0.81**

Table 6

Final trial specifications.

Trial	Description/stock hypothesis	PCFG or WFG in BSCS	$MSYR_{1+}$			PCFG		Bycatch	Conditioning
			North	PCFG	WFG	Imm.	Pulse		
Base-case trials									
0A	Reference 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
0B	Reference 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
Sensitivity tests									
1A	Lower MSYR PCFG 3a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
1B	Lower MSYR PCFG 5a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
2A	Higher MSYR PCFG and North 3a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
2B	Higher MSYR PCFG and North 5a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
3A	Lower WBS in Sakhalin 5a (Hyp 3e)	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
3B	Higher WBS in Sakhalin 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4A	PCFG mixing based on Northern WA only 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4B	PCFG mixing based on Northern WA only 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
5A	No PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
5B	No PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
6A	Higher PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
6B	Higher PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
7A	Lower Pulse into PCFG 3a (and no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
7B	Lower Pulse into PCFG 5a (and no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
8A	Higher pulse into PCFG 3a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
8B	Higher pulse into PCFG 5a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
9A	Bycatch=Dead + MSI 3a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
9B	Bycatch=Dead + MSI 5a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
10A	Bycatch x 10 3a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
10B	Bycatch x 10 5a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
11A	Bycatch x 20 3a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
11B	Bycatch x 20 5a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
12A	PCFG in BSCS 3a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
12B	PCFG in BSCS 5a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13A	WFG in BSCS 3a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13B	WFG in BSCS 5a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 3a	No		**Estimated**		2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 5a	No		**Estimated**		2	20	D x 4	Yes
15A	MSYR1+ estimated (by FA) 3a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
15B	MSYR1+ estimated (by FA) 5a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
16A	Lower PCFG immigration and higher bycatch 3a (and no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
16B	Lower PCFG immigration and higher bycatch 5a (and no 1998-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
17A	MSYR estimated and lower pulse 3a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
17B	MSYR estimated and lower pulse 5a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
18A	Stock hypothesis 3b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18B	Stock hypothesis 6b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18C	Stock hypothesis 3c	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
19A	Lower PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
19B	Lower PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
20A	Lower PCFG immigration and higher bycatch 3a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
20B	Lower PCFG immigration and higher bycatch 5a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
21A	Survival = 0.95; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
21B	Survival = 0.95; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
22A	Future catastrophic events (once in each of yrs 1-50 & 51-99) - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
22B	Future catastrophic events (once in each of yrs 1-50 & 51-99) - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
23A	Summer S&L rate = 0.5 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
23B	Summer S&L rate = 0.5 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
24A	PCFG false negative rate = 0.1 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
24B	PCFG false negative rate = 0.1 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
25A	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
25B	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes

that the struck and lost rate for summer and fall hunts would be 0.1 and that sensitivity would be explored to a value of 0.5.

(3) *False positive rate for PCFG (i.e. probability of a non-PCFG being identified as from the PCFG given a good quality photograph*). The probability that a non-PCFG whale might be falsely identified as a PCFG whale is estimated to be 0.05. Normally, there is near 100% confidence for matches that are identified to Cascadia's PCFG catalogue because these are double checked and photographs of poorer quality where there is some ambiguity are treated as Poor Quality and not used. The value of 0.05 is based on the assumption that a slightly different set of circumstances would exist for comparison of a whale struck or landed because there would be pressure to try to match regardless of the quality of the photograph, and it would be hard to justify not reporting as a match something where there was a relatively high degree of confidence (i.e. 95% confident of the match to a PCFG whale).

(4) *False negative rate for PCFG* (*i.e. probability of a PCFG whale not being identified as such given a good quality photograph*). This probability is estimated to be 0.25 for a hunt in the winter/spring, and zero for a hunt in summer since all struck whales are assumed to be of the PCFG. This value of 0.25 accounts for several factors, including whales only seen in fewer in two years in the PCFG because of a combination of being young, not being photographed, and the one year lag in the available catalogue. In addition, there could be a matcher error in missing a match due to things like changed markings.

(5) *False positive rate for WFG (i.e. probability of a non-WFG being identified as from the WFG given a good quality photograph*). This probability is estimated to be 0.01 based on the WFG catalogue being smaller and more well-known. Also, it is suspected that the matcher would likely only declare a match when there was a high level of confidence given the infrequent rate of these matches.

(6) *False negative rate for WFG* (*i.e. probability of a WFG whale not being identified as such given a good quality photograph*). On the assumption that calves and lactating mothers will not be hunted, the proportion of huntable WFG whales that would not be known as WFG whales if taken during the spring northward migration was estimated using the population model fit to the Sakhalin and Kamchatka photo-id data. An animal that has been seen off Sakhalin is assumed to be a WFG animal if seen or taken in the eastern North Pacific. An animal seen off eastern Kamchatka but not Sakhalin is not assumed to be a WFG animal, because it might be an NFG animal. The estimated proportion, averaged across the posterior distribution of the population trajectory, was 4-5% depending on the hypothesis. These estimates used data through 2011 only, that being the last season for which the catalogues were cross-matched. If only a single catalogue were used, the rate would be higher. The values used in the trials are: stock hypotheses 3a, 3c, 3e, and 6b: 0.041; stock hypothesis 3b: 0.040; stock hypothesis 5a: 0.049.

(7) *Probability of not assigning a sex to a struck and lost animal that has been identified to the PCFG.*
   (a) This probability is estimated at 19% for the feeding season based on 81% of encounters of PCFG whales from June-Nov through 2015 for the Oregon and Washington outer coast having known sex. For those with known sex in this sample 58% were female and 42% male, but this could be biased by some directed sampling toward females so the sex ratio should be treated as 50:50 in the model.
   (b) This probability is estimated at 27% for the migrating season based on 73% of encounters of PCFG whales from Dec-May through 2015 for the Oregon and Washington outer coast having known sex. For those with known sex in this sample 46% were female and 54% were male. This male-biased sex ratio is in the opposite direction of the bias from intentionally sampling females, which suggests that males are actually more abundant and available in the spring off the Oregon and Washington outer coast likely as a result of females with calves migrating later and being less available in spring. Given the bias for trying to sample known females, it is likely that the sex ratio in spring is likely closer to 60:40 male:female. If hunters avoid taking mothers with calves it would further reduce the chances of taking a female.

Estimates of the proportion of PCFG whales used in the Makah management plan for assigning a struck unidentified whale in the winter/spring hunt are subject to uncertainty due to for example shifting proportions based on sampling differences and these should be considered subject to a bias (which depends on trials) that ranges from -0.1 to 0.1.

4.4.2 Base-case trials and sensitivity tests

The 4th Rangewide workshop specified a series of trials. However, it had not been possible to implement all of these trials during the intersessional period. The Workshop reviewed the set of trials and made the following changes (trial numbers relate to revised numbering system):

(1) stock hypothesis 3e is now treated as a sensitivity test as it is a variant of stock hypothesis 5a (with no WBS animals in the SI sub-area);
(2) a new sensitivity test (18C) based on stock hypothesis 3c has been added as agreed at the 4th Rangewide workshop (IWC, 2018);
(3) the sensitivity test exploring a higher proportion of WBS whales in sub-area SI (3B) involves increasing the estimates of abundance for the WBS by 50% and correspondingly reducing the estimates of abundance for the WFG;
(4) the trials involving PCFG whales in the BSCS sub-area (12A/B) are based on assuming that all PCFG whales are in the BSCS sub-area. The assumption will be conservative given that most PCFG whales are located elsewhere when the aboriginal hunt off Chukotka occurs;
(5) the trials involving WFG whales in the BSCS sub-area (13A/B) are based on assuming that all WFG whales are in the BSCS sub-area. The assumption will be conservative given that most WFG whales are located elsewhere when the aboriginal hunt off Chukotka occurs;
(6) the trials exploring the sensitivity of how the California set gillnet catches were modelled (trials 14 and 15 in Table 8 of IWC, 2018) were dropped as the approach for modelling the SET1 and SET2 fleets was modified (see Item 4.3.1);
(7) the trials with MSYR estimated and a higher pulse were dropped as these trials are unlikely to be

informative (trials 14A/B and 8A/B examine these factors individually);

(8) variants of trials 5A/B and 16A/B (trials 18A/B and 19A/B) that have net immigration of 1 to the PCFG were added because the assumption of zero immigration into the PCFG is unlikely given the results of Lang and Martien (2012);

(9) trials 7A/B and 16A/B exclude the PCFG abundance estimates for 1998-2002 as a low pulse would not allow the model to mimic these data – this change in model specifications mimics the adoption in the trials used to evaluate the *SLA* for a Makah hunt at the 2013 review of a time-varying survey bias;

(10) trials 22A/B have been added to examine the future consequences of a catastrophic events in the NFG – these events occur randomly once in the first 50 years and randomly once in the second 50 years, with a magnitude equivalent to that of the mortality event in 1999/2000; and

(11) trials 23A/B and 24A/B have been added to explore sensitivity to the struck and lost rate for a Makah hunt in the feeding season, and the false negative rate for a Makah hunt in summer.

4.4.3 Conditioning statistics

The Workshop reviewed the diagnostic plots for evaluating the conditioning developed for the trials specified at the 4th Rangewide Workshop. The Workshop **agreed** that the following plots should be produced for each trial and provided to the Intersessional Steering Group for review:

(1) The estimates of absolute abundance (with 90% sampling intervals) and the median, 50% and 90% intervals for the time-trajectory of the model estimates of 1+ population size.
(2) The time-trajectory of the model estimates of the number of mature females.
(3) The distributions (median, 50% and 90% intervals) for the generated mixing proportions and those for the model-predicted mixing proportions.
(4) The distribution for the net immigration rate from the NFG to the PCFG and the target value (black vertical bar).
(5) The estimates of average bycatch over the period for which reporting is considered adequate [Annex D, table 3] (with 90% sampling intervals) and the median, 50% and 90% intervals for the model-estimate of the average bycatch over the period.
(6) The distributions (median, 50% and 90% intervals) for the generated survival rates for PCFG whales and those for the model-predicted survival rates for PCFG whales.
(7) The time-trajectories of removals, including the recorded removals (adjusted for under-reporting) and the bycatch inferred for the years for which reporting is not considered adequate.

4.4.4 Projection scenarios

Previous projections for the Sakhalin population (Reeves *et al.,* 2005) considered a scenario in which there is future bycatch of 1.5 mature females off Japan based on inferences from bycatch at that time. The Workshop noted that observed bycatch off Japan has declined since then. The Workshop **agreed** that a projection scenario with 1 mature female taken each year in the EJPJ sub-area should to be conducted.

In addition, the Workshop **agreed** that, if possible, projections should be conducted for the current Makah *SLA*, although it was recognised this may not be feasible to achieve before SC 67b.

The Workshop noted that care needs to be taken to compare the results from the previous *Implementation Review* with those based on the Rangewide review because the population structure hypotheses have changed and the Rangewide review has more fully accounted for bycatch and its uncertainty.

4.4.5 Performance statistics

4.4.5.1 TIME-TRAJECTORIES OF POPULATIONS

The results of the model fits and the projections will be summarised by time-trajectories of 1+ numbers of breeding stock/feeding group and by sub-area

4.4.5.2 MAKAH MANAGEMENT PLAN

The results of the projections to evaluate the performance of the Makah management plan will be based on the standard statistics used by the Committee to evaluate the performance of *Strike Limit Algorithms*:

(1) D1. Final depletion of 1+ and mature female numbers by breeding stock/feeding group (median, lower 5th and upper 5th percentiles)
(2) D8. Rescaled final depletion: P_T/P_0 (1+ and mature female numbers by breeding stock/feeding group; median, lower 5th and upper 5th percentiles) where P_0 is number of 1+/mature female animals had there been no future Makah hunts.
(3) D10. Relative increase. The ratio of the 1+ and mature population size after 10 and 100 years to that at the start of the projection period by breeding stock/feeding group (median, lower 5th and upper 5th percentiles)
(4) N9. Need satisfaction. The proportion of the total number of requested strikes that were taken over the first 10 years and the entire 100-year period (median, lower 5th and upper 5th percentiles).

Results are provided for both 10 and 100 years for the D10 and N9 statistics because (a) the Makah Management Plan current only operates for 10 years, and (b) previous evaluations of the performance of management procedures (RMP and AWMP) have considered performance over 100 years. Population-related statistics should be also be provided for the case there is no future Makah hunt (only bycatch and hunting off Chukotka).

5. WORKPLAN

Before/during 67b

(1) Update the code for the operating model (Punt)
(2) Validate any changes to the historical (conditioning) component of the operating model (Brandon)
(3) Conduct conditioning and distribution of conditioning diagnostics to the Steering Group (Punt)
(4) Review of the conditioning results (Steering Group)
(5) Code the revised Makah management plan and the associated testing code (Punt)
(6) Validate the revised Makah management plan and the associated testing code (Brandon)
(7) Conduct the projections and assemble the projection results (Punt)

After 67b

(1) Complete drafting of the CMP.

6. ADOPTION OF REPORT

The co-chairs thanked Brownell and his colleagues for the excellent and historic facilities provided at the laboratory in the beautiful setting of Granite Canyon (complete with gray whales migrating by). The report was adopted by email.

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Annex A

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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
2. Progress on 'non-modelling' recommendations and new data
   2.1 Updated information from the co-operative genetics studies
   2.2 Updated information from photo-identification studies including consolidation of WGW catalogues
   2.3 Gray whales off Korea
3. Updating scientific aspects of the CMP
   3.1 Review of existing sections
   3.2 Consideration of future stakeholder workshop
4. Update on modelling framework and runs
   4.1 Progress on modelling since SC/66b, including validation
      4.1.1 General progress, including validation
      4.1.2 Modelling related to the proposal Makah management plan
   4.2 Review of stock hypothesis
   4.3 Confirm final data sets
      4.3.1 Removals (direct and incidental)
      4.3.2 Abundance estimates
      4.3.3 Mixing proportions
   4.3 Confirm final trial structure and conditioning
      4.4.1 Changes to the trial specifications, including stock structure
      4.4.2 Base-case trials and sensitivity tests
      4.4.3 Conditioning statistics
      4.4.4 Projection scenarios
      4.4.5 Performance statistics
5. Work plan
6. Adoption of Report

Annex C

List of Documents

SC/M18/CMP
1. Scordino, J. and Bickham, J. Plausibility of stock structure hypothesis 6b
2. Tyurneva, O.Y., Takovlev, Y.M., Vertyankin, V.V. van der Wolf, P. and Scott, M.J. Long-term photo-identification studies of gray whales (*Eschrichtius robustus*) offshore northeast Salhalin Island, Russia, 2002-2017.
3. Brandon, J. IWC Gray Whale Rangewide Model: Code Validation for the 2018 Workshop.
4. Kim, H.W. and Sohn, H. Possible occurrence of gray whale off Korea in 2015.

Annex D

Terminology Used with Respect to Stock Structure Hypotheses

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 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).

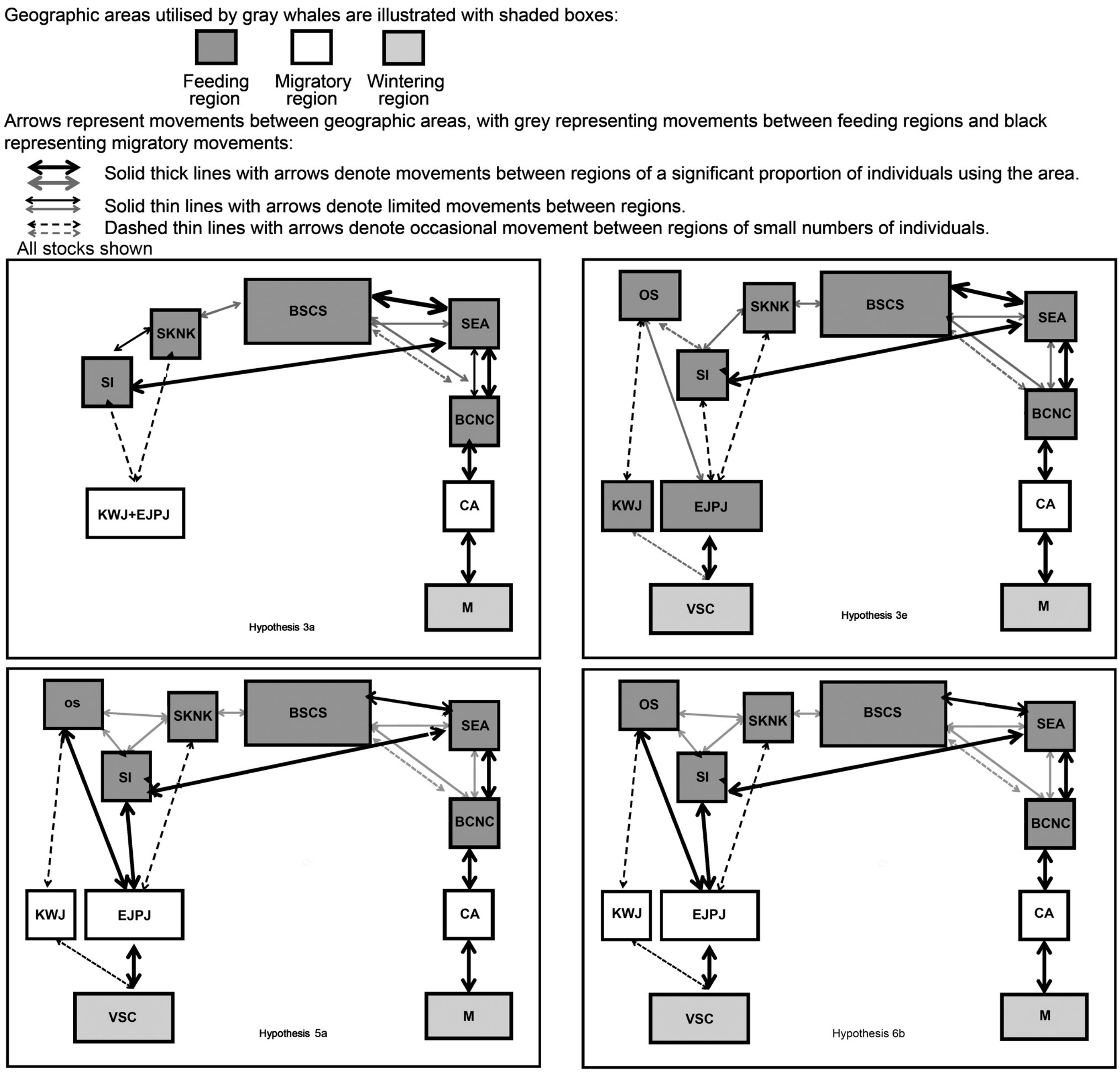
	Feeding groups or aggregations	Abbreviation	Definition (may vary with hypothesis)
1	Western Feeding Group	WFG	Animals that feed regularly (define?) off Sakhalin Island* according to photo-identification data
2	Pacific Coast Feeding Group	PCFG	Animals that feed regularly (define?) in the PCFG area according 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-ID)

* May need revising with regard to Southern Kamchatka animals.

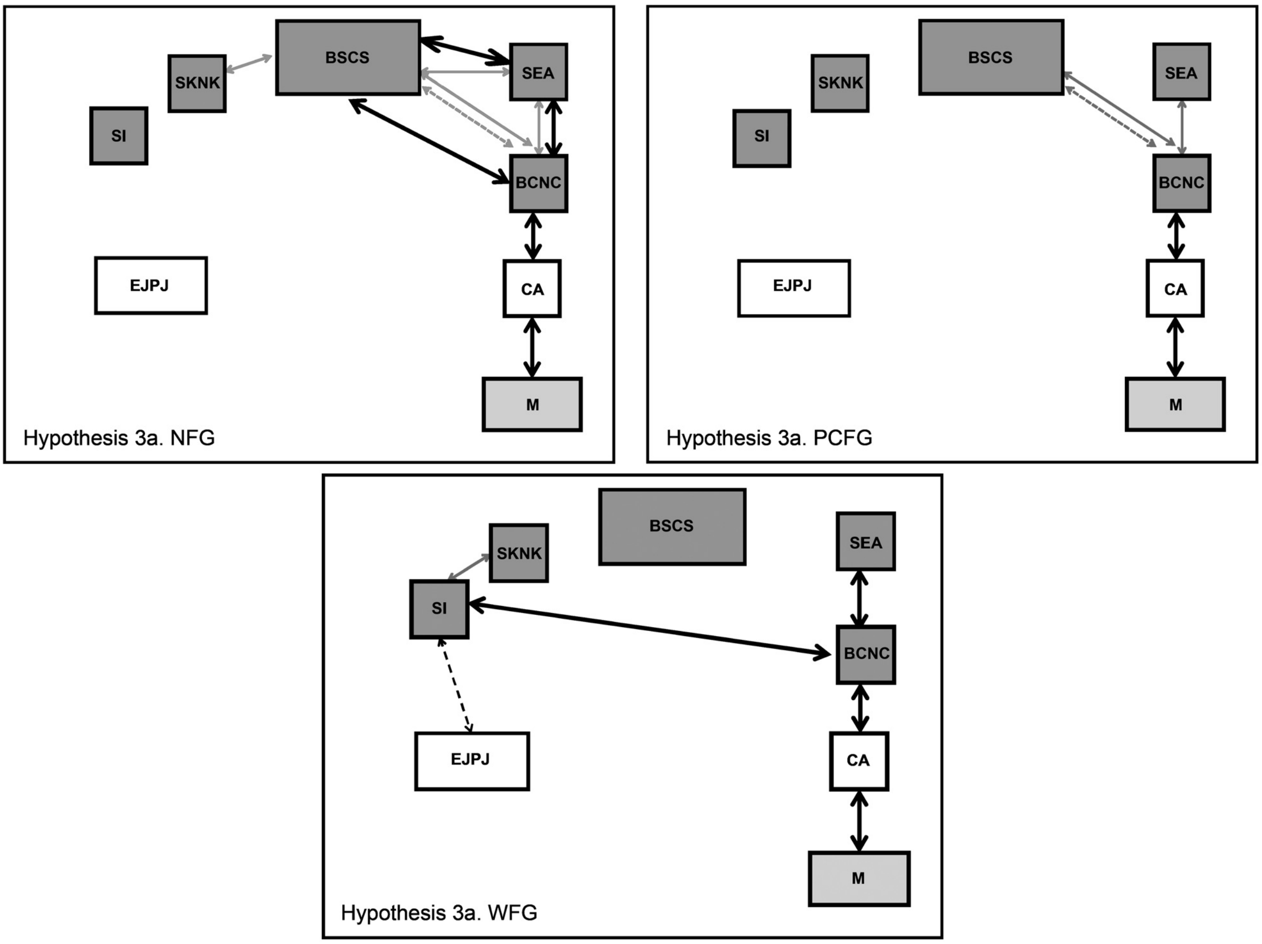
Sub-areas. The model includes 11 geographical sub-areas that are used to explain the movements of gray whales (breeding stocks and feeding groups) in the North Pacific and two 'latent sub-areas' used to link model predictions to observed indices of abundance.

	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

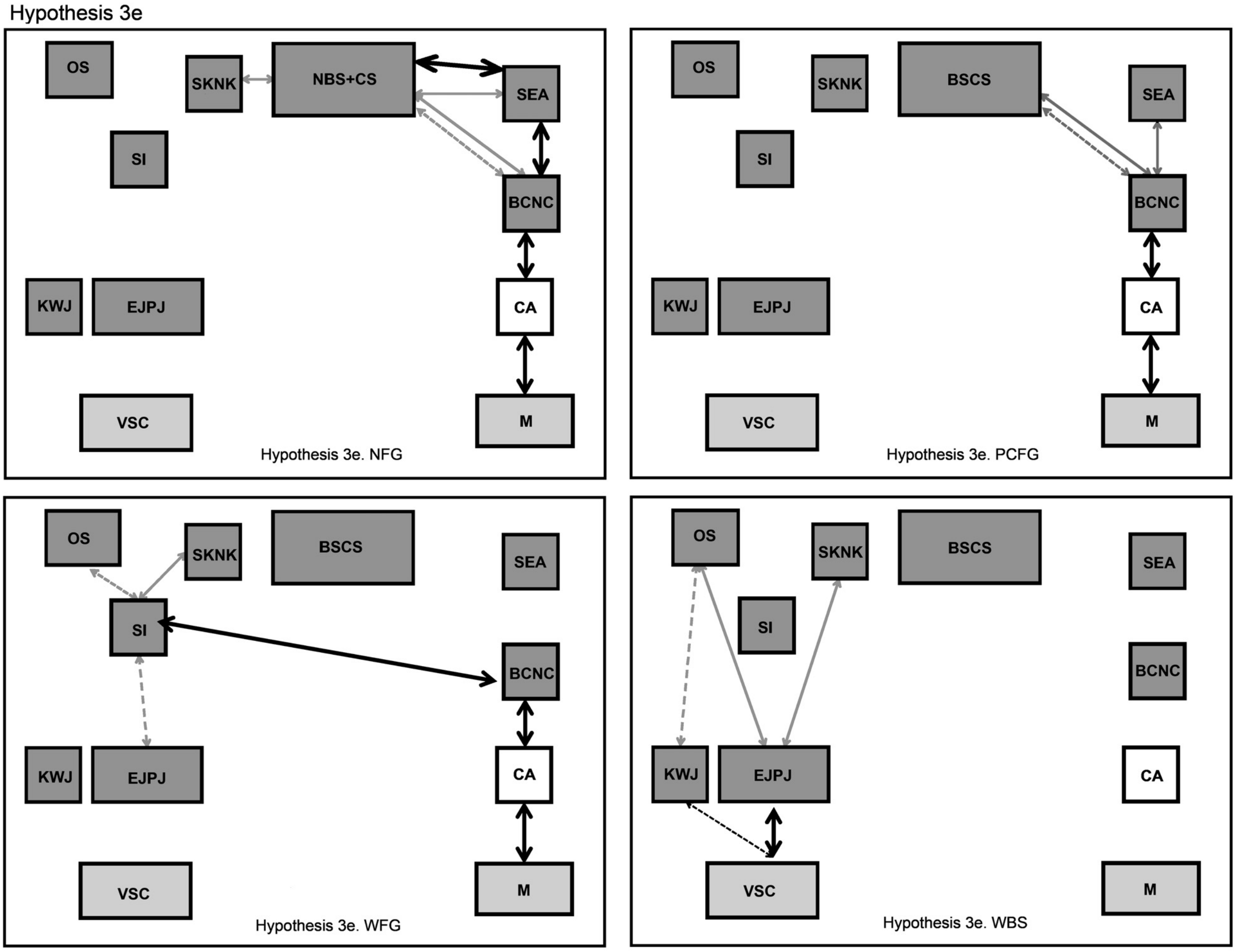
* New at this Workshop, replaces the old East Kamchatka and Kuril Islands to recognise the information from telemetry and photo-ID.



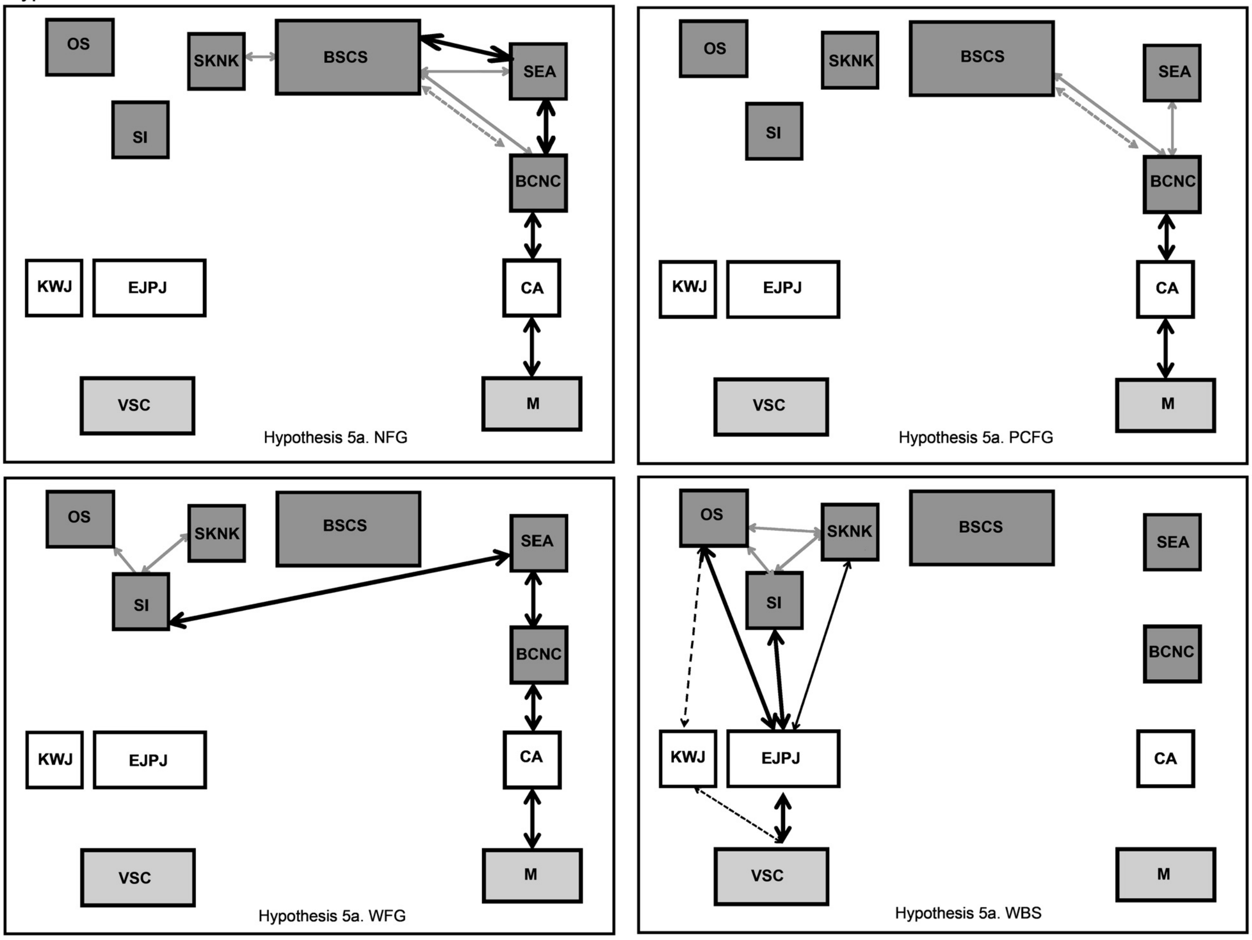
Hypothesis 3a



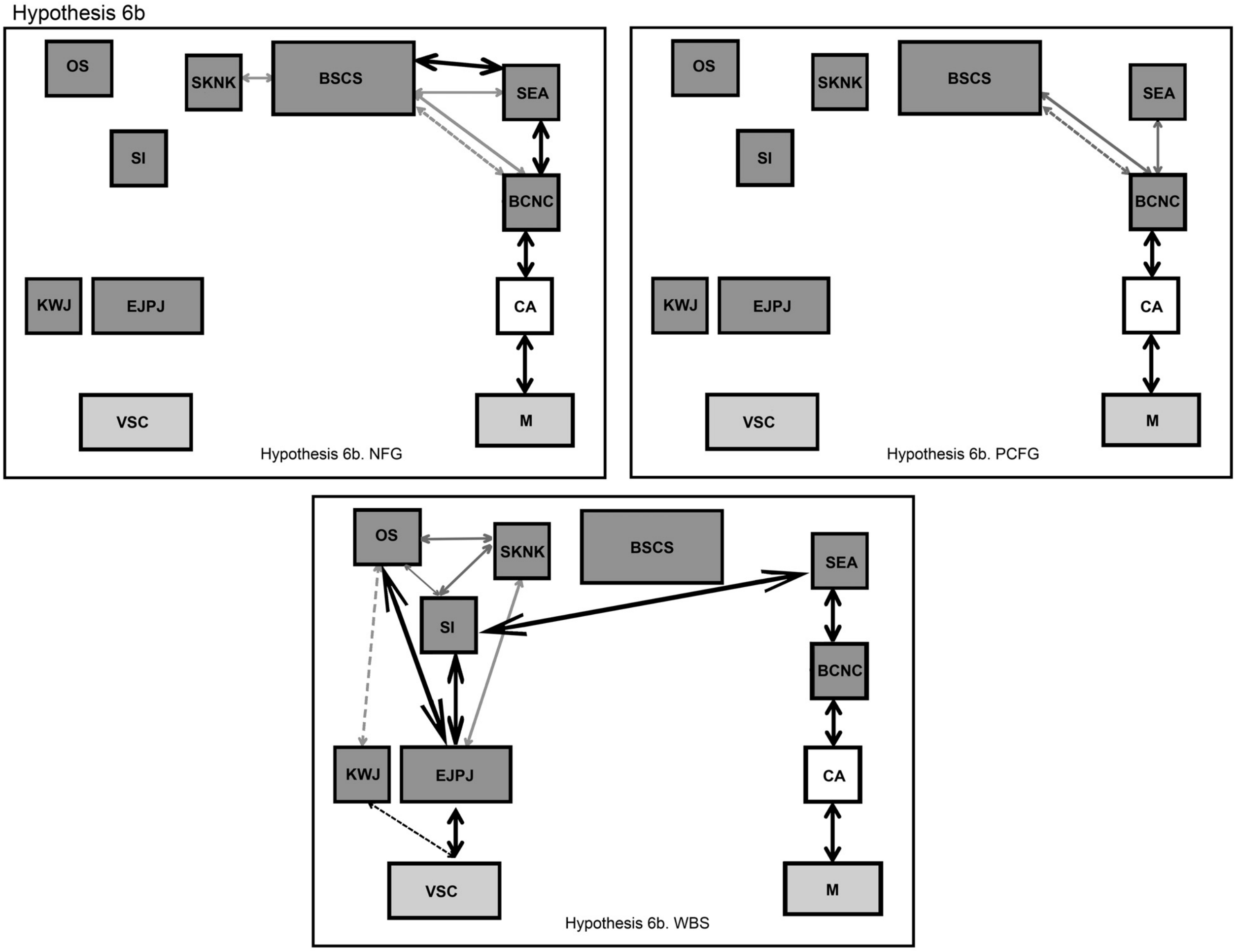
Hypothesis 3e



Hypothesis 5a



Hypothesis 6b



Annex E

Specifications of the Rangewide Model

A. **Basic concepts and stock structure**

The aim of the projections is to explore the population consequences of various scenarios regarding anthropogenic removals of gray whales, with a view to informing future conservation and management. The model distinguishes 'breeding stocks' and 'feeding aggregations'. Breeding stocks are demographically and genetically independent whereas feeding aggregations may be linked through dispersal of individuals[6], though perhaps at very low rates for some combinations of feeding aggregations. Each breeding stock / feeding aggregation is found in a set of sub-areas, each of which may have catches (commercial, aboriginal or incidental), proportions of breeding stock / feeding aggregation mixing[7] in those sub-areas, observed bycatch rates[8], estimates of survival rates, and indices of relative or absolute abundance. Removals may be specified to sets of months during the year for some sub-areas if the various feeding aggregations are not equally vulnerable to catches throughout the year for those sub-areas. The trials capture uncertainty regarding stock structure and MSYR, as well as uncertainty regarding bycatch and immigration.

The region concerned, the North Pacific, is divided into 11 sub-areas (Fig. 1). The model also includes several 'latent' sub-areas used to link model predictions to observed indices of abundance. These are denoted, WFG, WBS, WST, CA-3 and BCNC-3. There are up to two extant *breeding stocks* (Western and Eastern). The Eastern breeding stock consists of up to three *feeding aggregations* depending on the stock structure hypothesis: Western Feeding Group (WFG), Pacific Coast Feeding Group (PCFG) and North Feeding Group (NFG). There is dispersal between the PCFG and the NFG, but the WFG is demographically independent of the other two feeding aggregations (i.e. there is no *permanent* movement of animals from the NFG or PCFG to the WFG or vice-versa).

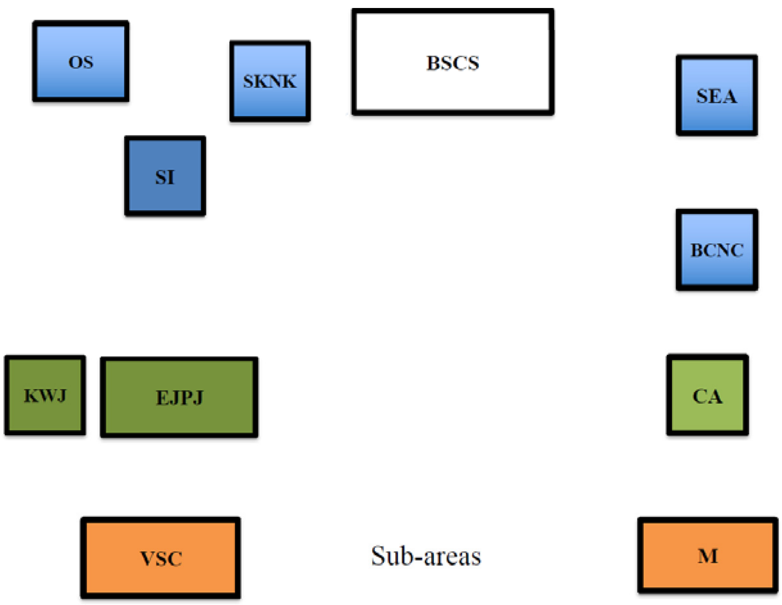


Fig. 1. The sub-areas in the model.

The trials consider five stock structure hypotheses

(1) *Hypothesis 3a*. Although two breeding stocks (Western and Eastern) may once have existed, the Western breeding stock is assumed to have been extirpated. Whales show matrilineal fidelity to feeding grounds, and the Eastern breeding stock includes three feeding aggregations: PCFG, NFG, and WFG.

[6] The term 'dispersal' is used here in the sense of 'effective dispersal', and refers to permanent movement of individuals among feeding aggregations. Such individuals become part of the feeding aggregation to which they move and contribute to future reproduction.

[7] Mixing is defined here as two feeding aggregations that overlap at some time on the feeding grounds, but do not exchange individuals.

[8] Bycatch is understood to include mortality or 'serious' injury from entanglement or entrapment in fishing gear (or debris) and ship strikes.

(2) *Hypothesis 3b*. Identical to hypothesis 3a, except that NFG whales do not feed off SKNK. In addition, a Western breeding stock 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 Western breeding stock.
(3) *Hypothesis 3c*. Identical to 3a, except that on occasion whales migrating between the Sakhalin feeding region and Mexico travel through the BSCS sub-area
(4) *Hypothesis 3e*. Identical to hypothesis 3a, except that the Western breeding stock is extant and feeds off both coasts of Japan and Korea and in the northern Okhotsk Sea west of the Kamchatka Peninsula. All of the whales feeding off Sakhalin overwinter in the eastern North Pacific
(5) *Hypothesis 5a*. Identical to hypothesis 3e except that the whales feeding off Sakhalin include both whales that are part of the extant Western breeding stock and remain in the western North Pacific year-round, and whales that are part of the Eastern breeding stock and migrate between Sakhalin and the eastern North Pacific
(6) *Hypothesis 6b*. This hypothesis assumes that the WFG does not exist, but that whales feeding in the SI sub-area represent an extant Western breeding stock that utilizes two wintering grounds (VSC and M). This hypothesis differs from hypothesis 5a, in that 1) all removals off China and Japan are assumed to be Western breeding stock animals, and 2) the abundance estimates for Sakhalin are assumed to relate only to the Western breeding stock.

B. **Basic dynamics**

The population dynamics are based on the standard age- and sex-structured model, which has formed the basis for the evaluation of *Strike Limit Algorithms* for eastern North Pacific gray whales, i.e.:

$$\begin{aligned} N^{m/f,i,j}_{t+1,0} &= 0.5B^{i,j}_{t+1} && a=0 \\ N^{m/f,i,j}_{t+1,a} &= (N^{m/f,i,j}_{t,a-1} + I^{m/f,i,j}_{t,a-1} - C^{m/f,i,j}_{t,a-1})\,S_{a-1}\,\tilde{S}^{i,j}_t && 1 \le a \le x-1 \\ N^{m/f,i,j}_{t+1,x} &= ((N^{m/f,i,j}_{t,x} + I^{m/f,i,j}_{t,x} - C^{m/f,i,j}_{t,x})S_x + (N^{m/f,i,j}_{t,x-1} + I^{m/f,i,j}_{t,x-1} - C^{m/f,i,j}_{t,x-1})\,S_{x-1})\,\tilde{S}^{i,j}_t && a=x \end{aligned} \quad \text{(B.1)}$$

where $N^{m/f,i,f}_{t,a}$ is the number of males / females of age a in feeding aggregation j of breeding stock i at the start of year t; $C^{m/f,i,f}_{t,a}$ is the number of anthropogenic removals of males / females of age a in feeding aggregation j of breeding stock i during year t (whaling/incidental catches are assumed to take place in a pulse at the start of each year); S_a is the annual survival rate of animals of age a in the absence of catastrophic mortality events (assumed to be the same for males and females):

$$S_a = \begin{cases} S_0 & \text{if } a=0 \\ S_{1+} & \text{if } 1<a \end{cases} \quad \text{(B.2)}$$

S_0 is the calf survival rate; S_{1+} is the survival rate for animals aged 1 and older; $\tilde{S}^{i,j}_t$ is the amount of catastrophic mortality (represented in the form of a survival rate) for feeding aggregation j of breeding stock i during year t (catastrophic events are assumed to occur at the end of the year after mortality due to anthropogenic removals, whaling and non-catastrophic natural causes and dispersal; in general $\tilde{S}^{i,j}_t=1$, i.e. there is no catastrophic mortality); $B^{i,j}_{t+1}$ is the number of births to feeding aggregation j of breeding stock i during year t; $I^{s,m/f}_{t,a}$ is the net dispersal of female/male animals of age a into feeding aggregation j of breeding stock i during year t; and x is the maximum (lumped) age-class (all animals in this and the x-1 class are assumed to be recruited and to have reached the age of first parturition). x is taken to be 15.

C. **Births and density-dependence**

Density-dependence is assumed to be a function of numbers of animals aged 1 and older by feeding ground relative to the carrying capacity by feeding ground. The density-dependence component for feeding aggregation j of breeding stock i is the sum of the density-dependence components by feeding aggregation weighted by the proportion of animals from feeding aggregation j of breeding stock i that are found on each feeding ground, i.e.:

$$F(i,j,t) = \sum_A \psi^{A,i,j}\left(X^{A,i,j}(N^{1+,A}_t / K^{1+,A})^z\right) / \sum_A \psi^{A,i,j} X^{A,i,j} \quad \text{(C.1)}$$

where z is the degree of compensation; $\psi^{A,i,j}$ indicates whether sub-area A impacts density-dependence for feeding aggregation j of breeding stock i, N_t^{1+A} is the number of 1+ animals on feeding ground A at the start of year t:

$$N_t^{1+,A} = \sum_i \sum_j X^{A,i,j} \sum_{a=1}^{x} (N_{t,a}^{m,i,j} + N_{t,a}^{f,i,j}) \tag{C.2}$$

K^{1+A} is the carrying capacity for feeding ground A:

$$K^{1+,A} = \sum_i \sum_j X^{A,i,j} \sum_{a=1}^{x} (N_{-\infty,a}^{m,i,j} + N_{-\infty,a}^{f,i,j}) \tag{C.3}$$

$X^{A,i,j}$ is the proportion of animals of feeding aggregation j of breeding stock i that are found in feeding ground A[9] (Tables 1 and 2).

The number of births at the start of year t for feeding aggregation j of breeding stock i, $B_t^{i,j}$, is given by:

$$B_t^{i,j} = b_t^{i,j} N_t^{f,i,j} \tag{C.4}$$

where $N_t^{f,i,j}$ is the number of mature females in feeding aggregation j of breeding stock i at the start of year t:

$$N_t^{f,i,j} = \sum_{a=a_m}^{x} N_{t,a}^{f} \tag{C.5}$$

a_m is the age-at-maturity (the convention of referring to the mature population is used here, although this actually refers to females that have reached the age of first parturition); $b_t^{i,j}$ is the probability of birth/calf survival for mature females:

$$b_t^{i,j} = \max(0, b_K\{1 + A^{i,j}(1 - F(I,j,t))\}) \tag{C.6}$$

b_K is the average number of live births per year per mature female at carrying capacity; and $A^{i,j}$ is the resilience parameter for feeding aggregation j of breeding stock i.

D. **Immigration (dispersal)**

The numbers dispersing into feeding aggregation j of breeding stock i, include contributions from pulse migration as well as diffusive dispersal:

$$I_{t,a}^{s,j,i} = I_{t,a}^{1,s,j,a} - I_{t,a}^{2,s,j,a} \tag{D.1a}$$

$$I_{t,a}^{1,s,j,i} = \sum_{k \neq j} \delta^{k,j,i} N_{t,a}^{s,i,k} \left(\frac{N_t^{f,i,k}}{N_{-\infty}^{f,i,k}}\right)^{\tilde{\lambda}} + \sum_{k \neq j} \Omega_y^{k,j,i} \frac{N_{t,a}^{s,i,k}}{\sum_{a=1}^{x} (N_{t,a}^{m,i,k} + N_{t,a}^{f,i,k})} \tag{D.1b}$$

$$I_{t,a}^{2,s,j,i} = \sum_{k \neq j} \delta^{j,k,i} N_{t,a}^{s,i,j} \left(\frac{N_t^{f,i,j}}{N_{-\infty}^{f,i,j}}\right)^{\tilde{\lambda}} + \sum_{k \neq j} \Omega_y^{j,k,i} \frac{N_{t,a}^{s,i,j}}{\sum_{a=1}^{x} (N_{t,a}^{m,i,j} + N_{t,a}^{f,i,j})} \tag{D.1c}$$

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[9] It is usually the case that $\sum X^{A,i,j} = 1$. However, for gray whales, this is not necessarily the case because removals can take place in the various sub-areas at different times. What is then important is the relative values of the $X^{A,i,j}$ among feeding aggregations for a given feeding ground.

where $\delta^{k,j,i}$ is the rate of dispersal from feeding aggregation *k* to feeding aggregation *j* of breeding stock *i*; λ is a factor to allow for density-dependence in the dispersal rate (set to 2); and $\Omega_y^{k,j,i}$ is the number of animals that disperse in year *y* from feeding aggregation *k* to feeding aggregation *j* of breeding stock *i* in a pulse.

E. Anthropogenic removals

The catch by feeding aggregation, sex and age is the sum of the catch over fleet (see Table 3 for fleet definitions), i.e.:

$$C_{t,a}^{m/f,i,j} = \sum_k C_t^{m/f,k} \frac{\alpha_a^k X^{A_k,i,j} N_{t,a}^{m/f,i,j}}{\sum_{i,j,a} \alpha_a^k X^{A_k,i,j} N_{t,a}^{m/f,i,j}} \tag{E.1}$$

where $C_t^{m/f,k}$ is the catch of males/females by fleet *k* during year *t*; A_k is the sub-area in which fleet *k* operates; and α_a^k is the relative vulnerability of animals of age *a* to harvest by fleet *k*. The values for the catches by fleet and sex are either pre-specified (Table 4[10]) or computed using Equation E.2. for the years for which actual estimates are not available:

$$C_{t,a}^{m/f,k} = \lambda^k E_t^k \sum_{i,j,a,m/f} \alpha_a^k X^{A,i,j} N_{t,a}^{m/f,i,j} \tag{E.2}$$

where E_t^k is a measure of the effort by fleet *k* during year *t* (Table 5) and λ^k is the catchability coefficient for fleet *k*.

F. Initializing the parameter vector

The numbers at age in the pristine population are given by:

$$\begin{aligned} N_{-\infty,a}^{m/f,i,j} &= 0.5\, N_{-\infty,0}^{i,j} \prod_{a'=0}^{a-1} S_{a'} && \text{if } a < x \\ N_{-\infty,x}^{m/f,i,j} &= 0.5\, N_{-\infty,0}^{i,j} \prod_{a'=0}^{x-1} S_{a'} / (1-S_x) && \text{if } a = x \end{aligned} \tag{F.1}$$

The value for $N_{-\infty,0}^{i,j}$ is determined from the value for the pre-exploitation size of the 1+ component of feeding aggregation *j* of breeding stock *i* using the equation:

$$N_{-\infty,0}^{m,i,j} = K^{1+,i,j} / \left(\sum_{a=1}^{x-1} \left(\prod_{a'=0}^{a-1} S_{a'} \right) + \frac{1}{1-S_x} \prod_{a'=0}^{x-1} S_{a'} \right) \tag{F.2}$$

where $K^{1+,i,j}$ is the carrying capacity (in terms of the 1+ population size size) for feeding aggregation *j* of breeding stock *i*:

$$K_t^{1+,i,j} = \sum_{a=1}^{x} (N_{-\infty,a}^{m,i,j} + N_{-\infty,a}^{f,i,j}) \tag{F.3}$$

$N_{-\infty,a}^{m/f,i,j}$ is the number of animals of age *a* that would be in feeding aggregation *j* of breeding stock *i* in the pristine population.

The model is based on the assumption that the age-structure at the start of year τ is stable rather than that the population was at its pre-exploitation equilibrium size at some much earlier year. The determination of the age-structure at the start of year τ involves specifying the effective 'rate of increase', γ, that applies to each age-class. There are two components contributing to γ, one relating to the overall population rate of increase (γ^+) and the other to the exploitation rate due to all forms of anthropogenic removal. Under the assumption of knife-edge recruitment to the fishery at age a_r, only the γ^+ component (assumed to be zero following Punt and Butterworth

[10] The bycatches for 2016 are set equal to those for 2015 as data on bycatch for 2016 are not finalized at present.

[2002]) applies to ages a of a_r or less. The number of animals of age a at the start of year τ relative to the number of calves at that time, $N^*_{\tau,a}$, is therefore given by the equation:

$$N^*_{\tau,a} = \begin{cases} 1 & \text{if } a = 0 \\ N^*_{\tau,a-1} S_{a-1} & \text{if } a \le a_r \\ N^*_{\tau,a-1} S_{a-1}(1-\gamma) & \text{if } a_r < a < x \\ N^*_{\tau,x-1} S_{x-1}(1-\gamma)/(1-S_x(1-\gamma)) & \text{if } a = x \end{cases} \tag{F.4}$$

where B_τ is the number of calves in year τ and is derived directly from equations C.1 and C.6.

$$B_\tau = \left(1 - \left[1/(N^f_\tau b_K) - 1\right]/A\right)^{1/z} \frac{K^{1+}}{N^{1+,*}_\tau} \tag{F.5}$$

The effective rate of increase, γ, is selected so that if the population dynamics model is projected from year τ to a year Ψ, the size of the 1+ component of the population in a reference year Ψ equals a value, P_Ψ.

G. **Conditioning**

The parameters of the model are: (a) the carrying capacity of each stock, (b) the population size for each stock at the start of 1930 (expressed relative to carrying capacity), (c) MSYR by stock, (d) annual survival under 'normal' conditions, (e) maturity as a function of age, (f) the impact of the mortality event in the eastern Pacific in 1999 and 2000, (g) selectivity, (h) the rate of dispersal between the NFG and the PCFG, (i) the parameters of the mixing matrices, (j) the catchability coefficients that determine bycatch by fleet (Eqn E.2), and (k) the extent of additional variation for each abundance index. Some of these parameters are pre-specified:

(1) MSYR (except for trials 14, 15, and 17);
(2) Annual survival under 'normal' conditions (base-case 0.98);
(3) Maturity as a function of age (a logistic function of age, with an age-at-50%-first-parturition of 8 years and a minimum age-age-at-first parturition of 3 years); and
(4) Selectivity (Table 3).

Under the assumption that the estimates of abundance for a sub-area (Table 6) are log-normally distributed, the negative of the logarithm of the likelihood function is given by:

$$-\ell nL = \ell n\sqrt{\mathrm{Det}[V]} + 0.5\sum_k (\ell\,\mathrm{n}\,\underline{N}^{A,obs} - \ell\,\mathrm{n}\,\underline{N}^A)[V^{-1}](\ell\,\mathrm{n}\,\underline{N}^{A,obs} - \ell\,\mathrm{n}\,\underline{N}^A)^T \tag{G.1}$$

where $N^{A,\mathrm{obs}}_t$ is the survey estimate of abundance for sub-area A during year t; and V is the sum of the variance-covariance matrix for the abundance estimates plus an additional variance term (assumed to be independent of year). Note that the abundance estimates for the western areas (Table 6a) depend on the stock hypothesis under consideration.

The data on the proportion of each stock (Tables 6a and 7) in each sub-area are modelled under the assumption that the proportions are normally distributed, i.e.:

$$-\ell nL = \sum_i \sum_A \sum_t \tfrac{1}{2(\tau^{i,A}_t)^2}(p^{i,A}_t - p^{i,A,\mathrm{obs}}_t)^2 \tag{G.2}$$

where $p^{i,A}_t$ is the model-estimate of the proportion of the animals in sub-area A that are from feeding aggregation i of the Eastern breeding stock; $p^{i,A,\mathrm{obs}}_t$ is the observed proportion of animals in in sub-area A that are from feeding aggregation i of the Eastern breeding stock; and $\tau^{i,A}_t$ is the standard error of $p^{i,A,\mathrm{obs}}_t$.

The (non-zero) bycatches by sub-area for the first five years for which data are available are assumed to be log-normally distributed, and the model is fitted to the average bycatch by sub-area over a pre-specified set of years (the years for which detection and reporting of entanglements, ship strikes, and strandings in general was relatively good; Table 3), i.e.:

$$-\ell\mathrm{n}L = \sum_A \tfrac{1}{2\sigma^2_{BC}}\left(\ell\mathrm{n}C^{I,A,\mathrm{obs}} - \ell\mathrm{n}\hat{\bar{C}}^{I,A}\right)^2 \tag{G.3}$$

where $C^{I,A,\text{obs}}$ is the observed average annual bycatch from sub-area *A* over the pre-specified period, $\hat{\bar{C}}^{I,A}$ is the average over this period of the model-estimate of the bycatch from sub-area *A*, and σ_{BC} is the standard error of the logarithms of the observed bycatches.

A penalty is imposed on the average number of animals moving permanently from the NFG into the PCFG between 2001 and 2008, i.e.:

$$-\ell nL = \frac{1}{2\sigma_I^2}\left(\tilde{I} - \frac{\delta^{\text{m/f,north},West}}{8}\sum_{t=2001}^{2008}\sum_{s=m/f}\sum_{a=1}^{x} I_{t,a}^{s,\text{East,north}}\right)^2 \tag{G.4}$$

where $\tilde{I}$ is the pre-specified average number of immigrants into the PCFG from the NFG, and σ_I is a weighting factor.

The estimates of survival for PCFG whales (Calambokidis *et al.*, 2017) are assumed to be normally distributed, i.e.:

$$-\ell nL = \frac{1}{2\sigma_{S,1}^2}(S^{\text{obs},1} - \hat{S}^1)^2 + \frac{1}{2\sigma_{S,2}^2}(S^{\text{obs},2} - \hat{S}^2)^2 \tag{G.5}$$

where $S^{\text{obs},1} = 0.917$, $\sigma_{L,1} = 0.0142$, $S^{\text{obs},2} = 0.967$, $\sigma_{L,2} = 0.0066$, $\hat{S}_1$ is the estimate of post-first-year survival for whales that entered in 1998 or earlier, and $\hat{S}_2$ is the estimate of post-first-year survival for whales that entered in 1999 or later.

H. **Quantifying uncertainty using bootstrap**

A bootstrap procedure is used to quantify uncertainty for a given model specification. Each bootstrap replicate involves:

(1) Generating pseudo time-series of abundance estimates based on the assumption that the abundance estimates are log-normally distributed with means and variance-covariance matrices given by the observed abundance estimates and the reported variance-covariance matrices.
(2) Generating pseudo mixing proportions from beta distributions with means and CVs given by the observed means and CVs.
(3) Generating pseudo bycatch rates by sub-area from log-normal distributions with means of $C^{I,A,\text{obs}}$ and a log standard error of σ_{BC}.
(4) Generating a pseudo immigration rate from the NFG into the PCFG based on a normal distribution (truncated at zero) with mean $\tilde{I}$ and standard error σ_I.
(5) Generating pseudo survival rates from normal distributions.

I. Generation of Data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the *Strike Limit Algorithms* are listed in Table 6. The future estimates of abundance for sub-areas WFG, WST, BCNC-3 and CA-3 (say sub-area *K*) are generated using the formula:

$$\hat{P} = PYw / P^*\beta^2 Yw \tag{I.1}$$

where *Y* is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_\varepsilon^2)$ and $\sigma_\varepsilon^2 = \ell n(1+\alpha^2)$; *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*:

$$P = P_t^K = \sum_i\sum_j\sum_g\sum_{a\ge 1} N_{t,a}^{g,i,j} \tag{I.2}$$

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 sub-area for which an abundance estimate is to be generated. For consistency with the first-stage screening trials for a single stock (IWC, 1991, 1994), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that $CV^2(\hat{P}) = \tau(0.12 + 0.025P^*/P)$. If $\overline{CV}$ is the target CV then $\tau = \overline{CV}^2/(0.12 + 0.025P_{\text{ref}}/P^*)$ where P_{ref} is the population size in a reference year.

An estimate of the CV is generated for each estimate of abundance:

$$CV(\hat{P})^2_{\text{est}} = \sigma^2 \chi^2 / n \tag{I.3}$$

where $\sigma^2 = \ell n(1 + \alpha^2 + \beta^2 P^* / \hat{P})$, and χ is a random number from a Chi-square distribution with n degrees of freedom (where n=10 as used for NP minke trials; IWC, 2004).

J. Trials

The factors included in the trials are listed in Table 8 and the trials in Table 9.

K. Management options

The strike limits for the BSCS sub-area are based on the Gray Whale *SLA* (IWC, 2005). The strike limits for the BCNC sub-area based on the Makah Management Plan (Appendix 1) although sensitivity is explored using variant 1 agreed to in 2012 (IWC, 2013; Appendix 2).

Removals due to bycatch are based on the scenarios regarding future trends in effort. Table 8 lists the factors considered in the projections.

L. Output Statistics

The population-size statistics are produced for each breeding stock / feeding aggregation, while the removal-related statistics are for each sub-area.

I.1 Risk

D1. Final depletion: P_T/K (1+ and mature female numbers by breeding stock / feeding group (median, lower 5th and upper 5th percentiles)).

D2. Lowest depletion: $\min(P_t / K) : t = 0,1,...,T$.

D3. Plots of $\{P_{t[x]} : t = 0,1,..,T\}$ where $P_{t[x]}$ is the xth percentile of the distribution of P_i . Results are presented for x = 5, 50, and 95.

D8. Rescaled final depletion: P_T/P_0 (1+ and mature female numbers by breeding stock / feeding group; median, lower 5th and upper 5th percentiles) where P_0 is number of 1+ / mature female animals had there been no future Makah hunts.

D10. Relative increase. The ratio of the 1+ and mature population size after 10 and 100 years to that at the start of the projection period by breeding stock / feeding group (median, lower 5th and upper 5th percentiles)

I.2 Removal-related

N9. Need satisfaction. The proportion of the total number of requested strikes that were taken over the first 10 years and the entire 100-year period (median, lower 5th and upper 5th percentiles).

R1. Plots of strikes by year for simulations 1-100.

R2. Plots of landed whales by year for simulations 1-100.

R3. Plots of incidental catches by year for simulations 1-100 (median, lower 5th and upper 5th percentiles by year).

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Table 1

The presence matrices for stock structure hypotheses 3a, 3b, 3c, 3e, 5a and 6b.

[a] Hypothesis 3a (no extant Western breeding stock)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Eastern														
WFG			1	1	1	1			1		1		1	1
North			1			1	1	1	1	1	1	1	1	1
PCFG							1[A]	1	1	1	1	1	1	1

[A] Sensitivity test (12) only

[b] Hypothesis 3b (extant Western breeding stock)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	1	1		1								
Eastern														
WFG				1	1	1			1		1		1	1
North			1				1	1	1	1	1	1	1	1
PCFG								1	1	1	1	1	1	1

[c] Hypothesis 3c (no extant Western breeding stock; WFG in BSCS)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Eastern														
WFG			1	1	1	1	1		1		1		1	1
North			1			1	1	1	1	1	1	1	1	1
PCFG								1	1	1	1	1	1	1

[d] Hypothesis 3e (extant Western breeding stock; WFG in EJPJ)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	1	1		1								
Eastern														
WFG			1	1	1	1			1		1		1	1
North						1	1	1	1	1	1	1	1	1
PCFG								1	1	1	1	1	1	1

[e] Hypothesis 5a (Western breeding stock in SI)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	1	1	1	1								
Eastern														
WFG			1	1	1	1			1		1		1	1
North						1	1	1	1	1	1	1	1	1
PCFG							1[A]	1	1	1	1	1	1	1

[A] Sensitivity test (12) only

[f] Hypothesis 6b (no Western feeding group)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	1	1	1	1			1		1		1	1
Eastern														
North						1	1	1	1	1	1	1	1	1
PCFG								1	1	1	1	1	1	1

Table 2

The mixing matrices for stock structure hypotheses 3a, 3b, 3e, 5a and 6b. The γs denote the estimable parameters of the catch mixing matrix and the χs denote values that are varied in the tests of sensitivity.

[a] Hypothesis 3a (no extant Western breeding stock)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Eastern														
WFG			1	1	1	1			γ6		γ3		γ6	1
North			γ1			1	1	1	1	1	1	1	1	1
PCFG							1 A	γ8 B	γ7	γ2	γ4	γ5	γ7	1

[A] Sensitivity test (12) only
[B] Sensitivity test (9) only

[b] Hypothesis 3b (extant Western breeding stock)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	γ1	1										
Eastern														
WFG				1	1	1			γ6		γ3		γ6	1
North			1			1	1	1	1	1	1	1	1	1
PCFG								1	γ7	γ2	γ4	γ5	γ7	1

[c] Hypothesis 3c (extant Western breeding stock; WFG in BSCS)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1												
Eastern														
WFG			1	1	1	1	1		γ6		γ3		γ6	1
North			γ1			1	1	1	1	1	1	1	1	1
PCFG								1	γ7	γ2	γ4	γ5	γ7	1

[d] Hypothesis 3e (extant Western breeding stock; WFG in EJPJ)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	γ1	1		1								
Eastern														
WFG			1	1	1	1			γ6		γ3		γ6	1
North						1	1	1	1	1	1	1	1	1
PCFG								1	γ7	γ2	γ4	γ5	γ7	1

[e] Hypothesis 5a (Western breeding stock in SI)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	γ1	1	1	1								
Eastern														
WFG			1	1	1	1			γ6		γ3		γ6	1
North						1	1	1	1	1	1	1	1	1
PCFG							1 A	γ8 B	γ7	γ2	γ4	γ5	γ7	1

[A] Sensitivity test (12) only
[B] Sensitivity test (9) only

[f] Hypothesis 6b (no Western feeding group)

Breeding stock/ Feeding Aggregation	Sub-area													
	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCS	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
Western	1	1	1	1	1	1			γ6		γ3		γ6	1
Eastern														
North						1	1	1	1	1	1	1	1	1
PCFG								1	γ7	γ2	γ4	γ5	γ7	1

Table 3

Fleets included in the population dynamics model, the associated selectivity patterns, and the years for which detection and reporting of entanglements, ship strikes, and strandings in general was relatively good. The columns "Years (hindcast)" and "Years (forecast)" denote the ranges of years used to infer bycatch rates respectively before and after the first year for which detection and reporting of entanglements, ship strikes, and strandings in general was relatively good.

Fleet	Season	Type	Years	Years (hindcast)	Years (forecast)	Selectivity
Northern Bering and Chukchi Sea (BSCSA)	All	Subsistence	N/A			Uniform 1+
WA U&A (feeding) (WAUAF)	June-Nov	Subsistence	N/A			Uniform 1+
WA U&A (migration) (WAUAM)	Dec-May	Subsistence	N/A			Uniform 1+
CA-scientific (migration)	Dec-May	Scientific	N/A			Uniform 1+
Vietnam-South China Sea (VSC)	All	All removals	No removals			
Korea and western side of the Sea of Japan (KWJ)	All	All removals	No removals			
Eastern side of the Sea of Japan and the Pacific coast of Japan (EJPJ)	All	All removals	1982 – 2015	1982 – 2015	1982 – 2015	Uniform 0-5
Northeastern Sakhalin Island (SI)	All	All removals	1982 – 2015	1982 – 2015	1982 – 2015	Uniform 0-5
Southern Kamchatka and Northern Kuril Islands (SKNK)	All	All removals	No removals			
Areas of the Okhotsk Sea not otherwise specified (OS)	All	All removals	No removals			
Northern Bering and Chukchi Sea (BSCSE)	All	Entanglements	1987 – 2015	1987 – 1991	2011 – 2015	Uniform 0-5
Southeast Alaska (SEA1E)	June-Nov	Entanglements	M/SI only	1987 – 1991	2011 – 2015	Uniform 0-5
Southeast Alaska (SEA2E)	Dec-May	Entanglements	1987 – 2015	1987 – 1991	2011 – 2015	Uniform 0-5
British Columbia to Northern California (BCNC1E)	June-Nov	Entanglements	1990 – 2015	1990 – 1994	2011 – 2015	Uniform 0-5
British Columbia to Northern California (BCNC2E)	Dec-May	Entanglements	1990 – 2015	1990 – 1994	2011 – 2015	Uniform 0-5
California (CA1E)	June-Nov	Entanglements	1982 – 2015	1982 – 1986	2011 – 2015	Uniform 0-5
California (CA2E)	Dec-May	Entanglements	1982 – 2015	1982 – 1986	2011 – 2015	Uniform 0-5
Mexico (MEXE)	All	Entanglements	MS/I only	1982 – 1986	2011 – 2015	Uniform 0-5
Northern Bering and Chukchi Sea (BSCSS)	All	Ship strikes	No ship strikes			
Southeast Alaska (SEA1S)	June-Nov	Ship strikes	No ship strikes			
Southeast Alaska (SEA2S)	Dec-May	Ship strikes	1987 – 2015	1987 - 2015	1987 - 2015	Uniform 0+
British Columbia to Northern California (BCNC1S)	June-Nov	Ship strikes	1990 – 2015	1990 – 2015	1990 – 2015	Uniform 0+
British Columbia to Northern California (BCNC1S)	Dec-May	Ship strikes	1990 – 2015	1990 – 2015	1990 – 2015	Uniform 0+
California (CA1S)	June-Nov	Ship strikes	1982 – 2015	1982 – 2015	1982 – 2015	Uniform 0+
California (CA2S)	Dec-May	Ship strikes	1982 – 2015	1982 – 2015	1982 – 2015	Uniform 0+
Mexico (MEXS)	All	Ship strikes	MS/I only	1982 – 2015	1982 – 2015	Uniform 0+
California (SET1)	June-Nov	Set Gillnet	1982 – 1990	1982 – 1990	None	Uniform 0-5
California (SET2)	Dec-May	Set Gillnet	1982 – 1990	1982 – 1990	None	Uniform 0-5
California (SET3)	June-Nov	Set Gillnet	1991 – 2015	None	1991 – 2015	Uniform 0-5
California (SET4)	Dec-May	Set Gillnet	1991 – 2015	None	1991 – 2015	Uniform 0-5

Table 4a

Non-bycatch removals. The BSCS 'fleet' represents the aboriginal catches, the two WAUA 'fleets' represent Makah hunting in the Makah usual and accustomed area, and the CA migration 'fleet' is the scientific catches off California.

Year	Fleet				Year	Fleet			
	BSCS	WAUA Feeding	WAUA Migration	CA Migration		BSCS	WAUA Feeding	WAUA Migration	CA Migration
1930	47	0	0	0	1974	184	0	0	0
1931	10	0	0	0	1975	171	0	0	0
1932	10	0	0	10	1976	165	0	0	0
1933	15	0	0	60	1977	187	0	0	0
1934	66	0	0	60	1978	184	0	0	0
1935	44	0	0	110	1979	183	0	0	0
1936	112	0	0	86	1980	182	0	0	0
1937	24	0	0	0	1981	136	0	0	0
1938	64	0	0	0	1982	168	0	0	0
1939	39	0	0	0	1983	171	0	0	0
1940	125	0	0	0	1984	169	0	0	0
1941	77	0	0	0	1985	170	0	0	0
1942	121	0	0	0	1986	171	0	0	0
1943	119	0	0	0	1987	159	0	0	0
1944	6	0	0	0	1988	151	0	0	0
1945	58	0	0	0	1989	180	0	0	0
1946	30	0	0	0	1990	162	0	0	0
1947	31	0	0	0	1991	169	0	0	0
1948	19	0	0	0	1992	0	0	0	0
1949	26	0	0	0	1993	0	0	0	0
1950	11	0	0	0	1994	44	0	0	0
1951	13	0	1	0	1995	92	0	0	0
1952	44	0	0	0	1996	43	0	0	0
1953	38	0	10	0	1997	79	0	0	0
1954	39	0	0	0	1998	125	0	0	0
1955	59	0	0	0	1999	123	0	1	0
1956	122	0	0	0	2000	115	0	0	0
1957	96	0	0	0	2001	112	0	0	0
1958	148	0	0	0	2002	131	0	0	0
1959	194	0	0	2	2003	128	0	0	0
1960	156	0	0	0	2004	111	0	0	0
1961	208	0	0	0	2005	124	0	0	0
1962	147	0	0	4	2006	134	0	0	0
1963	180	0	0	0	2007	131	1	0	0
1964	199	0	0	20	2008	130	0	0	0
1965	181	0	0	0	2009	116	0	0	0
1966	194	0	0	26	2010	118	0	0	0
1967	249	0	0	125	2011	130	0	0	0
1968	135	0	0	66	2012	143	0	0	0
1969	140	0	0	74	2013	127	0	0	0
1970	151	0	0	0	2014	124	0	0	0
1971	153	0	0	0	2015	125	0	0	0
1972	182	0	0	0	2016	120	0	0	0
1973	178	0	0	0					

Table 4b

Bycatches. The bycatches in the remaining areas are: VSC (2 in 2011), EJPJ (1 in 1995; 1 in 1970; 1 in 1996; 5 in 2005; 1 in 2007); and SI (2 in 2014). Values replaced by the predictions of Eqn E.2 are indicated by dashes.

(a) Deaths

Year	Entanglements								Ship strikes								Entanglements	
	BSCS	SEA Feeding	SEA Migration	BCN Feeding	BCN Migration	CA Feeding	CA Migration	MEX	BSCS	SEA Feeding	SEA Migration	BCN Feeding	BCN Migration	CA Feeding	CA Migration	MEX	SET Feeding	SET Migration
1982	-	-	-	-	-	0	1	0	-	-	-	-	-	0	0	0	0	0
1983	-	-	-	-	-	1	2	0	-	-	-	-	-	0	0	0	0	0
1984	-	-	-	-	-	0	3	0	-	-	-	-	-	0	1	0	0	0
1985	-	-	-	-	-	0	6	0	-	-	-	-	-	0	0	0	1	2
1986	-	-	-	-	-	0	1	0	-	-	-	-	-	0	0	0	0	0
1987	1	0	0	-	-	0	2	0	0	0	0	-	-	0	4	0	0	1
1988	0	0	1	-	-	0	1	0	0	0	0	-	-	0	3	0	0.75	0
1989	0	0	0	-	-	0	1	0	0	0	0	-	-	0	0	0	0	2
1990	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1991	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0
1992	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1994	0	0	0	0	2	1	1	0	0	0	0	0	0	0	1	0	0	0
1995	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0
1996	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1
1998	1	0	1	1	0	0	1	0	0	0	0	0	1	0	2	0	0	0
1999	2	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0
2000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0
2004	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0.75	0
2005	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0
2006	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
2010	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
2012	0	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	1	0	4	0	0	0	0	0	1	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.75	0

Table 5

Relative effort for the set gillnet fishery off California (J. Carrette, SWFSC, pers. comm.). Effort is constant at 1 prior to 1981.

Year	Effort	Year	Effort	Year	Effort
1981	1.000	1993	1.438	2005	0.428
1982	1.819	1994	0.571	2006	0.365
1983	1.940	1995	0.460	2007	0.401
1984	2.459	1996	0.519	2008	0.384
1985	2.598	1997	0.690	2009	0.304
1986	2.048	1998	0.554	2010	0.358
1987	1.883	1999	0.737	2011	0.370
1988	1.560	2000	0.754	2012	0.324
1989	1.376	2001	0.624	2013	0.278
1990	1.444	2002	0.668	2014	0.265
1991	1.395	2003	0.607	2015	0.419
1992	1.197	2004	0.626		

Table 6a

Abundance estimates (1+) for the WFG feeding aggregation and the western breeding stock (J.G. Cooke, pers. comm.).

Year	Group	Stock hypothesis	Estimate	SD	CV
1995	WFG	3a/3c/3e/6b	75.1	3.8	0.051
1995	WBS	3b	25.8	7.3	0.282
1995	WFG	3b	75.5	3.3	0.043
1995	WBS	3e	30.0*	15.0	0.500
1995	WBS	5a	26.6	6.9	0.259
1995	WFG	5a	47.8	7.7	0.160
1995	WBS+WFG	5a	74.4	3.9	0.052
1995	WBS/(WBS+WFG)	5a	0.358	0.093	0.259
2015	WFG	3a/3c/3e/6b	199.8	5.4	0.027
2015	WBS	3b	63.8	15.8	0.248
2015	WFG	3b	198.9	5.7	0.029
2015	WBS	3e	30.0*	15.0	0.500
2015	WBS	5a	64.4	14.0	0.218
2015	WFG	5a	135.6	14.1	0.104
2015	WBS+WFG	5a	200.0	5.7	0.029
2015	WBS/(WBS+WFG)	5a	0.322	0.069	0.200

Table 6b

Estimates of absolute abundance (with associated standard errors) for the eastern North Pacific stock of gray whales based on shore counts (source: 1967/78-2006/07: Laake *et al.*, 2012; 2006/07-2015/16: Durban *et al.*, 2013, 2017). These estimates are assumed to pertain to the total number of gray whales.

Year	Estimate	CV	Year	Estimate	CV
1967/68	13426	0.094	1987/88	26916	0.058
1968/69	14548	0.080	1992/93	15762	0.067
1969/70	14553	0.083	1993/94	20103	0.055
1970/71	12771	0.081	1995/96	20944	0.061
1971/72	11079	0.092	1997/98	21135	0.068
1972/73	17365	0.079	2000/01	16369	0.061
1973/74	17375	0.082	2001/02	16033	0.069
1974/75	15290	0.084	2006/07	19126	0.071
1975/76	17564	0.086	2006/07	20750	0.060
1976/77	18377	0.080	2007/08	17820	0.054
1977/78	19538	0.088	2009/10	21210	0.046
1978/79	15384	0.080	2010/11	20990	0.044
1979/80	19763	0.083	2014/15	28790	0.130
1984/85	23499	0.089	2015/16	26960	0.050
1985/86	22921	0.081			

Table 6c

Estimates of absolute abundance (with associated CVs) for the PCFG feeding aggregation based on mark-recapture analysis (source: Calambokidis *et al.,* 2017).

Year	Estimate	CV	Year	Estimate	CV
1998	126	0.087	2009	208	0.101
1999	145	0.101	2010	200	0.095
2000	146	0.098	2011	205	0.078
2001	178	0.076	2012	217	0.052
2002	197	0.069	2013	235	0.059
2003	207	0.084	2014	238	0.080
2004	216	0.077	2015	243	0.078
2005	215	0.125			
2006	197	0.108			
2007	192	0.136			
2008	210	0.089			

Table 7

Data on mixing proportions (definite and likely matches/non-matches only) to be used when conditioning the models.

Sub-area	Season	Stock/Feeding aggregation	Mixing proportion (assumed SD)
EJPJ	All	WBS/NFG	0.33 (0.1)
SEA	Feeding	PCFG	0.57[1] (0.1)
SEA	Feeding	WFG	0
SEA	Migration	PCFG	0.1[2] (0.1)
SEA	Migration	WFG	0.002[3] (0.05)
BCNC	Feeding	PCFG	0.93 (0.1)
BCNC	Feeding	WFG	0
BCNC	Migration	PCFG	0.28 (0.1)
BCNC	Migration	WFG	0.002 (0.05)
CA	Feeding	PCFG	0.60 (0.1)
CA	Feeding	WFG	0
CA	Migration	PCFG	0.1 (0.05)
CA	Migration	WFG	0.002[3] (0.05)

[1] Not used in the conditioning except for the sensitivity test based when the bycatch is based on M/SI as no dead bycatch is recorded for the SEA sub-area during the feeding season.
[2] Assumed value owing to lack of data to estimate mixing proportions.
[3] Set to the value calculated for BCNC by Moore and Weller (2013).

Table 8

Factors considered in the model scenarios. The **bold** values are the base-levels and the values in standard font form the basis for sensitivity analyses.

Factor	Levels
Model fitting related	
Stock hypothesis	**3a,** 3b, 3c, 3e, **5a,** 6b
$MSYR_{1+}$(western)	As for WFG
$MSYR_{1+}$(north)	**4.5%**, 5.5%, Estimated (common); estimate(separately)
$MSYR_{1+}$(WFG)	**4.5%** Estimated (common); estimate(separately)
$MSYR_{1+}$(PCFG)	2%, **4.5%**, 5.5%¸ Estimated (common); estimate (separately)
Mixing rate (migration season in BCBC	**0.28**, 0.17, 1.00
Immigration into the PCFG	0, 1, **2**, 4
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
Projection-related	
Additional catch off Sakhalin (mature female)	0, 1
Catastrophic events	**None**, once in years 0 – 49, and once in years 50-99
Northern need in final year (from 150 in 2014)	**340**
Struck and lost rate	**(0.1; odd-years; 0.5 even years),** 0.5 all years
Future effort	**Constant**, Increase by 100% over 100 years
Probability of a photo (struck and lost whales)	**0.8; odd-years; 0.6 even years**
Probability of a photo (landed whales)	**0.9**
Probability of false positive rate PCFG	**0.05**, 0.1
Probability of false negative rate PCFG	**0.25**
Probability of false positive rate WFG	**0.01**
Probability of false negative rate WFG	**0.041 (stock hypotheses 3a, 3c, 3e, 6b);** 0.040 (stock hypothesis 3b); **0.049 (stock hypothesis 5a)**
Probability of a sex assignment given a PCFG match	**0.81**

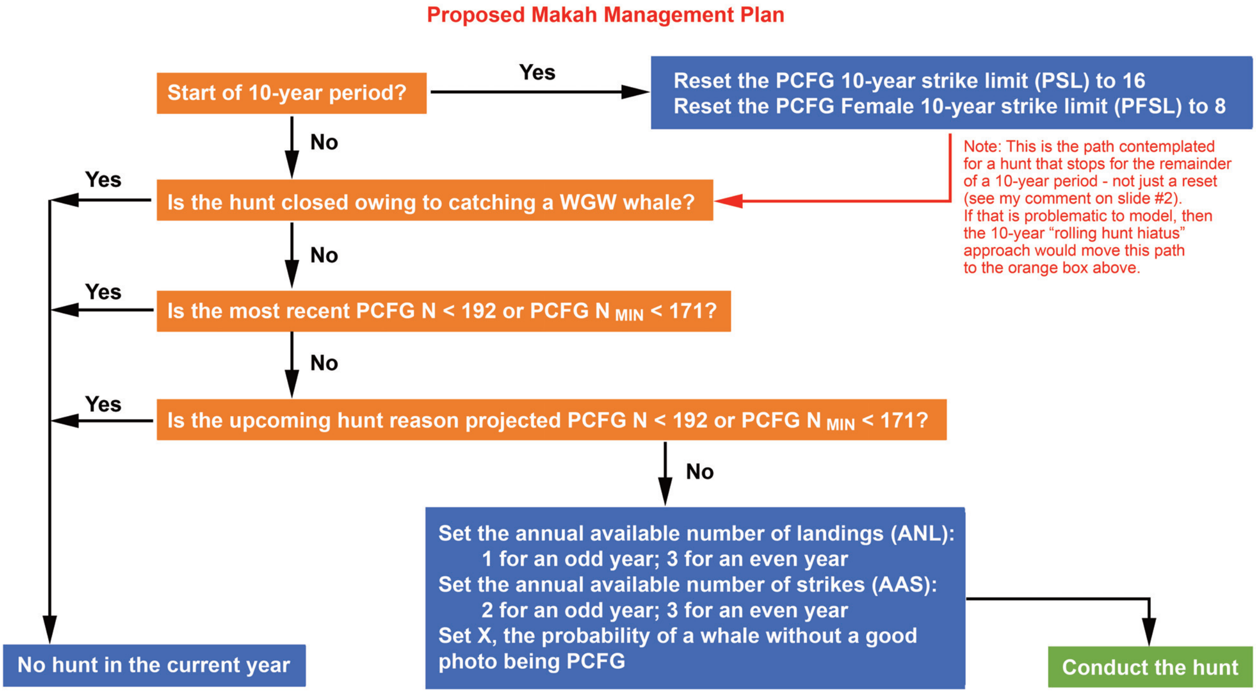
Table 6

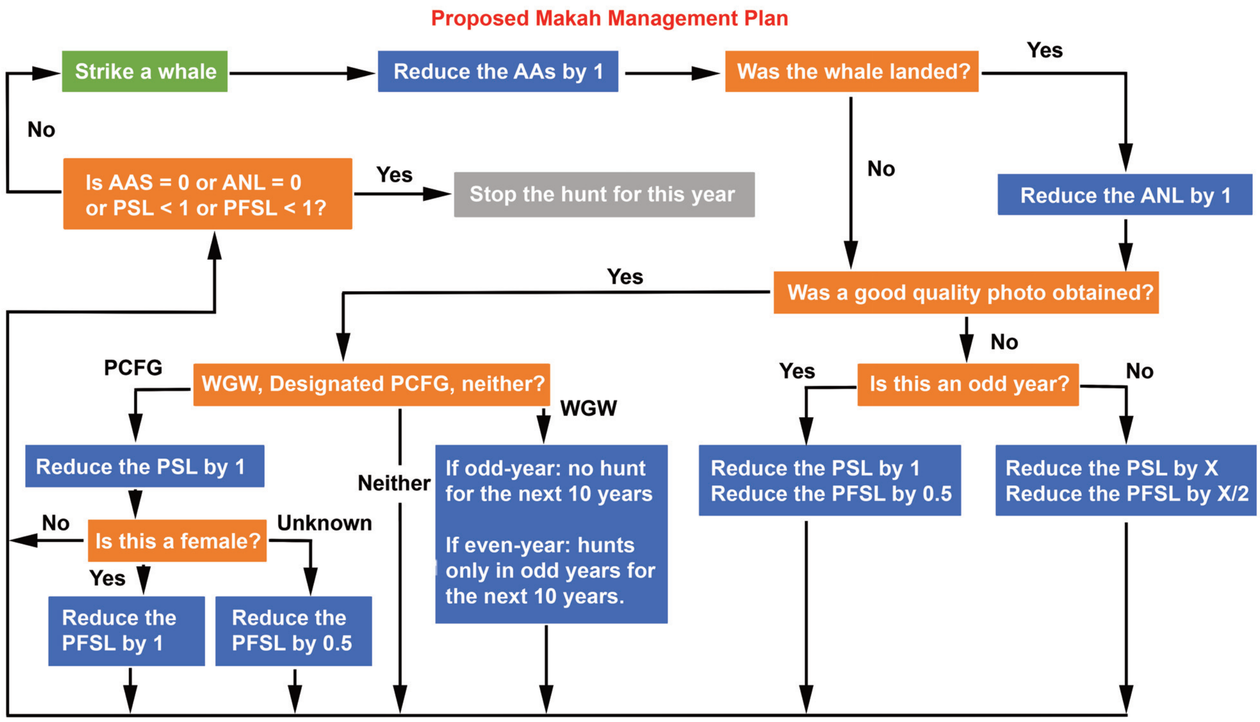
Final trial specifications.

Trial	Description/stock hypothesis	PCFG or WFG in BSCS	MSYR$_{1+}$			PCFG		Bycatch	Conditioning
			North	PCFG	WFG	Imm.	Pulse		
Base-case trials									
0A	Reference 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
0B	Reference 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
Sensitivity tests									
1A	Lower MSYR PCFG 3a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
1B	Lower MSYR PCFG 5a	No	**4.50%**	**2%**	**4.50%**	2	20	D x 4	Yes
2A	Higher MSYR PCFG and North 3a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
2B	Higher MSYR PCFG and North 5a	No	**5.50%**	**5.50%**	**4.50%**	2	20	D x 4	Yes
3A	Lower WBS in Sakhalin 5a (Hyp 3e)	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
3B	Higher WBS in Sakhalin 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4A	PCFG mixing based on Northern WA only 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
4B	PCFG mixing based on Northern WA only 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
5A	No PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
5B	No PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**0**	20	D x 4	Yes
7A	Higher PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
7B	Higher PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**4**	20	D x 4	Yes
9A	Lower Pulse into PCFG 3a (and no 1668-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
9B	Lower Pulse into PCFG 5a (and no 1668-2002 PCFG data)	No	4.50%	4.50%	4.50%	2	**10**	D x 4	Yes
8A	Higher pulse into PCFG 3a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
8B	Higher pulse into PCFG 5a	No	4.50%	4.50%	4.50%	2	**30**	D x 4	Yes
6A	Bycatch=Dead + MSI 3a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
6B	Bycatch=Dead + MSI 5a	No	4.50%	4.50%	4.50%	2	20	**D + MSI**	Yes
10A	Bycatch x 10 3a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
10B	Bycatch x 10 5a	No	4.50%	4.50%	4.50%	2	20	**D x 10**	Yes
11A	Bycatch x 20 3a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
11B	Bycatch x 20 5a	No	4.50%	4.50%	4.50%	2	20	**D x 20**	Yes
12A	PCFG in BSCS 3a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
12B	PCFG in BSCS 5a	**PCFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13A	WFG in BSCS 3a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
13B	WFG in BSCS 5a	**WFG**	4.50%	4.50%	4.50%	2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 3a	No		**Estimated**		2	20	D x 4	Yes
14A	MSYR1+ estimated (common) 5a	No		**Estimated**		2	20	D x 4	Yes
15A	MSYR1+ estimated (by FA) 3a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
15B	MSYR1+ estimated (by FA) 5a	No	**Est**	**Est**	**Est**	2	20	D x 4	Yes
17A	Lower PCFG immigration and higher bycatch 3a (and no 1668-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
17B	Lower PCFG immigration and higher bycatch 5a (and no 1668-2002 PCFG data)	No	4.50%	4.50%	4.50%	**0**	20	**D x 10**	Yes
19A	MSYR estimated and lower pulse 3a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
19B	MSYR estimated and lower pulse 5a	No	**Est**	**Est**	**Est**	2	**10**	D x 4	Yes
18A	Stock hypothesis 3b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18B	Stock hypothesis 7b	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
18C	Stock hypothesis 3c	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
16A	Lower PCFG Immigration 3a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
16B	Lower PCFG Immigration 5a	No	4.50%	4.50%	4.50%	**1**	20	D x 4	Yes
20A	Lower PCFG immigration and higher bycatch 3a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
20B	Lower PCFG immigration and higher bycatch 5a	No	4.50%	4.50%	4.50%	**1**	20	**D x 10**	Yes
21A	Survival = 0.65; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
21B	Survival = 0.65; 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
22A	Future catastrophic events (once in each of yrs 1-50 & 51-66) - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
22B	Future catastrophic events (once in each of yrs 1-50 & 51-66) - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
23A	Summer S&L rate = 0.5 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
23B	Summer S&L rate = 0.5 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
24A	PCFG false negative rate = 0.1 - 3a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 3a
24B	PCFG false negative rate = 0.1 - 5a	No	4.50%	4.50%	4.50%	2	20	D x 4	No, 5a
25A	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes
25B	PCFG mixing based on Northern WA is 100%	No	4.50%	4.50%	4.50%	2	20	D x 4	Yes

Appendix 1

OUTLINE OF THE MAKAH MANAGEMENT PLAN AND ITS IMPLEMENTATION IN TRIALS





Appendix 2

THE 'RESEARCH WITH VARIANT' (*SLA* VARIANT 1) OPTION

This option (IWC, 2012) operates as follows:

(1) Update the ABL (Allowable Bycatch Limit of PCFG whales) if this is the start of a new 6-year block as:

$$ABL = N_{MIN} * 0.5 * R_{MAX} * F_R$$

Where:

N_{MIN} is the log-normal 20th percentile of the most recent abundance estimate for the Oregon to Southern Vancouver (OR-SVI) sub-area of the PCFG. The abundance estimates for use in the ABL formula are generated as specified in Section I, except for allowance is made for a bias which differs among simulations but is constant over time between the estimates for OR-V and those for the PCFG, i.e. $\ell nBA \sim N$ (–0.335, 0.112) (IWC, 2012).

R_{MAX} is equal to 0.04;

F_R is equal to 1.0.

(2) Strike an animal

(3) If the total number of struck animals equals the need of 7 stop the hunt.

(4) If the animal is struck-and lost:

(a) if the total number of struck and lost animals is 3, stop the hunt.

(b) go to step (2).

(5) If the animal is landed and is matched against the PCFG catalogue:

(a) add one to the number of whales counted towards the ABL

(b) if the ABL is reached; stop the hunt

(c) if the total number of landed whales equals 5; stop the hunt

(d) if the number of landed whales for the current six-year block equals 24; stop the hunt

(e) go to step (2).

(6) If the animal is landed and does not match any whale in the PCFG catalogue:

(a) if the total number of landed whales equals 5; stop the hunt

(b). if the number of landed whales for the current six-year block equals 24; stop the hunt

(c) go to step (2).

REFERENCE

IWC. 2012. Report of the Standing Working Group in the Aboriginal Whaling Management Procedure. *J. Cetacean Res. Manage.* 13 (Suppl.) 130-53

Report of the Workshop on the Poorly Documented Takes of Small Cetaceans in South America: Including In-Depth Review of the Hunting of the Amazon River Dolphin (*Inia geoffrensis*) for the Piracatinga (*Calophysus macropterus*) Fishery

Report of the Workshop on the Poorly Documented Takes of Small Cetaceans in South America: Including In-Depth Review of the Hunting of the Amazon River Dolphin (*Inia geoffrensis*) for the Piracatinga (*Calophysus macropterus*) Fishery[1]

CHAIR'S SUMMARY

The poorly documented take of small cetaceans for use as wildmeat is a priority topic of the Scientific Committee (SC). An Intersessional Correspondence Group (ICG) was established to ensure progress on this topic between SC meetings. The ICG was tasked with the development of a toolbox of techniques that could guide and coordinate research into this topic with the aim of better understanding the issue on regional and global levels. A series of workshops were proposed to fulfill this task, the first of which took place in Thailand in 2016 and covered South East Asia. A second Workshop focused on South America and also incorporated a detailed review of the use of Amazon river dolphins as bait in the piracatinga fishery, which is also a wildmeat issue. The Workshop held in South America aimed to:

(1) identify threats, past and present, in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Suriname, Peru, Uruguay and Venezuela with respect to 'wildmeat' and discuss which techniques can be utilised to better understand this issue; and
(2) review current knowledge of the use of Amazon river dolphins as bait in the piracatinga fishery and provide recommendations for future work and action.

The Workshop was divided into two separate sessions, one which discussed the issue of wildmeat in South America and one which reviewed the take of Amazon dolphins for bait in the piracatinga fishery. This Workshop fulfilled several goals of the SC; the ongoing work of the Intersessional Correspondence Group (ICG 30) on the poorly documented take of small cetaceans and the completion of the work of the Amazon Dolphin/Piracatinga Steering Group (SG 21).

Information was summarised for all countries, except Guyana and Suriname. Products from small cetaceans are used throughout South American countries and Costa Rica, for both food and non-food purposes. This type of use is referred to as 'aquatic wildmeat'. The usefulness of various tools and techniques was discussed, including data gathering techniques and forensic investigation. A database, comprising more than 3000 references, was used to map existing knowledge and understand data gaps. A framework was established with the intention that future data collection should be collated in such a way as to be standardised and systematic, with a view to gathering sufficient information to better understand regional and global patterns of small cetacean wildmeat use. The Workshop participants populated a database from which regional patterns were mapped. Areas that were highlighted as a cause of conservation concern were; Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Peru and Venezuela.

The take of Amazon river dolphins as bait in the piracatinga fishery was reviewed. All range countries of *Inia* and *Sotalia* have laws in place to protect dolphins and prohibit intentional killing. Fishing for piracatinga is banned in Brazil and its trade is prohibited in Colombia, due to its impact on river dolphins and other wildlife. Colombia does not have a piracatinga fishery using dolphins as bait, however, the high demand for this fish in Colombia drives fisheries elsewhere. The practice of using dolphins as bait has recently expanded to Peru, Bolivia and Venezuela, following the imposition of restrictions in Brazil, however, no other range country has developed specific legislative or regulatory action, beyond the general protection of river dolphins, in response to the emergence of this practice.

Small cetaceans are used throughout South American countries for a variety of purposes, e.g. food, bait, love charms, talismans, medicine, boat maintenance etc. Areas of the greatest concern are reflected in the specific recommendations provided in the Workshop text. A consolidation of science-related recommendations is provided in the summary.

Recommendations

With regards to the piracatinga fishery, Brazil is **commended** on its swift action of declaring a moratorium and is **urged** to maintain this moratorium to allow sufficient time to evaluate the effectiveness of protective measures and continue the necessary protection of river dolphins. The Workshop, therefore, **recommends** that the moratorium on the piracatinga fishery in Brazil continues after 2019.

With specific reference to the river dolphin populations that are impacted by the piracatinga fishery, the Workshop **recommends** that surveys designed to monitor trends in abundance should be conducted for the:

- Boto (*Inia geoffrensis*) in Purus and Japurá rivers, Brazil and Içá/Putumayo river in both Brazil and Colombia, utilising previously established standardised methods. Also, studies should be expanded into other areas where take for bait may be a cause for concern.

To improve regional knowledge and aid conservation research, the Workshop **recommends** that divisions within the genus *Inia* are evaluated and genetic conservation units are established. The Workshop also **encourages** the use of new technologies, such as drones and telemetry, to establish trends, habitat use and dispersion patterns. Further, the Workshop **urges** new efforts to improve regional research capacity. The Workshop also strongly **encourages** an evaluation of historical data on river dolphins to better understand other threats, e.g. from bycatch, to provide further insights into current trends. The Workshop **reiterates** the previous recommendation of the Scientific Committee of the IWC that range states engage in bilateral and multilateral discussions of legislative, enforcement, management and scientific efforts to ensure effective cooperation among them. Such

[1] Presented to the meeting as SC/67b/Rep01.

collaboration includes the Amazon range-wide review of existing fishery management plans to promote sustainable and legal fisheries and avoid the emergence of negative interactions against cetaceans in the future. A single and coordinated, regional sustainable fisheries management plan for the Amazon should be considered as a goal for all range states. The Workshop further **encourages** range state authorities to work together to exchange information on the movement of piracatinga products across international borders.

The Workshop also identified additional threats to river dolphins, other than use as bait in the piracatinga fishery. In particular, the Workshop draws attention to the dolphins that have been isolated by the Tocantins dam system. Given the confined condition of the dolphins' habitat, the Workshop recommends that the status of these dolphins be evaluated, to include abundance, genetic, habitat quality, prey availability, with a view to developing a translocation protocol, including under what circumstances such a protocol should be enacted.

The Workshop also noted with concern the extensive habitat modification that will result from the Mega Project 'Arco Minero del Orinoco', a massive mining operation proposed along the Orinoco River and watershed of Venezuela. The Workshop **recommends** that population sizes and trends of both *I. geoffrensis* and *S. guianensis,* in the Orinoco River basin, be monitored before and during this project.

The Workshop concluded that the network of academic institutes, non-government organisations and management and regulatory authorities currently working on river dolphins and their habitat should design a regional strategy so that data collection is coordinated and comparable.

The Workshop identified several other small cetacean species and/or populations that are likely being impacted by their use as wildmeat. The Workshop therefore, **recommends** that abundance and distribution surveys, in tandem with investigation into the magnitude of aquatic wildmeat use, be conducted on these species. Appropriate survey designs should be implemented that consider the statistical power required to detect trends and the resultant data should then be used to estimate the impact of deliberate take for wildmeat on the following populations:

- Chilean dolphin (*Cephalorhynchus eutropia*) in Chile;
- Burmeister's porpoise (*Phocoena spinipinnis*) in both Chile and Peru;
- Burmeister's porpoise (*Phocoena spinipinnis*) in Peru, noting that current evidence suggests that the Peruvian population is distinct;
- dusky dolphin (*Lagenorhynchus obscurus*) in Peru, noting that evidence shows that landings of this species has decreased and populations may have been heavily impacted;
- Guiana dolphin (*Sotalia guianensis*) and other small cetaceans in Amapá, Pará, Maranhão, Piauí, Ceará, Espírito Santo, São Paulo and Paraná, in Brazil, as there is a documented use of bycatch for wildmeat purposes;
- bottlenose dolphins (*Tursiops truncatus*) and pantropical spotted dolphins (*Stenella attenuata*) in Bahia Solano, Colombia, noting that deliberate take for a long line fishery is ongoing;
- Tucuxi (*Sotalia fluviatilis*) throughout its range, in Brazil, Colombia, Ecuador, as it shares most of the same threats as *Inia geoffrensis,* and may also be used as bait in the piracatinga fishery; and
- Guiana dolphin (*Sotalia guianensis*) in Lake Maracaibo in Venezuela, noting that deliberate take for food is ongoing.

Further, this Workshop **recommends** that:

- An investigation be made of the magnitude of by-catch of Guiana dolphins (*Sotalia guianensis*) in the gillnet fishery operating off Maranhão, Pará and Amapá, north Brazil, noting that by catch is being used commercially for shark bait, human consumption and cultural use.
- A forensic investigation of the cetacean products for sale in the north and northeastern Brazilian markets be conducted coupled with better enforcement of wildlife trade legislation.
- Separate assessments for (a) directed take for bait and (b) for other uses be made in the small-scale fisheries of Peru.
- The use of dolphins for bait in the long-line fishery in Bahia Solano, Choco in the Colombian Pacific, is evaluated using dedicated interview surveys and the use of alternative bait evaluated.
- Heavy metals levels of *Sotalia guianensis* and *Inia geoffrensis* in the Orinoco river basin and Maracaibo Lake be estimated and the impact on of consumption of dolphin meat on human health be evaluated.
- The governments that are part of the Eastern Pacific Corridor (CMAR), Colombia, Costa Rica, Panama and Ecuador assess the current practice of using marine mammals in Fish Aggregating Devices (FADs) and enforce the existing legislation which prohibits the use of cetaceans as attractors of these gears.
- The Inter American Tropical Tuna Commission RFMO documents and registers the capture and incidence of cetaceans (or pinnipeds) during their fishing operations along the Eastern Pacific through the appropriate onboard observers programme.

As all countries in South America, and Costa Rica, have laws in place to protect small cetaceans, it was **highlighted** that existing legislation pertaining to wildlife trade should be strictly enforced and all seizures and prosecutions should be openly reported. All countries are requested to consider, where necessary, increasing penalties for engaging in activities that result in the killing of dolphins to provide stronger deterrence against these illegal activities.

The Workshop **concludes** that as the magnitude of use of small cetaceans as aquatic wildmeat is a regional cause of concern, all parties, including researchers and management authorities, are **strongly encouraged** to standardise data collection efforts to better understand this issue and to actively encourage a collaborative and coordinated approach to understand regional patterns and trends. A framework for such an approach was developed at this meeting that can be adapted for such a purpose.

1. INTRODUCTION

The Workshop was held from 19-21 March 2018, in the Novotel, Santos, Brazil. The Workshop was divided into two separate sessions, one which discussed the issue of wildmeat in South America, chaired by Porter and Scheidat, and one which reviewed the take of Amazon dolphins for bait in the piracatinga fishery, chaired by Fruet and Zerbini. This Workshop fulfilled several aims; the ongoing work of the Intersessional Correspondence Group (ICG 30) on the poorly documented take of small cetaceans and the completion of the work of the Amazon Dolphin/Piracatinga Steering Group (SG 21).

Participants were identified in consultation with the Scientific Committee (SC) Chair, Head of Science and members of both the ICG and SG. In addition, support was provided to Jimenez to attend the International Congress for Conservation Biology (ICCB), Colombia, 2017, which had several sessions dedicated to cetacean research in South America. Jimenez was thus able to identify emerging research that was directly relevant to the topics of wildmeat and the Amazon dolphin issue. From this process, a list of experts was compiled and co-ordinators from each country were requested to compile a summary of information relevant to the aims of the Workshop. There were 36 participants from 14 countries and written contributions from two countries. The list of participants is given as Annex A and the agenda is given as Annex B.

2. MEETING OPENING

2.1 Opening remarks

Scheidat, Porter, Fruet and Zerbini opened the meeting. Mr. Rodrigo Mendes Carlos de Almeida, the Head of the Brazilian Delegation to the IWC Scientific Committee, welcomed Workshop participants and noted that this is an important year for Brazil, which will host the IWC plenary in Florianópolis, in September 2018. Dr. Fábia Luna, Chief of the Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos (CMA) of the Brazilian government, welcomed the meeting to Santos and remarked on the region's importance to marine mammal research and conservation efforts in Brazil. The convenors commended Jimenez on her preparation for the Workshop which included the identification of appropriate researchers, liaison with the Workshop participants during Workshop document preparation and her continued support throughout the Workshop itself.

2.2 Appointment of Rapporteurs

Thomas and Jimenez were appointed as rapporteurs.

2.3 Documents available

The documents available to the Workshop are listed in Annex C.

3. WORKSHOP AIMS AND OBJECTIVES

3.1 Overview

A priority topic of the Scientific Committee is the issue of the poorly documented take of small cetaceans. An Intersessional Correspondence Group (ICG) was established to ensure progress on this topic between SC meetings and with the aim of better understanding the issue globally. The ICG is tasked with the development of a toolbox of techniques that will guide and coordinate research into this topic with the aim of better understanding the issue on regional and global levels. A series of workshops were proposed to fulfill this aim, the first of which took place in Thailand in 2016 and covered South East Asia. This second Workshop focuses on South America and also aims to assess, in detail, the use of Amazon river dolphins as bait for the piracatinga fishery. Assessment of this problem will also inform the review of the status of the Amazon river dolphins to be conducted by the SC during the 2018 annual meeting (SC67B).

The Workshop aims to:

(1) identify threats, past and present, in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, French Guinea, Guyana, Paraguay, Peru, Uruguay and Venezuela with respect to 'wildmeat', and discuss which techniques can be utilised to better understand this issue; and
(2) review current knowledge of the use of Amazon river dolphins as bait in the piracatinga fishery and provide recommendations for future work and action.

3.2 Defining the issue and establishing common terms

There had been much discussion on the appropriate terminology to use when discussing the use of small cetaceans, and other aquatic megafauna, for food and non-food purposes. For terrestrial animals, the term 'bushmeat' has been used, but the term poses problems in understanding and translation for use of this in the aquatic realm. Thus, a major outcome from the first IWC workshop on this issue was to propose the term 'aquatic wildmeat'. This term has now been adopted by the IWC SC and the Convention on Migratory Species (CMS), which work closely on this issue, and has been embedded into various resolutions and working documents (CMS 2017). To facilitate regional and global discussion and review, it was also necessary to establish common terminology to describe how aquatic wildmeat is obtained or sourced and the terms 'non-targeted salvage', 'non-targeted deliberate' and 'targeted' were defined, following the descriptions in Robards and Reeves (2011). These terms were discussed, and appropriate translations made into Portuguese and Spanish, the working languages of South America.

3.2.1 Aquatic wildmeat and its derivation (English)

Aquatic wildmeat refers to the products derived from aquatic megafauna (e.g. mammals, sea turtles and crocodiles) that are used for food and non-food purposes.

Aquatic wildmeat is defined as the products derived from aquatic mammals and reptiles that are used for subsistence food and traditional uses, including shells, bones and organs and also bait for fisheries. Aquatic wildmeat is obtained through unregulated, and sometimes illegal, hunts as well as from stranded (dead or alive) and/or by caught animals. This definition may need to be broadened to include seabirds, sharks and rays.

Non-targeted-salvage acquisition is neither planned nor intentional but is the utilisation of an aquatic mammal which is already dead and usually found: (a) stranded; or (b) accidently drowned in a net, trap, or line (by catch).

Non-targeted-deliberate acquisition is the intentional killing of a aquatic mammal when it is: (a) found live-stranded on a beach; (b) caught alive in fishing gear; or (c) entrapped by natural phenomena (e.g. sea ice in high latitudes, changing water levels in rivers and channels).

Targeted acquisition is the deliberate killing of free ranging aquatic mammals that are either encountered during the course of other activities (opportunistic) or are the main target and purpose of an expedition (directed).

3.2.2 Aquatic wildmeat and its derivation (Portuguese)

Carne de fauna aquática refere-se a produtos de megafauna aquática (e.g. mamíferos, tartarugas aquáticas e jacarés) que são utilizados como alimento e para outros fins não alimentícios.

Carne de fauna aquática refere-se a produtos originados de mamíferos aquáticos e répteis que são utilizados para subsistência e usos tradicionais, incluindo carapaças, ossos e órgãos, mas também como iscas para a pesca. Carne de fauna aquática é obtida por meio de formas não regulamentadas, e algumas vezes ilegais, pela caça, assim como de animais encalhados (vivos ou mortos) e/ou capturados acidentalmente. Esta definição precisa ser estendida para incluir aves marinhas, tubarões e raias.

O termo '**Aproveitamento Não Direcionado**' refere-se à utilização não planejada nem intencional de um mamífero aquático morto e geralmente encontrado (a) encalhado; ou (b) preso incidentalmente em uma rede, armadilha ou linha (captura incidental).

O termo '**Uso Não Premeditado**' se refere a matança de um mamífero aquático quando (a) encontrado vivo encalhado em praia; (b) capturado vivo em equipamentos de pesca ou; (c) aprisionado por fenômenos naturais (e.g. gelo marinho em altas latitudes, mudanças no nível da água em rios e canais).

O termo '**Uso Intencional**' se refere à matança de mamíferos aquáticos em vida livre que são encontrados de maneira oportunistica (ex. durante o curso de outras atividades), ou quando estes são o principal alvo e propósito de uma expedição (dirigida).

3.2.3 Aquatic wildmeat and its derivation (Spanish)

Carne silvestre acuática se define como los productos derivados de la megafauna acuática (ej. mamíferos, tortugas marinas y cocodrilos) que son utilizados como alimento y con otros propósitos.

Carne silvestre acuática se define como aquellos productos derivados de mamíferos y reptiles acuáticos, utilizados como alimento de subsistencia y usos tradicionales. Incluye caparazones, placas, órganos, huesos, y como carnada para pesquerías. Esta carne es obtenida de forma no regulada, e ilegal en algunas circunstancias. Asimismo, puede provenir de animales varados y/o capturados incidentalmente (vivos o muertos). Esta definición podría incluir a aves marinas, tiburones y rayas.

El termino '**Blanco de Aprovechamiento No Intencional**' se refiere a la utilización no planificada ni intencional de un mamífero acuático que ya está muerto y generalmente se encuentra (a) varado, o (b) atrapado incidentalmente en una red, trampa, o línea (captura incidental).

El término '**Utilización No Premeditada**' se refiere a la matanza de un mamífero acuático cuando (a) encontrado vivo en la playa, (b) capturado vivo en equipos de pesca o (c) atrapado por fenómenos naturales (por ejemplo, hielo marino en altas latitudes, cambios del nível del aágua en ríos y canales).

El término '**Utilización Intencional**' se refiere a la matanza de mamíferos acuáticos en vida libre que se encuentran de manera oportunista (por ejemplo durante el curso de otras actividades), o cuando éstos son el principal objetivo y propósito de una expedición (dirigida).

4. NATIONAL PERSPECTIVES ON THE WILDMEAT ISSUE IN SOUTH AMERICA

4.1 Argentina

Crespo provided information on past and present small cetacean use as wildmeat in Argentina (SC/M18/SAW03). In the artisanal gillnet fisheries of Buenos Aires Province, franciscanas (*Pontoporia blainvillei*) were often found dead in nets when fishermen retrieved their catch. In the 1940s, by-caught franciscanas were used for meat and oil in Buenos Aires. Meat that had been sun dried and salted and known as 'mushame' was consumed by local communities. The blubber and oil were used for maintenance of wooden masts in small vessels used in shark gillnet fisheries, for waterproofing fishermen's jackets, for home-remedy medical treatments and for treatment of saddle leather. All of these uses have now disappeared, but the by-catch in gillnets still occurs. Carcasses are normally discarded but some fishermen have reported that franciscana dolphin and Burmeister's porpoise (*Phocoena spinipinnis*) meat is sometimes still used for feeding their dogs, but not for human consumption. Franciscanas are currently protected by National Laws, but law enforcement is poor in addressing bycatch issues.

At the southern tip of South America, from the 1970s and until the late 1990s, various species of small cetaceans, mainly Commerson's dolphins (*Cephalorhynchus commersonii*) and Peale's dolphins (*Lagenorhynchus australis*), were harpooned and used as bait in the fisheries for Southern King Crab (Centolla; *Lithodes santolla*) and False King Crab (Centollón; *Paralomis granulosa*). These fisheries operated in both Argentina and Chile but the fishing effort was primarily on the Chilean side of the region. The scale of this killing was great enough to cause reduced abundance of dolphins by the late 1980s. However, according to Lescrauwaet and Gibbons (1994), there was some evidence that the scale of this exploitation had declined, due in part to the fact that legal bait was more readily available and in part to measures taken by Chilean government agencies. Commerson's dolphins were generally not found in Chile but were relatively abundant in the eastern part of the Strait. In Argentina, the crab fishery operated in the Beagle Channel, where there are relatively few Commerson's dolphins. Small numbers of Commerson's dolphins were live-captured in Argentina and Chile and exported to Japan, Germany and the US during the late 1970s and 1980s.

Among the species affected by the Patagonian trawling fleet are the dusky dolphin (*Lagenorhynchus obscurus)*, the common dolphin (*Delphinus delphis*) and the Commerson's dolphin. The most damaging trawl gear for small cetaceans is the mid-water trawling net, especially for dolphins that feed on anchovy (*Engraulis anchoita*). In southern Santa Cruz and Tierra del Fuego, incidental mortality has been recorded in coastal gillnets and trammel nets. The species involved include Peale´s and Commerson's dolphins, Burmeister's porpoise and spectacled porpoise (*Phocoena dioptrica*). In the past, high levels of incidental mortality recorded in Patagonia have seriously impacted the population of dusky dolphins. The dynamics of the trawling fishery, in rapidly redirecting the fishing effort towards different target species, suggests a high variability and uncertainty in the mortality rates and the small cetacean species affected. Research results do not suggest significant effects on the predators involved. Nevertheless, any fishing gear used to pursue anchovies is harmful for pelagic dolphins. None of these small cetacean species are used for human consumption, bait or any other use.

More than 15 national and provincial laws protect marine mammals in Argentina. Nevertheless, law enforcement is ineffective in addressing the by-catch or any other conservation problem. There are provincial stranding networks only, with different levels of effectiveness. Stranding networks operate under provincial authority, usually the Fauna and Flora Departments. They comprise local people with an interest in marine mammal research and conservation working in universities, NGOs, etc. They coordinate work on individual and mass strandings.

4.2 Bolivia

Aliaga-Rossel presented information on the river dolphin and its use as wildmeat in Bolivia (SC/M18/SAW07). The Bolivian river dolphin or bufeo (*Inia geoffrensis boliviensis*) is the only cetacean in landlocked Bolivia. It is distributed mainly in the rivers of the Department of Beni and Santa Cruz and listed as vulnerable in the 'Red Book of Vertebrates of Bolivia'. Several cases of net entanglement have been detected, mainly consisting of calves or juveniles. There is a traditional use of the fat and other parts of the Bolivian river dolphin, but it is thought that this is does not present a direct or severe threat to the populations. The biggest threat the dolphins face is directed take for use as fish bait. This practice was first noted in 2008 and reported in Aliaga-Rossel *et al*., (2012) and highlighted in the 2012 River Dolphin Action Plan as a significant threat.

4.3 Brazil

Siciliano presented information on the use of small cetaceans in the coastal areas of Brazil (SC/M18/SAW06; SAW13). Cetaceans have been used for multiple purposes since at least the 1980s (Borobia *et al*., 1991; Siciliano, 1994). Dolphin harpooning was reported in some coastal villages of Pará and Ceará for the purpose of obtaining bait for the local shark fishery. Guiana dolphin (*Sotalia guianensis*) was the target species. This activity stopped in the mid-90s in these two states due to effective law enforcement but it is reported to have occurred at least for the last ten years in the central coast of Bahia. Species captured are *S. guianensis* but also can include rough-toothed dolphins (*Steno bredanensis*) and bottlenose dolphins (*Tursiops truncatus*).

Dolphin consumption has been reported to occur in Maranhão and eastern Pará states, Eastern Amazon coast. In this case, Guiana dolphins by-caught in gill nets are used for human consumption, as bait in the shark fishery, and for magical or religious purposes, including love or luck charms, traditional medicines and handicrafts. It is important to mention that food taboos associated with the dolphin (boto) legend in Marajó Bay area and surroundings, in Pará, are helping to protect Inia species (both *I. geoffrensis* and *I. araguaiaensis*). Live-stranded Fraser's dolphins (*L. hosei*) have been used for human consumption in Maranhão.

In Rio de Janeiro, the use of dolphins as bait for the shark fishery has not occurred in over a decade or is very rare. By-caught Guiana dolphins off the coasts of Amapá, Pará and Maranhão are the main source of bait for the shark fishery and also as raw material for the production of love luck-charms, handicrafts and for medicinal uses. Since November 2005, 700 by-caught dolphin carcasses have been recovered and curated by the Aquatic Mammal Study Group of Museu Paraense Emílio Goeldi. These have been obtained from the beaches of Marajó Island and Northeast Pará and of which 95% are *S. guianensis* and 3% are *I. geoffrensis* and *I. g. araguaiaensis*.

The production of love charms is commonplace throughout Brazil. An investigation of products in Pará and Maranhão were confirmed to contain parts from Guiana dolphins. By contrast, products on sale in Rio de Janeiro do not contain dolphin products, as evidenced by genetic analyses which proved that the samples were derived from various breeds of pig. Various love potions were acquired in Santos and provided by Siciliano to the Workshop. The flesh within each sample was tested using the whale detection forensic kit developed in Asia (Chan *et al.,* 2015). Of the four potions tested, none were identified as cetacean (Annex D).

Recently, there were reports on the use of the blubber of stranded dolphins and whales in the central coast of Bahia. It is understood that fishermen bury cetacean flesh so that it can be used months later, as bait, in the shark fishery. Two threatened zoological groups, both cetaceans and sharks, are implicated.

On the eastern Amazon coast, myths surrounding the boto induce fear in local populations and it is taboo to eat small cetaceans in Marajó area, Pará. The high regard and reverence with which these species are associated, in Marajó Bay and its surroundings, assist efforts to protect botos from human harm.

4.4 Chile

Sepulveda presented an overview of small cetacean use in Chile. Since 1974, small cetaceans, fur seals, sea lions, sea birds and sea otters, were deliberately taken for bait in the Chilean artisanal fishery for southern king crab and false king crab in southern Chile (Magellan Region). The main species of small cetaceans affected by this activity were Peale's, Chilean and Commerson's dolphins. However, by the beginning of the 1990s the dynamic of this fishery changed, thus lessening the pressure on dolphins (Lescrauwaet and Gibbons, 1994; Hucke-Gaete, 2000; Alfaro-Shigueto *et al*., 2008; Goodall, 2009).

There are still some present-day anecdotal reports of individual small cetaceans being killed by harpoons or incidental bycatch and then used as a bait and also, as food by local people. The main species that could be affected by this activity include Chilean dolphins and Burmeister's porpoise.

As in many countries of South America, there are several threats to small cetaceans, including bycatch, habitat alteration, pollution and economic activities that are directly and indirectly affecting marine mammals in general. A particular and critical concern is the development of salmon and shellfish aquaculture that occupies most of the continental coast of southern Chile and overlaps with the distribution of coastal small cetaceans.

4.5 Colombia

Trujillo and Avila presented information on the take of small cetaceans, focusing on coastal species, in Colombia (SC/M18/SAW05; Avila *et al.,* 2008). Colombia has 25 small cetacean species both in marine and fresh waters. At least 11 of these have been reported killed or harvested either accidentally, opportunistically or through direct take (42 cases). The most affected species are the Amazon river dolphin (*I. geoffrensis*) and the bottlenose dolphin (*T. truncatus*). Avila reported that bottlenose dolphins (*T. truncatus*) and the pan tropical spotted dolphin (*S. attenuata*) are hunted for bait by local fishermen in Bahía Solano (Choco, Colombia) for long-line fisheries. Other bait species include the Pacific bearded brotula, groupers and smooth-hound. Fishermen stated that at least 1.1 dolphin/month (a maximum estimation of 3 dolphins/month) were hunted during 2005-2006 (Avila *et al*., 2018). Authors could not estimate how dolphin hunting might affect long-term population viability, since population parameters for dolphins in this region were unknown. The preference for hunting mother-calf pairs could potentially influence the reproductive success of dolphins and alter their social structures (Avila *et al*., 2018). There are indications that this practice of hunting dolphins for bait could still be occurring in the area when fish bait is scarce (pers. comm. to Isabel Avila and Diego Amorocho).

There are no reports of systematic killing of river dolphins for the piracatinga (*Calophysus macropterus*) fishery in Colombia.

Small cetaceans that inhabit Colombian waters face several threats: incidental and direct catch, boat traffic related threats, pollution (e.g. noise from vessels, seismic exploration and chemical pollution), infections and diseases, retaliation by fishermen that consider dolphins as competition, climate change, depleted food sources, indiscriminate deforestation (which affects sedimentation and turbidity), unregulated tourism growth and the potential construction of mega-projects e.g. commercial ports, oil platforms and hydropower plants.

4.6 Costa Rica

Rodriguez-Fonseca presented new information on small cetacean use as bait in Costa Rica (SC/M18/SAW09). There has been no tradition of hunting for small cetaceans in Costa Rica for any purpose. In the last two decades, however, there has been an emergence of hunting activities focused on coastal dolphins which are used as bait for shark fisheries. It is noted that the Asian demand for shark fins for soup has dramatically increased shark fisheries in the area. This practice has been identified from both Costa Rican coasts. Three areas on the Pacific coast involve two species: the Pantropical spotted dolphin (*S. attenuata*) and the bottlenose dolphin (*T. truncatus*), and two areas on the Caribbean coast involve two species: the Atlantic spotted dolphin (*S. frontalis*) and the bottlenose dolphin (*T. truncatus*). All the available information has been obtained opportunistically, but it indicates some of the species that could potentially be at risk and provides areas in which to focus preliminary evaluations of the magnitude of the issue.

4.7 Ecuador

Castro presented information from Ecuador and provided a summary of the country overview submitted by Félix (SC/M18/SAW02; SAW08). Ecuador's coastline lies between Colombia and Peru and includes the mainland and the Galapagos Islands as well as the rivers of the Amazon. Early reports document the use and trade of dolphins for bait in the early 1990s (Félix and Samaniego, 1994) by fishers in Puerto López in central Ecuador and Puerto Bolívar in southern Ecuador with a price up to US $75 for a carcass depending on its size. Interviews with fishers in 2014 confirmed the practice continues in Puerto Bolívar.

While there are no official statistics, bycatch is the major threat for small cetaceans in Ecuador with several reports and scientific papers addressing its occurrence in artisanal fisheries and gillnets used for large pelagic fish such as tuna, marlins, sharks; nylon monofilament gillnets used for shrimps and large coastal fish; and long lines. No information on bycatch in commercial fisheries is recorded but interviews with fishers in 2014 confirmed that small cetaceans are also caught in purse seine nets targeting small pelagic fish (unpublished data).

The Ministry of Environment, through regional branches and MPA offices, is developing a megafauna stranding database, as well as a draft protocol for megafauna stranding which includes cetaceans, elasmobranchs and sea turtles. A workshop comprising groups interested in this initiative was held in December 2017. This initiative will hopefully provide better connectivity between the strandings databases held by individual institutions (e.g. Chiluiza *et al*., 1997; Félix *et al*., 2011). The Ministry of the Environment is the authority responsible for the conservation of marine biodiversity and the Ministry of Aquaculture and Fisheries oversees all fishing activities. Unfortunately, there is poor coordination between these authorities, mainly due to the resistance of the fishing sector to acknowledge that fishing is use of marine biodiversity.

4.8 Peru

Campbell presented information on coastal cetaceans from Peru (SC/M18/SAW01). Despite the implementation in 1996 of a law banning the capture and trade of small cetaceans, the Peruvian small-scale driftnet fishery still has one of the highest reported rates of small cetacean bycatch in the world, due in part to its vast fishing capacity, with an estimated 15,000-20,000 animals killed per year (Read *et al*., 1988; Van Waerebeek and Reyes, 1990; Alfaro-Shigueto *et al*., 2010; Mangel *et al*., 2010). This number is mostly composed of four species: common dolphins (*Delphinus* spp.), dusky dolphins (*L. obscurus*), common bottlenose dolphins (*T. truncatus*) and Burmeister's porpoises (*P. spinipinnis*). Cetaceans are either bycaught or harpooned to be used as bait for shark fisheries or other wildmeat uses. Bycaught Burmeister's are often favoured as food, either on-board or brought to shore. Dusky dolphins are preferred as bait (Van Waerebeek, Reyes and Luscombe, 1988; Van Waerebeek and Reyes, 1994; Alfaro-Shigueto *et al*., 2010; Tzika *et al*., 2010; Mangel *et al*., 2013). Both species are data deficient, with limited distributions and are understood to comprise distinct populations within Peru (Cassens *et al*., 2003).

River dolphins (*I. geoffrensis*) are also threatened since they are used as bait in the piracatinga (*C. macropterus*) fishery in the Loreto region. This is of special concern as the practice is growing in Loreto and spreading to the southern Peruvian Amazon in the Ucayali region.

4.9 Uruguay

In Uruguay, the use of small cetaceans as wildmeat has been poorly reported and its extent is unknown. Therefore, Passadore conducted an online anonymous survey prior to the Workshop that was used to rapidly assess this issue (SC/M18/SAW04). The survey showed that the small cetaceans bycaught in the artisanal fishery were occasionally used as wildmeat. The most frequently bycaught species, the franciscana (*P. blainvillei*), is used by fishermen, primarily as food or as oil to cure wooden boat hulls. Other bycaught species may also be used as wildmeat, such as the Burmeister's porpoise (*P. spinipinnis*). Limited knowledge of distribution patterns, habitat use and population size of most of the small cetaceans inhabiting Uruguayan waters hampers the proper assessment of the impacts of threats such as wildmeat use and bycatch.

4.10 Venezuela

Briceño presented updated information on previously reported takes of small cetaceans for bait and an emerging threat in Venezuela (SC/M18/SAW11). In Venezuela 25 cetacean species are recognised, 22 of these are Delphinidae. The law 'Ley de Protección a la Fauna Silvestre', issued in 1970, governs the protection and rational use of wild fauna and its products and hunting. The hunting of any cetaceans is prohibited. The use as bait in shark fisheries of eight small cetacean species has been reported throughout the country. Two of them, the Guiana dolphin (*S. guianensis*) and the boto (*I. geoffrensis*) have also been used for food and some cultural purposes (Bolaños, 1995; Ramírez, 2005; Sánchez *et al.,* 2008; Diniz,2012; Briceño *et al*., 2016).

A situation which is causing concern is the directed take of the Guiana dolphin from Lake Maracaibo. In the northern area of the lake, direct captures are estimated to be four individuals per week for use as bait in shark fisheries. In the southern region of the lake, the take is also estimated at four individuals per week, but here the flesh is used for food, both by the fishermen themselves and for sale in the market

In the Orinoco River the Guiana dolphin and the boto are deliberately captured for use as bait for the *C. macropterus* fishery (commonly named 'zamurito' in Venezuela). The number of boto taken between 1990 and 2008 is estimated to be 840 animals but no estimate exists for the Guiana dolphin. Additionally, there are a few reports of boto being used as food, as well as its oil being utilised for other purposes. It is unknown if boto and Guiana dolphin are still used as bait in the Zumurito fishery in Venezuela, as in the past all production was sold to Colombia which now prohibits the import and sale of this fish.

Other threats identified for small cetaceans are bycatch and pollution from oil spills, particularly in Lake Maracaibo. The proposed Orinoco Mining Arch mega project is predicted to involve large discharges of mercury and other pollutants into the Orinoco River and its tributaries, threatening populations of both boto and Guiana dolphin.

4.11 The Guianas: French Guiana, Guyana and Suriname

Little information is known from these countries. Rhone-Dos Reis submitted a written update that focused primarily on information from French Guiana. In French Guiana, the Guiana dolphin (*S. guianensisis*) has been hunted by indigenous people for food and, on the east coast, fishermen from Brazil utilise various dolphin parts as talisman, tinctures and tonics. In addition to hunting, both stranded and bycaught dolphins are used. Robards and Reeves (2011) note that dolphins have been deliberately targeted for food in Suriname. No information was available from Guyana, however, given its location between Suriname and French Guiana, it is likely that small cetaceans are used as wildmeat both locally and by fishermen from elsewhere working in Guyana national waters.

4.12 National perspective summary

There is no country in South America that has not, at some time, utilised small cetaceans as wildmeat. From the information provided at this Workshop, areas where the current take of both riverine and coastal cetacean species is believed to be a cause for concern, according to the expert opinion of the Workshop attendees, are; Costa Rica, Colombia, Venezuela, Brazil, Bolivia, Peru and Ecuador (Fig. 1).

5. THE DEVELOPMENT OF DATABASES TO PROVIDE BROAD SCALE INFORMATION

5.1 Overview

Ingram presented perspectives from current research on the use of terrestrial animals as wildmeat. Although this utilisation has been well researched and has been identified as one of the main pressures on terrestrial wildlife, currently there is no broad-scale information on the similar exploitation of cetaceans. Studies that have investigated the take of cetaceans for aquatic wildmeat are often at a local scale, are sporadically collected and the methods used differ widely. A regional picture is urgently needed to inform conservation policy and action. Analyses of databases on other threats to wildlife have been successfully used to understand regional patterns and trends and to identify data gaps. Lessons learnt during the development of these

Fig. 1. Areas of South America where the use of small cetaceans as aquatic wildmeat is a cause for concern.

databases highlight that methods must be standardised and informed by best practice guidelines to ensure that datasets are comparable. To specifically address data gaps and to assess the current state of published knowledge with regards to risk to small cetaceans both from deliberate take, for bait, research and the aquarium trade, and subsistence take for food and other non-food uses, Avila extracted the relevant details from the extensive database she and co-authors have developed (Avila *et al.,* 2018[2]). In this way, the risk to **marine** small cetaceans can be visualised. Risk areas were obtained based on documented threats for marine mammals which occurred between 1991 and 2016. Threat is an action or event that causes to the species harmful effects, while risk is the possibility for a species of experiencing harmful effects (Avila *et al*., 2018). For the purposes of IWC, small cetaceans are defined as those cetacean species (whales, dolphins and porpoises) not considered to be one of the 'great whales' (bowhead whales, right whales, gray whales, blue whales, fin whales, sei whales, Bryde's whale, minke whales, humpback whales and sperm whales). The cetaceans used for this visualisation comprise those small cetaceans res5.2 tricted to coastal and marine habitats.

5.2 Reporting effort

Avila identified the geographic distribution of published information on threats attributable to small cetaceans, which was extracted from the threat database of Avila *et al*., (2018). The number of publications listing threats to small cetaceans were linked to a specific location occurring within a given country, ocean basin and Longhurst biogeographical province. There is a higher reporting effort from Brazil, Peru, Chile and Argentina but less so from other South American countries (Fig. 2).

5.3 Risk maps for small cetaceans based on all documented threats

Threats for 121 marine mammals were localised by assigning incidents to countries where they were reported (Avila *et al*., 2018). This was further refined allocating incidents to ocean basins and Longhurst biogeographical provinces and by intersection with the mapped species' distributions of AquaMaps (Kaschner *et al*., 2016). Marine mammal species classification in AquaMaps follows the Taxonomy of Catalogue of Life (*http://www.catalogueoflife.org/col/*) and for the threats collection, Avila *et al.,* (2018) used the classification published by the SMM Committee on Taxonomy (2016). As a result of these taxonomic discrepancies, Avila *et al.,* (2018) obtained risk maps for 114 different species (see Avila *et al*., 2018 for methods). The risk maps were produced based on binary (presence/absence) range maps using the core habitat, defined as species present in any cell with a species-specific predicted probability threshold of ≥0.60. Risk severity was quantified with respect to (1) number of species affected per cell, or (2) proportion of affected species compared to the total number of species present per cell. High risk areas or hotspots were where more than 75% of species were affected (Avila *et al*., 2018).

For small cetaceans, when all threats were combined, Avila identified high-risk areas (where >15 species were exposed to threats), located along both the Pacific and the Atlantic coasts of the US as well as around Japan and southwest Australia (Fig. 3A). In terms of the locally occurring marine mammal species community, high-risk areas (where >75% of all small cetaceans were exposed to threats), hotspots were noted in the coastal waters of North America, South America, parts of Europe/north Africa, East Asia, and northern Australia (Fig. 3B).

By focusing on South American coastal waters and adjacent jurisdictions (Fig. 4), hotspots in terms of the number of species occur within the waters of Brazil (Fig. 5A), however, in terms of the proportion of species affected by threats, hotspots occur throughout all of South American (Fig. 5B).

5.4 Risk maps for small cetaceans based on documented threats from direct harvesting

Direct harvesting is defined by Avila *et al.,* (2018) as threats emanating from direct hunting, killing and harvesting, including live capture for the aquarium trade. Five attributes, which detail the threat, have been identified (Avila *et al.,* 2018):

(1) Commercial: kill for commercial purposes, use as bait and illegal kill.

[2] Also available at *http://www.biom.uni-freiburg.de/MarineMammalThreat Database*.

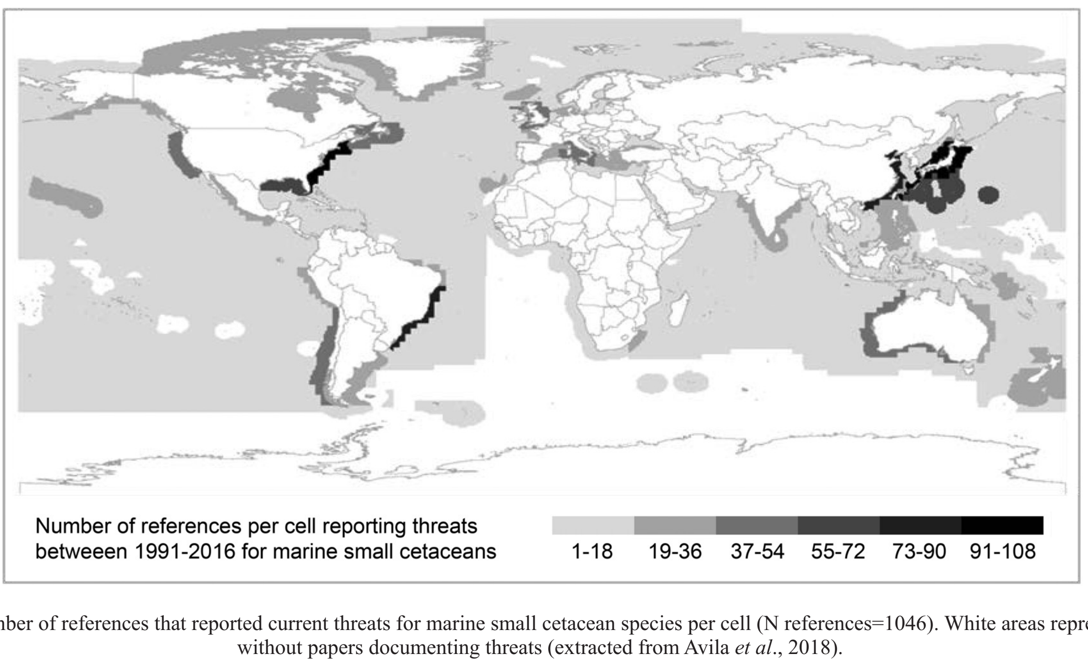


Fig. 2. Number of references that reported current threats for marine small cetacean species per cell (N references=1046). White areas represent areas without papers documenting threats (extracted from Avila *et al*., 2018).

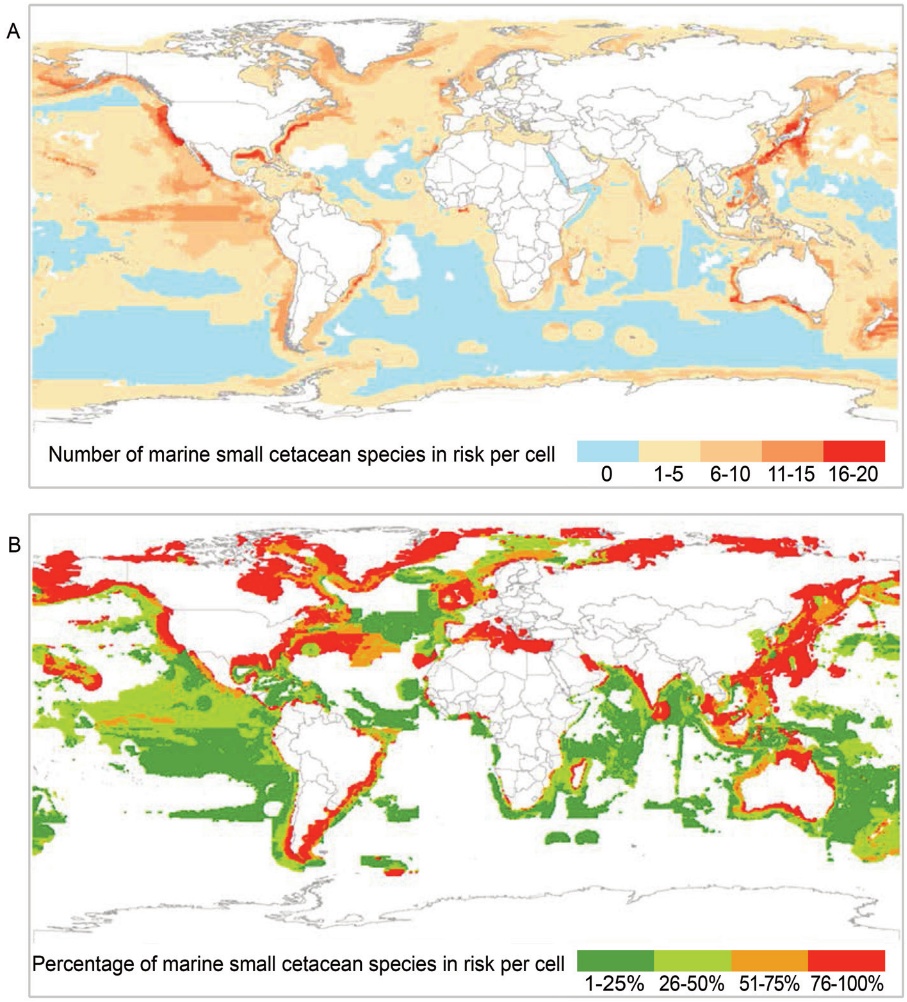


Fig. 3. Risk maps based on documented threats for all threat types and all marine small cetacean species combined. A: cumulative risk map showing the number of species affected by any threat category. Blue areas represent the core habitats for small cetacean marine mammals without any documented threat; and B: cumulative risk map showing the proportion of species of the total of species predicted to be present per cell with at least one documented threat (extracted from Avila *et al*., 2018).

(2) Subsistence: kill for subsistence purpose, also aboriginal hunt.
(3) Control: kill for control or self-defense.
(4) Live captured: harvest alive and remove from freedom e.g. for aquariums and zoos.
(5) Research: kill for research or with special permit, or for museums.

Between 1991-2016, direct harvesting represented the third main threat for marine mammals worldwide, affecting 74% of marine mammal species. For small cetaceans (non-riverine) 53 species were affected (Avila *et al*., 2018). Areas of risk from direct harvesting (all threat attributes above included) for small cetaceans are concentrated in the polar regions of the Northern hemisphere and some areas of the Mediterranean Sea, Asia and coastal South America (Figs 6A and 6B).[3]

Risk areas differ in relation to the direct harvesting attributes. In South American waters, hotspots of commercial harvesting are apparent in southern Chile and in some places in northern Brazil (Fig. 7A), and a hotspot for subsistence harvesting occurs in Maracaibo Lake, Venezuela (Fig. 7B). Although control harvesting is documented in Chile, Colombia and Venezuela, it is not sufficiently high to indicate a risk hotspot (Fig. 7C). For the live capture industry, risk areas are apparent on the Atlantic coast of Colombia and in Guyana waters (Fig. 7D). No cases of takes for research were documented for South American waters between 1991-2016.

[3] For methods see Avila *et al.* (2018).

5.5 Towards developing a regional framework for assessing the South American wildmeat issue

To better develop a regional picture of the issue of wildmeat in South America, the Workshop developed a series of questions and discussed appropriate data collection methods and analyses (Annex E). This provided a data collection framework that can be referred to prior to any investigation so that scope, magnitude and impact of any wildmeat issue can be gathered systematically, thus providing standardised data that can be ultimately fed into a broad-scale analysis (Annex F).

5.5.1 Regional overview of current knowledge

These questions and framework were then used to develop a database which provided an overarching view of the current state of knowledge for both marine and riverine small cetacean species from regions throughout South America (Annex F). For all countries reviewed, except from Uruguay and French Guiana, there is ongoing use of small cetaceans as wildmeat. In Bolivia, Brazil and Peru, small cetaceans are acquired as salvage, through deliberate killing of stranded or bycaught animals and through targeted catch. In Venezuela, small cetaceans are not acquired from live bycatch, however,

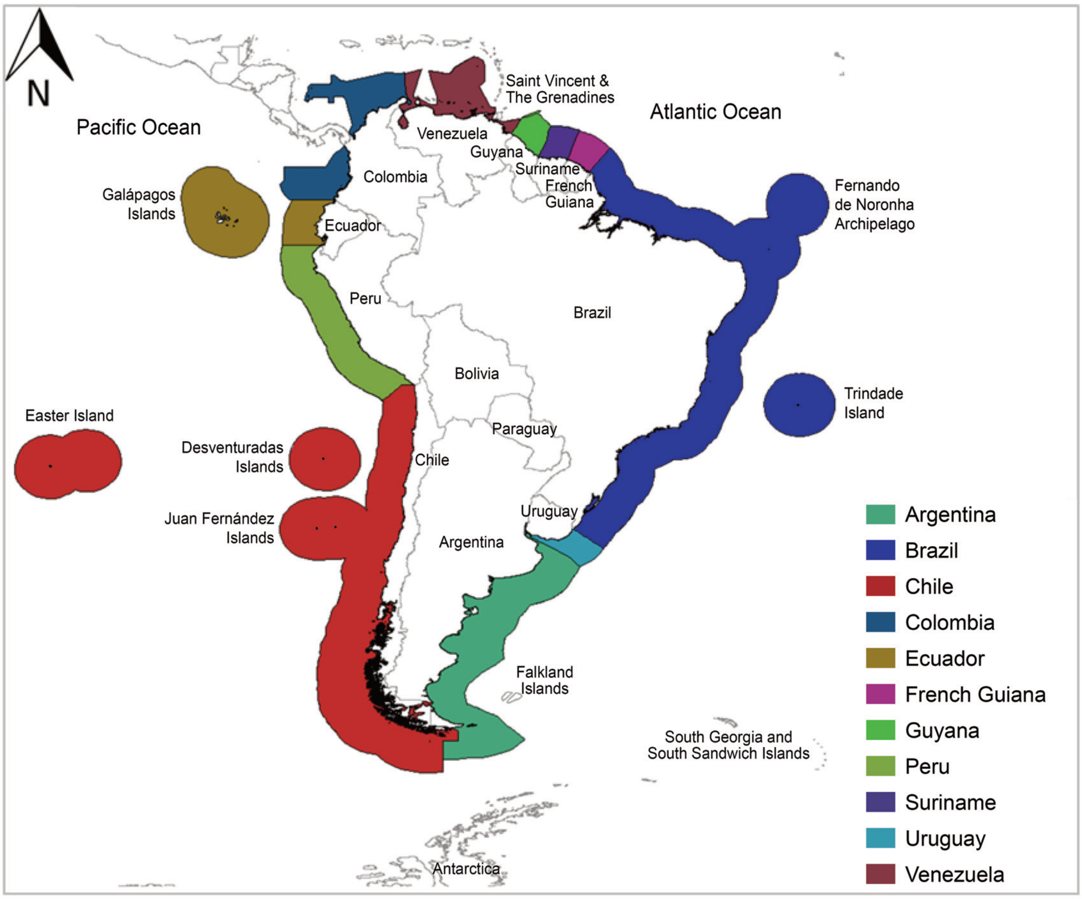


Fig. 4. South American waters including Exclusive Economic Zone (EEZ) and disputed waters.

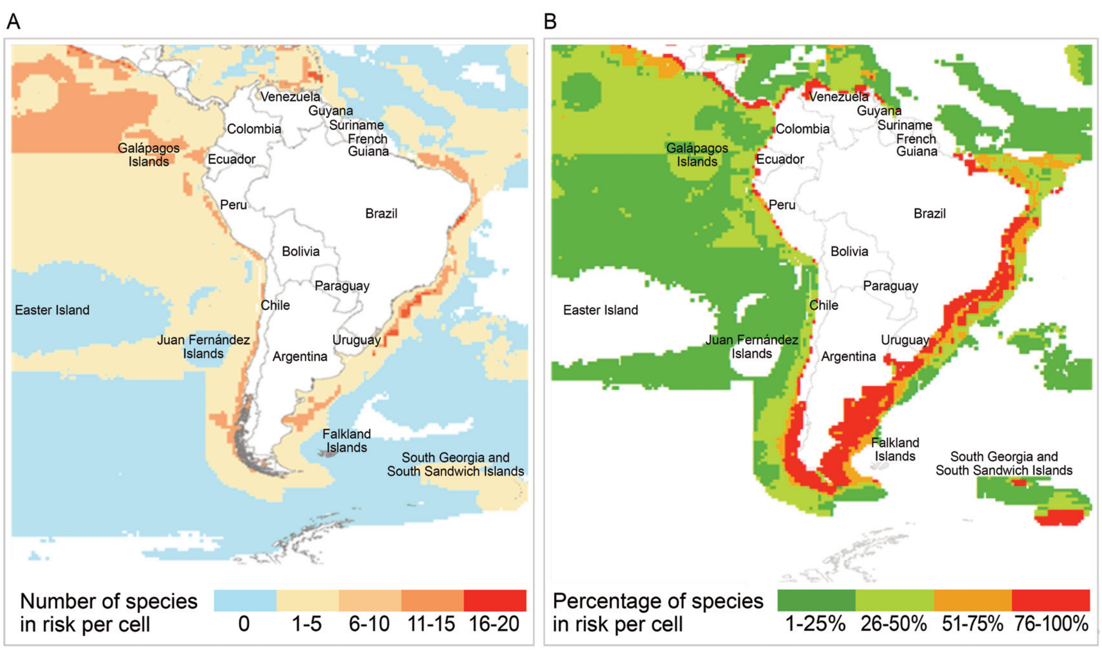


Fig. 5. Risk maps based on all documented threats to all small cetaceans. A: cumulative risk map of the number of species affected by any threat and B: cumulative risk map of the proportion of species predicted to be present per cell with ≥1 threat (extracted from Avila *et al*., 2018).

are obtained by all other means, including from organised and directed catch. In Costa Rica, small cetaceans are acquired from bycatch (salvage and live) and from directed catch. Argentina, Chile and Colombia acquire small cetaceans from salvage of bycatch and from directed catches. Ecuador acquires small cetaceans from the salvage of bycatch (salvage and live). In Colombia, French Guiana and Uruguay, there are some records of use of small cetaceans as wildmeat, however, it is unknown if this practice was in the past or is currently ongoing. For Bolivia, Costa Rica, Ecuador and Venezuela, there are no reports of the previous use of small cetaceans as wildmeat, however, it is an ongoing issue with records of small cetaceans being used for various reasons, particularly as bait (Fig. 8). Targeted acquisition of

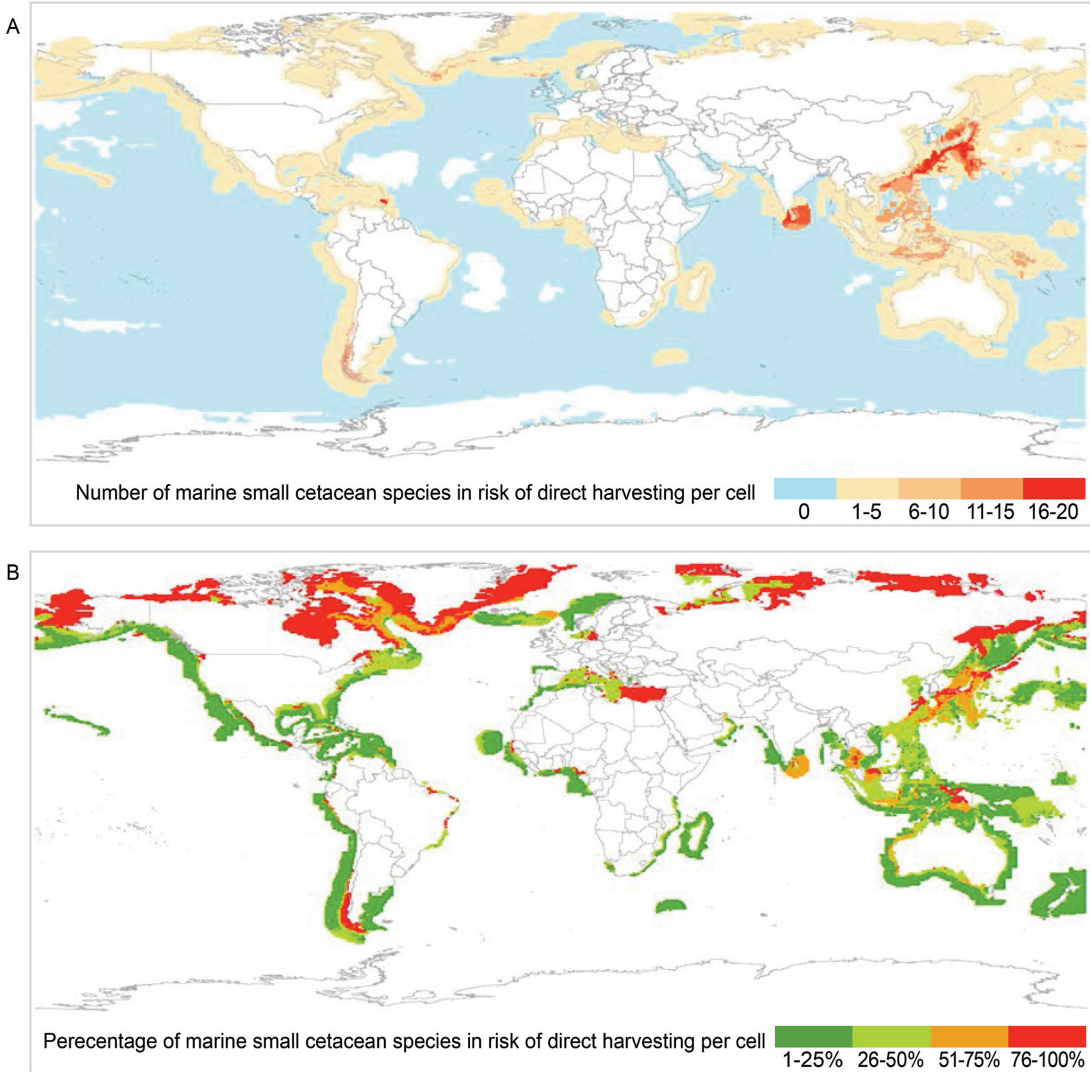


Fig. 6. Risk maps based on documented threat from direct harvesting for small cetacean. Cumulative risk maps for A: the number of species affected by direct harvesting and B: the proportion of species affected per cell by direct harvesting (extracted from Avila *et al*., 2018).

small cetaceans has been documented previously for Argentina, Brazil Chile and Colombia. Targeted acquisition is ongoing in all these countries and is also recorded in Bolivia, Costa Rica, Peru and Venezuela. Targeted acquisition in some parts of Colombia and French Guiana is known, however, it is not known if this is ongoing. In all countries which document targeted acquisition, small cetaceans are also obtained from salvage or the deliberate killing of stranded or bycaught animals. Only Ecuador and Uruguay do not report targeted acquisition (Fig. 9). Although this knowledge review is not exhaustive, there is a pattern of increasing use of small cetaceans in most South American countries and countries which did not document small cetacean use in the past, are now doing so. In all areas, little was known of the magnitude of use nor what impacts this might have on the small cetacean population being affected.

5.6 Recommendations

Throughout the data identification process, certain areas and issues were highlighted that give cause for concern. After review, there is evidence from all countries, other than Uruguay, that small cetaceans are regularly being used as wildmeat, acquired by both targeted and non-targeted means. The recommendations developed from the Workshop discussions are based on available knowledge and the expert opinion of the Workshop participants.

It was **highlighted** that all countries should strictly enforce existing legislation pertaining to wildlife trade and openly report all seizures and prosecutions.

Following presentations of current information, expert knowledge and opinion, and the understanding that the magnitude of small cetacean take as aquatic wildmeat is a cause of concern, the Workshop **strongly encourages** all parties to make a concerted effort to standardise data collection to better understand the issues surrounding aquatic wildmeat, and to actively encourage a collaborative and coordinated approach to understand regional patterns and trends. A framework for such an approach is provided in Annex F.

This Workshop **recommends** that abundance and distribution surveys, in tandem with investigation into the magnitude of aquatic wildmeat use, be conducted on the following species and areas, and that data should be used to estimate the impact of deliberate takes for wildmeat on these populations:

- Chilean dolphin (*Cephalorhynchus eutropia*) in Chile;
- Burmeister's porpoise (*Phocoena spinipinnis*) in both Chile and Peru;

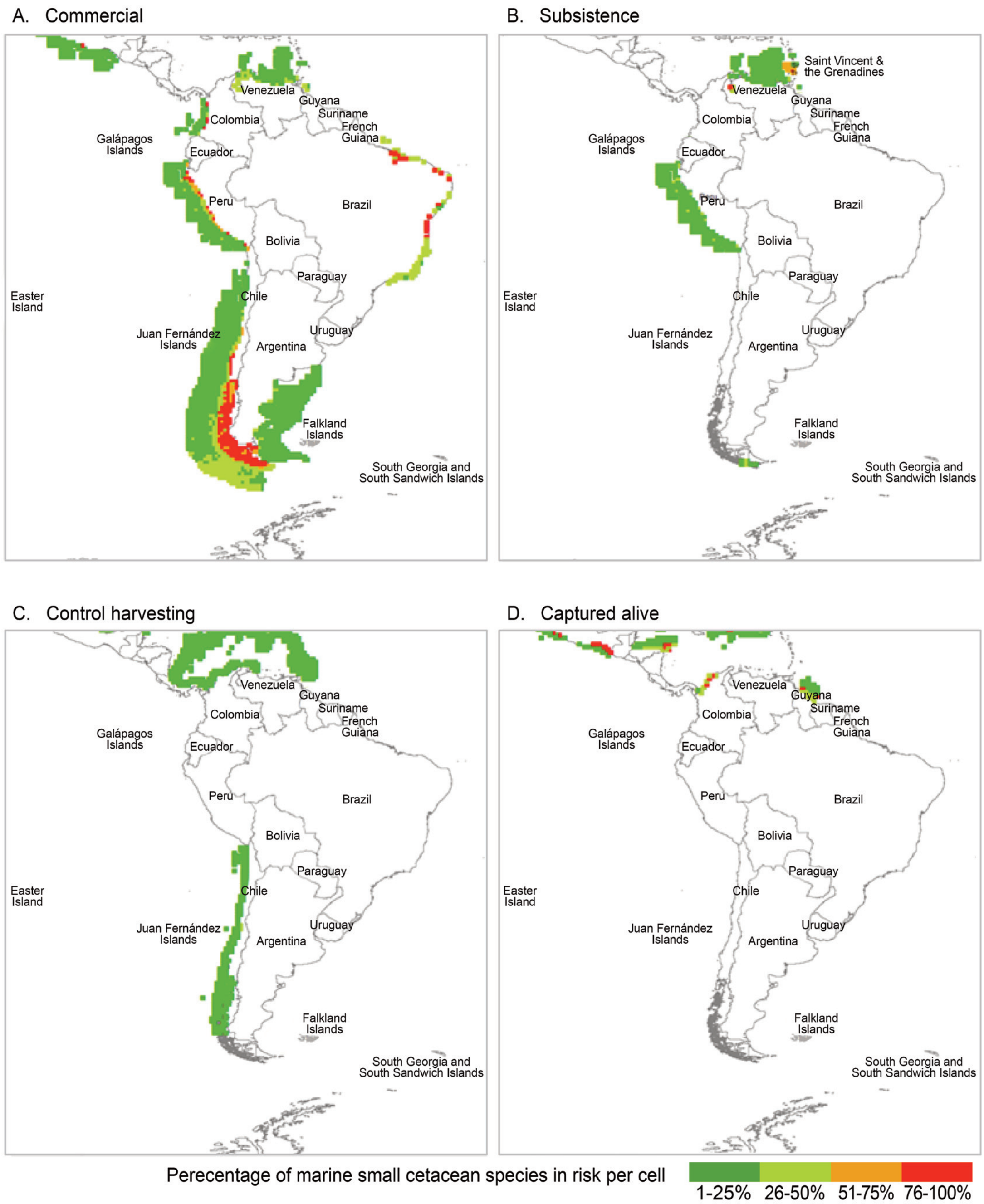


Fig. 7. Risk maps based on documented direct harvesting attributes. Cumulative risk map of A: commercial harvesting; B: subsistence harvesting; C: control harvesting; and D: live captures (extracted from Avila *et al.,* 2018).

- Burmeister's porpoise (*Phocoena spinipinnis*) in Peru, noting that current evidence suggests that the Peruvian population is distinct;
- dusky dolphin (*Lagenorhynchus obscurus*) in Peru, noting that evidence shows that landings of this species has decreased and populations may have been heavily impacted;
- Guiana dolphin (*Sotalia guianensis*) and other small cetaceans in Amapá, Pará, Maranhão, Piauí, Ceará, Espírito Santo, São Paulo and Paraná, in Brazil, as there is a documented use of bycatch for wildmeat purposes;
- bottlenose dolphins (*Tursiops truncatus*) and pantropical spotted dolphins (*Stenella attenuata*) in Bahia Solano, Colombia, noting that deliberate take for a long line fishery is ongoing;
- Tucuxi (*Sotalia fluviatilis*) throughout its range, in Brazil, Colombia, Ecuador, as it shares most of the same threats as *Inia geoffrensis,* and may also be used as bait in the piracatinga fishery;
- Guiana dolphin (*Sotalia guianensis*) in Lake Maracaibo in Venezuela, noting that deliberate take for food is ongoing.

Further, this Workshop **recommends** that:

- An investigation be made of the magnitude of by-catch of Guiana dolphins (*Sotalia guianensis*) in the gillnet fishery operating off Maranhão, Pará and Amapá, north Brazil, noting that by catch is being used commercially for shark bait, human consumption and cultural use.
- A forensic investigation of the cetacean products for sale in the north and northeastern Brazilian markets be conducted coupled with better enforcement of wildlife trade legislation.

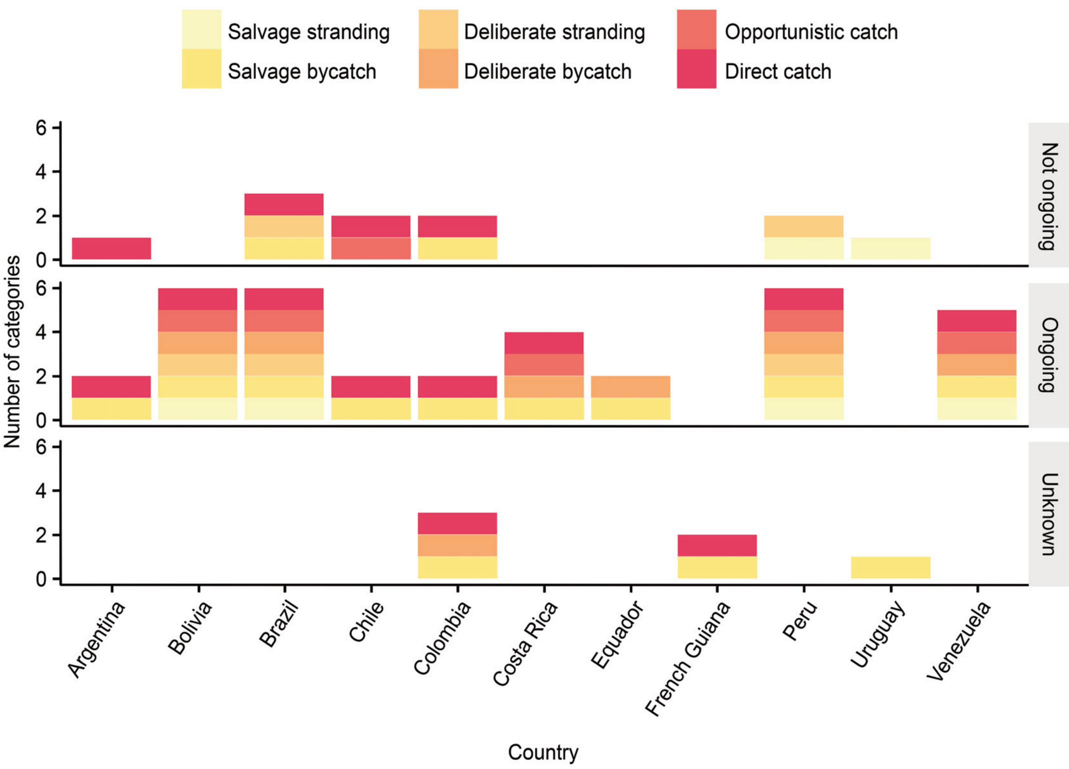


Fig. 8. Presence and number of categories for which small cetaceans were used for aquatic wildmeat per country in South America and Costa Rica as identified by experts. Stacked bars are shaded following a modified version of Robards and Reeves (2011) categories for cetacean acquisition. Panels separate records based on whether cetacean take for aquatic wildmeat occurred in the past (not ongoing), currently occurs (ongoing), or whether there was insufficient information (unknown). No information was available for Suriname and Guyana.

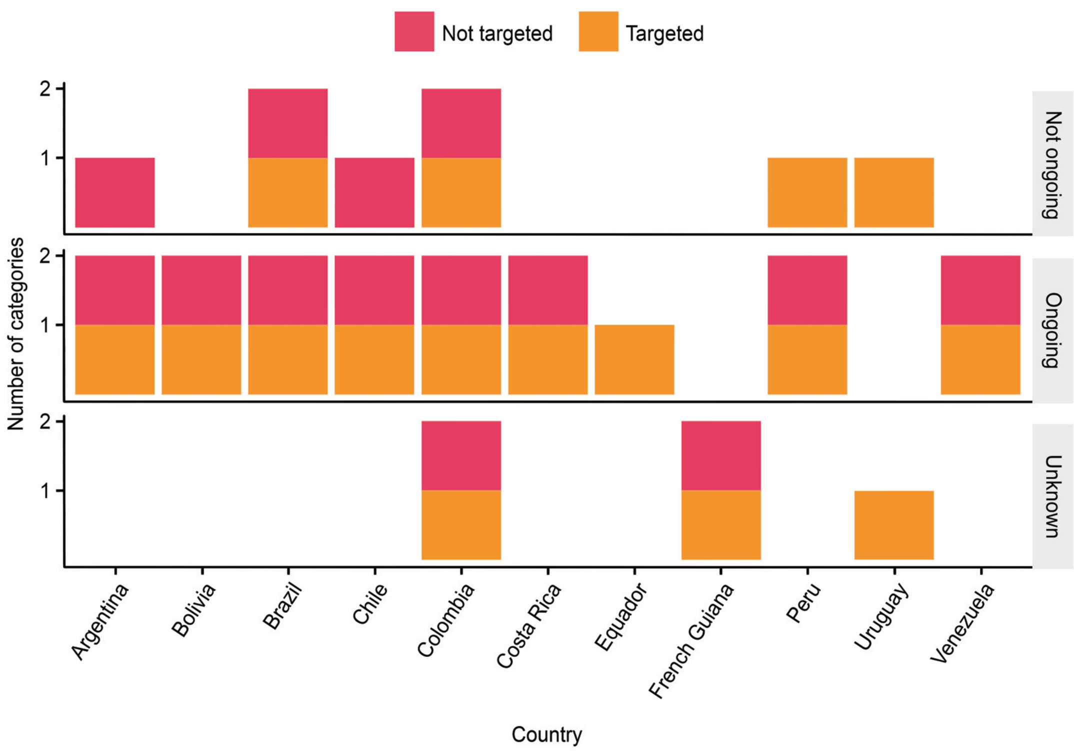


Fig. 9. The number of categories of small cetaceans used for aquatic wildmeat per country in South America and Costa Rica as identified by experts. Stacked bars are shaded based on whether cetacean acquisition was targeted or not. Panels separate records based on whether cetacean take for aquatic wildmeat occurred in the past (not ongoing), currently occurs (ongoing), or whether there was insufficient information (unknown). No information was available for Suriname and Guyana.

- Separate assessments for (a) directed take for bait and (b) for other uses be made in the small-scale fisheries of Peru.
- The use of dolphins for bait in the long-line fishery in Bahia Solano, Choco in the Colombian Pacific, is evaluated using dedicated interview surveys and the use of alternative bait evaluated.
- Heavy metals levels of *Sotalia guianensis* and *Inia geoffrensis* in the Orinoco river basin and Maracaibo Lake

be estimated and the impact on of consumption of dolphin meat on human health be evaluated.

- The governments that are part of the Eastern Pacific Corridor (CMAR), Colombia, Costa Rica, Panama and Ecuador assess the current practice of using marine mammals in Fish Aggregating Devices (FADs) and enforce the existing legislation which prohibits the use of cetaceans as attractors of these gears.
- The Inter American Tropical Tuna Commission RFMO documents and registers the capture and incidence of cetaceans (or pinnipeds) during their fishing operations along the Eastern Pacific through the appropriate onboard observers programme.

6. REVIEW OF INFORMATION ON THE AMAZON RIVER DOLPHIN

Two genera of dolphins occur within the Amazon, Orinoco, Tocantins and Araguia River basins. In this report, the common names 'boto' and 'tucuxi' are used to refer to *Inia* and *Sotalia*, respectively. Both genera were reviewed with information compiled throughout the dolphin's riverine ranges in Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela.

6.1 Taxonomy and population structure

With respect to the taxonomic status of the genus *Inia* and *Sotalia*, the position of the Taxonomy Committee of the Marine Mammal Society (SMM) is that only one species, *Inia geoffrensis* is recognised with two sub-species: *I.g. geoffrensis* for the Amazon basin and *I. g. humboldtiana* for the Orinoco basin. At the regional level, most researchers recognise the existence of *I. boliviensis* as a separate species based on genetic studies that show a clear difference from *I. geoffrensis* (Banguera-Hinestroza *et al*., 2002, Ruiz-García *et al.*, 2008, Gravena *et al.*, 2015). Likewise, the recently described *I. araguaiaensis* is recognised for the Tocantins and Araguaia basins (Hrbek *et al*., 2014; Siciliano *et al*., 2016), although continued genetic evaluation throughout its distribution is recommended. A fundamental point is that the Tocantins basin is geologically and hydrologically separate from the Amazon basin, which reinforces the hypothesis of isolation of *Inia* in the former. For clarity this report will use the taxonomy currently recognised by SMM.

In the case of *Sotalia*, two separate species are recognised at present: *S. guianensis* (marine) and *S. fluviatilis* the freshwater form in the Amazon basin, however, the dolphins that occur in the Orinoco basin probably represent an independent population unit, isolated from coastal populations of this species (Monteiro-Filho *et al*., 2002; Cunha *et al.,* 2005; Caballero *et al.,* 2006; Caballero *et al.,* 2017). Additional population genetic studies with increased sampling and analyses of more variable molecular markers (i.e., microsatellites or Single Nucleotide Polymorphisms, SNPs) are required to further understand population structure of *S. guianensis* in this region.

6.2 Abundance estimations and population trends

Information on abundance of boto and tucuxi has been produced by a number of different research groups in the region over the last two decades. One example is a regional initiative that has surveyed more than 30 rivers in Brazil, Colombia, Peru, Ecuador, Bolivia and Venezuela (28,600km), producing density and abundance values (Martin *et al.,* 2004; Gomez-Salazar *et al*., 2012; Pavanato *et al*., 2016; Williams *et al*., 2016). The primary benefits of this study have been standardisation of methods which has led to the comparability of results along the Amazon and Orinoco basins, training of more than 240 researchers and the creation of a regional network.

While there are abundance estimations for several rivers, there is limited information on population trends. Systematic evaluation of river dolphin's abundance is only possible in the case of small areas of Brazil and Colombia. For the central Amazon (Mamirauá) River Japurá, da Silva *et al.* (2018) estimate a 70.4% decline of botos during the last 22yrs in a 40km^2 area. In the Upper Amazon River, at the border between Colombia and Peru, Williams *et al.,* (2016) estimated a 3.4%/year reduction of the Inia population between 1993 and 2007.

Additional methods have been used to estimate abundance and evaluate the distribution and behaviour of dolphins. These include the use of drones and deployment of satellite transmitters. Drones have been used in Brazil and Colombia in order to produce correction factors for abundance estimates computed from boat surveys, especially at river confluences and lakes. As for satellite tagging, in 2017 satellite transmitters were attached to 15 botos: five in Brazil (Tapajos), five in Bolivia (Itenez/Guaporé), four in Colombia (Orinoco) and one in the Amazon River between Colombia and Peru. Preliminary results show that some animals moved more than 450km while others remained associated with productive areas such lakes.

6.3 Threats

There are several threats to dolphins in the Amazon and Orinoco. Both basins are experiencing significant habitat degradation. The human population of the Amazon basin is expanding, with more than 34 million people, of whom only 3.5 million are indigenous. Immigration has been motivated by large-scale soybean farming, hydroelectric development, oil and gas exploration, road construction and the consolidation of large population centres. With regards to contaminants, there is evidence of high levels of mercury in fish, dolphins and even humans in the region. The South American Action Plan for the Conservation of Dolphins and national action plans endorsed by the governments of Brazil, Colombia, Ecuador, Bolivia, Venezuela and Peru, provide guidance to governments on priorities and mitigation against threats to dolphins.

6.3.1 Deforestation

Although the rate of deforestation stabilised at the beginning of the century, there has been a marked increase in recent years, amounting to approximately 600,000km^2 of lost forest. This has an indirect effect on dolphins, especially on the 'blackwater' (tannic) rivers, where productivity is low and the fish that dolphins prey upon depend on the seeds and fruits of the flooded forest. It is estimated that one hectare of this ecosystem can produce 20t of seeds per year. When the forest is lost, there is no way to sustain fish stocks and this affects the availability of prey for the dolphins.

6.3.2 Hydropower development

Dams and future dam development are currently among the greatest threats in the Amazon since they affect the connectivity of rivers, the migrations of fish and in some cases, result in the fragmentation of dolphin populations (e.g. as observed in the Tocantins and Madeira river basins). It is estimated that 155 large dams are currently operating in the Amazon, Orinoco and Tocantins/Araguaia basins, and there are proposals for 277 more, although it is noted that there is uncertainty with regards to the number of dams in operation and those proposed.

6.3.3 Tourism
Inappropriate tourism practices, including feeding and swimming with dolphins conditioned to human interaction and dependent on human feeding, disrupt normal foraging and social behaviour. The operation of boats at high speed in the vicinity of dolphins may also cause disturbance and even, when animals are struck by boats, injury and death.

In January 2018, the Environmental Agency of the Amazon Government (Brazil) established a regulation for tourism activities with wild dolphins in the Amazon (Resolução /CEMAAM No. 28, de 22 de janeiro de 2018) with the view of better controlling poor practices.

6.3.4 Negative interactions with fisheries
Negative interactions with fisheries are also a major threat to dolphins. In the sixties, the mechanisation of fishing practices allowed large fishing nets to be used for the first time and, according to reports from fishermen and traders, this resulted in a large bycatch of dolphins. In the eighties, when more systematic assessments of dolphins began, significant mortality was also reported. In the nineties, in the Colombian Amazon, dolphins were reported approaching nets without always being caught and, at the beginning of the 2000's, the first observations were made of dolphins removing fish directly from nets. This created a conflict with some fisheries, especially those of large catfish, and retaliation against dolphins was reported. Dolphin poisoning is reported as commonplace in several locations in Peru. In Brazil, botos caught accidentally in nets are killed by the fisherman to avoid net damage. On the other hand, if tucuxi's are accidentally caught, they are released unharmed.

6.3.5 Deliberate take
In recent years, the deliberate killing of dolphins for use as bait in the piracatinga fishery has resulted in a high mortality of Amazon river dolphins. The need to better understand the potential impact of this mortality on both *Inia* and *Sotalia* prompted the following in-depth review of the fishery and its practices.

6.4 In-depth review of the use of Amazon river dolphins as bait in piracatinga fisheries
After several decades of unregulated fishing for the catfish 'capaz' (*Pimelodus grosskopfii*) in the Magdalena River, Colombia, the fishery collapsed. This prompted the opening of new fisheries for the catfish 'piracatinga' (*C. macropterus*), at first in Brazil and later in other countries within the Amazon. The meat of dolphins, caimans and other animals is used as bait in these fisheries, with dolphins being the preferred choice. This led to the intentional killing of botos and tucuxis, as well as the use of carcasses from bycatch in other fisheries (Flores *et al*., 2008; Trujillo *et al*., 2010; Alves *et al.,* 2012; Brum *et al.,* 2015).

Da Silva provided an overall summary of the status of the use of Amazon dolphins for bait in the piracatinga fisheries. After initial reports in the 1990s, evidence of killing dolphins started to accumulate from interviews with fishermen and increasing observations of the distinctive piracatinga fish traps. A decline of caimans and botos became evident in well-studied areas in the following years. In 2015, with the understanding that this use of dolphins as bait was having a detrimental impact on populations, a five-year moratorium on the commercial fishing and trade of the piracatinga was established by the Brazilian government.

Both dolphin species that occur in the Amazon river basin, botos and tucuxis, are used as bait. Most of the hunting pressure is on botos, which are larger, easier to catch, and slower swimmers than tucuxis, which are used only occasionally. There is a preference among fishermen for botos because of their larger size (which provides more bait per animal) and the greater attractiveness of their meat to piracatinga (more fish are caught per unit of effort). Of the bait being utilised, it is estimated to comprise 70% caimans and 28-30% botos.

On the basis of reports and expert knowledge, Workshop participants identified areas where dolphins have been, or are currently being, used for bait in Bolivia, Brazil, Peru and Venezuela (Figs 10A and 10B). The occurrence of this practice was divided into two periods: historical (pre-2015) and recent (2015-2018). There is a concentration of trading activity at the border of Colombia, Peru and Brazil.

6.4.1 National Perspectives
6.4.1.1 Bolivia
The killing of botos (referred to as bufeos in Bolivia) for use as bait in Bolivia was first observed in 2008 (Aliaga-Rossel *et al*., 2012) and was highlighted in the River Dolphin Action Plan of 2012 (Trujillo, 2012) as one of the current threats to this species. Botos were being used as bait in commercial fishing for whitefish (*Pinirampus pirinampu*) and for the piracatinga, and possibly also meeting the demand for 'traditional' products and oils derived from this cetacean species in local and international markets. An interview study documented reports from fishermen or community members of 150 botos killed in 2015 and 30 in the period from January to April 2016 (Escobar *et al*., 2016). The fishing is oriented to local markets in the cities of Cochabamba and Santa Cruz where there is a large demand for fish products. In the central area of Mamoré, Department of Beni, commercial fishing is still traditional, but intense. Work has been undertaken to introduce sustainable practices and find sustainable markets for less invasive or destructive fishing practices, although the effectiveness of these interventions has been difficult to quantify. This practice largely occurs in the central part of the country but information is lacking on how this evolving activity might be spreading throughout the country. Since the publication of the moratorium on the piracatinga fisheries in Brazil in 2015, there are suspicions that the piracatinga trade in Bolivia is orienting toward Brazilian markets.

6.4.1.2 Brazil
SC/M18/SAW10 provided information on the killing of dolphins for use as bait in the piracatinga fisheries in Brazil, as well as presentations given by Britcha, da Silva and Marmontel. Dolphin catches for the piracatinga fishery in Brazil have occurred since the late 90s, mainly in the Central Amazon. The fisheries occur throughout the year, with peaks during the dry season – from July to October (Iriarte and Marmontel, 2013; da Silva *et al*., 2011; Brum *et al.* 2015). An intense fisheries period was identified in 2012 and 2013 in the rivers Purus, Japurá, Solimões, Juruá, Amazonas, including within the Sustainable Development Reserves of Mamirauá (MSDR, 11,240km^2) and of Amanã (ASDR, 23,500km^2). Surrounding areas along these rivers are also known to have similar practices, but less intensively. There are large areas where piracatinga fisheries may occur but have not yet been formally documented and other larger areas where such fisheries are neither known nor suspected to occur, e.g. no fisheries for piracatinga or killing of botos have been documented in the Araguaia and Tocantins. The most widespread method of catching piracatinga is with 'currals' (or boxes), with or without doors (Fig. 12). These

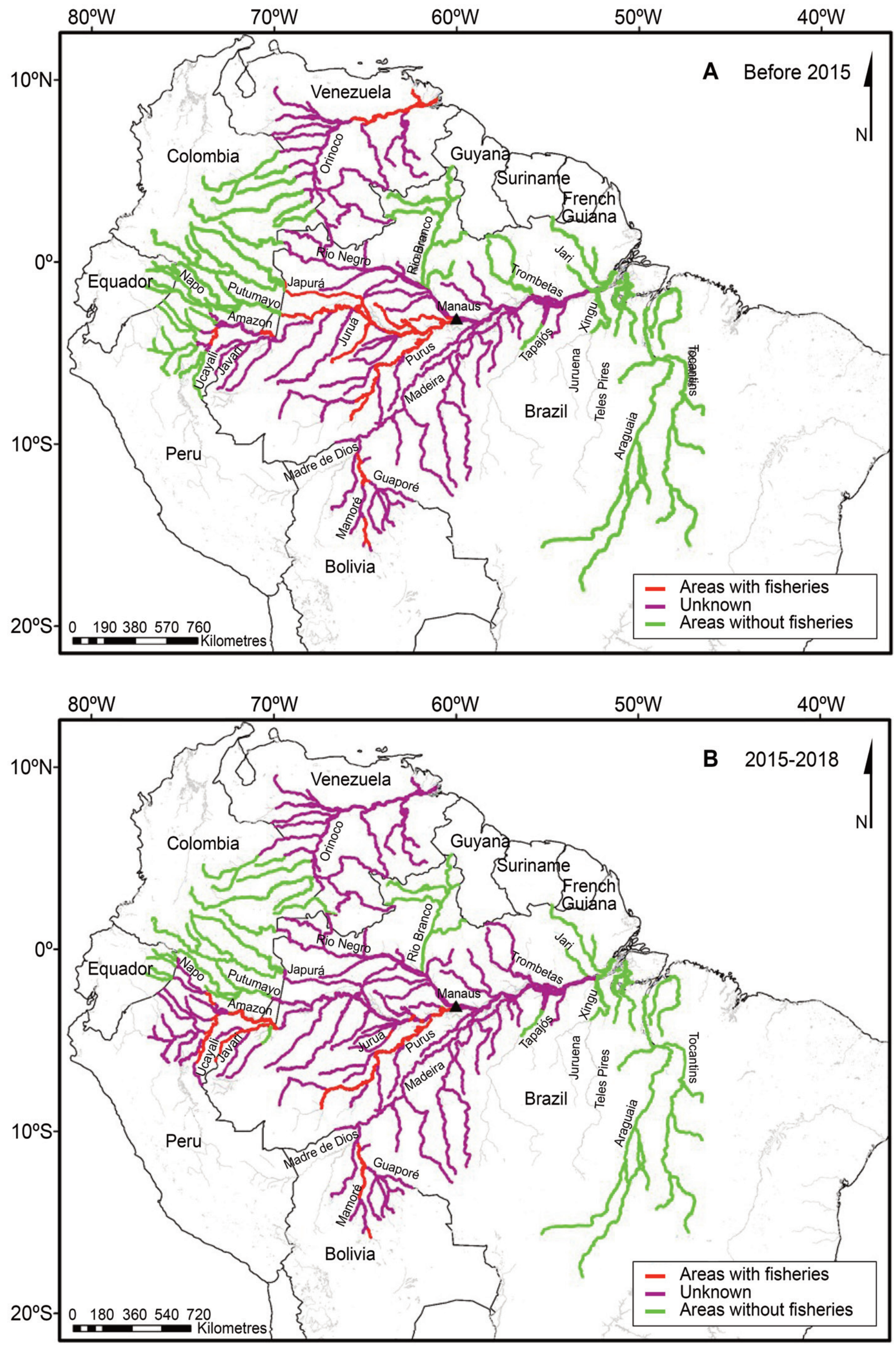


Fig. 10. A: historical (pre-2015) and B: recent (2015-2018) presence of fishing activities using dolphins as bait. Also included are areas where the practice does not occur and areas where information is lacking.

traps are built by the fishermen solely for capturing this fish (Botero-Arias *et al.,* 2014; Brum *et al*., 2015; Brum and da Silva, 2017). From the 1990s to 2014 the production of piracatinga in Brazil was oriented to Colombian markets. Since 2008 the market has also expanded to cities in Brazil as well and is sold in internal markets as 'douradinha' and other names (Cunha *et al.,* 2015). Landing statistics are poorly known but monitoring by the Mamirauá Institute for Sustainable Development (MISD) of only one freezing plant in Tefé indicate that 330t of piracatinga were landed from 2011 to 2014. Aditional data were provided by da Silva following the Workshop and is provided in Fig. 11.

Brum *et al*. (2015), in a study conducted between 2010 and 2013 in the middle Solimões river comprising the cities of Tefé, Alvaraes and Uarini and the surroundings of the MSDR and the lower Purús River comprising the cities of Beruri, Anori, and Tapauá, inside the Piagaçú-Purus Sustainable Development Reserve, revealed that in the middle Solimões river area all interviewed fishermen used botos and caimans meat as bait; in the lower Purús 70% of the fishers used boto as bait and 52% used caimans. Fisher's Association historical records of piracatinga yields in the middle Solimões region revealed that during the study period, the yields increased by 2679% (at an average increase rate of 446.5% per year), from 865kg in 2003 to 23.176kg in 2009.

The use of both species of dolphins, and of caimans, as bait in the piracatinga fisheries in Brazil was only confirmed in the 2000s. Although dolphin is preferred – due to its firmer flesh and higher blubber content – meat from caiman is more prevalent. It was estimated that in July 2003, 6-8 dolphins

The Boletim do Desembarque Pesqueiro do IDSM report the following volume of Piracatinga in one Freezing Plant (Frigorifico Frigopeixe):

1st Semester 2014 (Jan-Jun)	25.134kg
2nd Semester 2013 (Jul-Dec)	140.227kg
1st Semester 2013 (Jan-Jun)	37.618kg
2nd Semester 2012 (Jul-Dec)	108.830kg
1st Semester 2012 (Jan-Jun)	No mention
2nd Semester 2011 (Jul-Dec)	4.545kg

After the Moratorium, there were no more official reports of piracatinga landings

Fig. 11. Additional information on landing provided post-Workshop.

were being killed per day at the confluence of Japurá River and Paranã do Aranapu (Souza, *pers. comm*. to Marmontel). Monitoring of the fisheries and examination of piracatinga traps near MSDR and ASDR in 2010 and 2011 indicated that 68% of traps used caimans and 32% used dolphins as bait (Iriarte and Marmontel, 2013). In traps involving only cetaceans, botos corresponded to 91% and tucuxis to 9% of the bait. The proportion of caimans and river dolphins may be different in other areas and often a mix of dolphin and caiman carcasses are used as bait (Lima, 2015). Most of the bait used in the piracatinga fishery comes from incidental catches in gillnets, from both salvaged and intentionally killed dolphins (Botero-Arias *et al*., 2014). The use of dolphins as bait has become so common that fishermen have reported the existence of a specific market for trading carcasses. Depending on the dolphins size, a carcass can be valued value between R$ 50 to R$ 300 (US$ 20 to US$ 100) (Alves *et al*., 2012; Botero-Arias *et al*., 2014; Brum *et al*., 2015; Franco *et al*., 2016). Of 315 mortality events recorded in the mid-Solimões between 1991 and 2016, 143 were associated with fishing nets (mostly entanglement in gillnets), 55 suffered harpoon wounds and 59 of them were somehow associated with the piracatinga fishery (2004-2016) (Loch *et al.,* 2009, Iriarte and Marmontel 2013a, 2013b; Marmontel, *unpub. data*). Using piracatinga landing data from Tefé, da Silva *et al*. (2011) estimated that 1650 botos were killed annually in the MSDR area. The 25-year long population monitoring database compiled by Projeto Boto has records, from 2000 onwards, of animals with wounds, such as punctures from harpoons, machetes, etc. ropes around the caudal peduncle; and the removal of pectoral fins and dorsal ridges.

Since the 1990s, the MISD and Marine Mammal Laboratory of the Instituto Nacional de Pesquisas da Amazônia (INPA) have conducted river dolphin monitoring, in various parts of the Amazon River basin in Brazil, including the MSDR and the ASDR, and in areas around the mid-Solimões river, the western Amazon and other river basins within the Brazilian Amazon (e.g. Loch *et al*., 2009; Iriarte and Marmontel, 2013; da Silva *et al*., 2018). Research methods used in the monitoring include boat surveys, radio and satellite tagging as well as unmanned aerial vehicles (UAV) surveys to conduct interviews, estimate population abundance and to recover carcasses. Some of these studies suggest that the use of both species of dolphins as bait in the piracatinga fisheries has contributed to the severe decline of botos and tucuxis in the MSDR (Mintzer *et al*., 2013; Brum *et al*., 2015; da Silva *et al*., 2018). It was noted, however, that as incidental mortality in fishing nets is observed in the region, it is difficult to determine the relative contribution of the intentional killing of dolphins to the population decline.

In 2014, the Government of Brazil published an inter-ministerial directive (INI nr. 06/2014) and established a moratorium on fishing and commercialization of piracatinga within the Brazilian jurisdictional waters and in its national territory for a period of five years (2015-2019). Subsequently, in August 2014 a working group was established by ordinance for the purpose of monitoring compliance and the effects of the moratorium. This working group developed a monitoring and follow-up plan outlining the actions to be undertaken, including initial monitoring expeditions of the populations of botos and tucuxis, with subsequent bi-annual monitoring in priority rivers, formalisation of agreements between countries for the effective implementation of the moratorium and increased inspection of local markets, supermarkets, slaughterhouses and warehouses to ascertain the availability of piracatinga in commerce.

Enforcement actions have included inspections of the region's freezing plants, but these have been suspended due to lack of funds. While these inspections did not find piracatinga, the Instituto de Proteção Ambiental do Amazonas (IPAAM) reported that approximately 1.8t of piracatinga were seized at the MSDR and ASDR in 2016. This agency noted that, in the Amazon region, irregularities in fish trade are related to other illicit activities, such as drug trafficking. Threats to the lives of the inspectors by traffickers in the regions have resulted in suspension of surveillance operations. The Secretaria Estadual de Meio Ambiente do Amazonas (SEMA) reported that the activity of piracatinga fishing in the middle Solimões (Mamirauá region) had decreased since the establishment of the moratorium, and it has become less likely that piracatinga are found in the freezing plants of that region. Both the possible establishment of an IBAMA office in Tabatinga on the Colombian border and the development of the Document

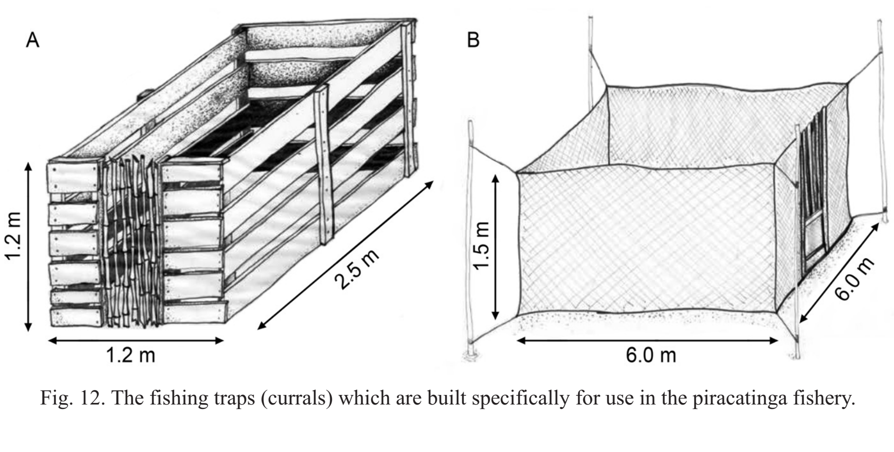


Fig. 12. The fishing traps (currals) which are built specifically for use in the piracatinga fishery.

of Origin of Fish – DOP by IBAMA, could help in the control of the piracatinga trade. SC/M18/SAW10 provided the results of a molecular analysis of fish products obtained from freezing plants in Manaus and local supermarkets. It was discovered that some products were labelled as one species of catfish but proved to be piracatinga, thus confirming that despite the moratorium, the fishing of piracatinga, albeit on a smaller scale, continues.

Future possibilities for addressing trade issues at higher levels include the Sustainable Landscapes Project of the Amazon, in which, based on a field diagnosis of the trade routes of the piracatinga, Brazilian Government officials, with the support of Amazon Cooperation Treaty Organisation (ACTO), could develop diplomatic strategies to promote dialogue with Peru and Colombia on the trade and its ecological consequences for the native populations of dolphins and caimans in the Brazilian Amazon.

Since the publication of piracatinga fishing prohibition in 2015, fishing and trade of piracatinga still occurs in most areas identified in Fig. 8, but with much less intensity. Information is lacking from a large portion of the Amazon but there are indications that this practice occurs elsewhere.

The continuation of the five-year moratorium is an issue for internal discussion and a rationale for its continuation needs to be developed. It must be considered that dolphins are long-lived and occur in widespread populations and thus determining population trends in the short term is not possible. There is also a need to continue outreach efforts to both the retail sector and communities in the Amazon so that the ban might be better understood. There is also a need to develop transparent product identification so that it is clear what fish is being sold.

6.4.1.3 Colombia

A piracatinga fishery using river dolphins as bait has not developed in Colombia, although there are anecdotal accounts of dolphins being used as bait especially in the Putumayo (Amazon) and Meta (Orinoco) rivers. A government resolution enforcing the prohibition of using dolphins as bait was established in 2014.

In the early 2010s, the main market for piracatinga was Colombia. The piracatinga trade into Colombian markets relied primarily on the Brazilian (70%) and Peruvian (20%) fisheries. The piracatinga was exported from Brazil via Manaus (air) or via Leticia (fluvial) and distributed to the main Colombian cities (Gómez *et al.,* 2008; Trujillo *et al.,* 2010b). Local communities along the rivers in the Amazon and Orinoco basins of Colombia do not consume piracatinga fish. In recent years, after the Brazilian moratorium, a greater proportion of the catch came from Peru, but there is also evidence of the movement of piracatinga fish illegally from Brazil.

Before 2015, it was common to find piracatinga being sold as capaz (the Colombian fish product for which it is a substitute) from the Magdalena River or as capacete in Colombian supermarkets and in popular markets (Salinas *et al.,* 2013). After the national media publicised the issue of the piracatinga fishery using river dolphins as bait, as well as the information regarding high mercury concentrations in piracatinga, a recommendation against consumption of piracatinga meat was issued by the Government (INVIMA 2015). This resulted in piracatinga being removed from commercial sale in supermarkets but commercialization continued in popular local markets (Plazas de Mercado).

A pilot study conducted by researchers and students from the Economy Faculty at Universidad de los Andes, examined the amount of piracatinga traded in popular markets in Bogotá for two months in 2016. This pilot study showed that between 6 and 10% of the income of fish traders came from piracatinga sales in these markets, and there was a peak in piracatinga sales (3t) in the weeks before Easter.

In August 2017 a Resolution permanently banned the trade of piracatinga in Colombia because of high mercury levels and public health concerns.

6.4.1.4 Ecuador

In Ecuador, there is no record of the killing of botos or tucuxis to use as bait in fishing activities. Opportunistic and occasional catches are related to entanglements in fishing nets and conflicts with local people, especially in the Putumayo River.

6.4.1.5 Peru

Information on the use of botos as bait for the piracatinga (referred to as mota in Peru) fisheries was provided by Gilleman and Campbell. The intentional killing of botos has been monitored by the non-governmental organisations Solinia and ProDelphinus through questionnaires and interviews, workshops and, sometimes, photo or video documentation. Surveys have been conducted with fishermen and the local communities in the Loreto and Ucayali regions since 2010.

Reports of catching dolphins for use as bait in Peru are historically recorded for the lower regions of the Ucayali River and Caballococha area that comprises the upper Amazon River region in Peru. There is evidence that a fishery for piracatinga is present throughout the department of Loreto, as an artisanal practice by local fishermen in isolated cases and on a larger scale by 'moteros', fishermen skilled in this practice from other regions, who are helped by local fishermen. The product is exported to Colombia but there is also a national market in the Andes with products shipped via Pucallpa and Yurimaguas. While more investigation is required, it appears that killing of botos (and caimans) for bait and piracatinga fisheries occurs mainly near Requena and Caballo Cocha. Other events of poisoning and direct aggressive actions (gun shots, harpoons) against river dolphins, spurred by fisheries competition were also registered in significant numbers in the last five years.

There is no estimate of the number of dolphins used for bait in the piracatinga fishery in Peru. Hernandez & Gonzalves (2010) estimated that the boto population of the Javarí river (Peru) was 250 animals and that 20 botos were harvested to catch piracatinga in this area, representing a hunt of 8% per annum. Surveys show that this is a relatively new practice which is not carried out by the majority of fishers. The timing of its emergence indicates that the moratorium in Brazil led to an increase in the fisheries (and killing of dolphins) in Peru to supply the Colombian market.

Only 4-15% of survey respondents in Loreto reported the piracatinga as their main target species. Local communities do not typically consume this fish and fishing for other species is more profitable. The piracatinga has been sold in Andean towns or exported. Previous investigations have reported an average of 0.5 ± 0.1t of this fish species landed in Iquitos per year (Garcia *et al.,* 2012).

After the implementation of the piracatinga moratorium in Brazil in 2015, it is believed that Brazilian immigrants introduced this fishery and the use of dolphins as bait into the Maranõn and Pucalpa regions. Even in areas with more environmental enforcement such as Iquitos City, there are first hand reports of this practice occurring nearby.

Piracatinga are now exported for Colombian markets and also consumed by the national market.

6.4.1.6 Venezuela

The use of boto as bait for the piracatinga fishery was recorded in many villages (26) along the Orinoco in Venezuela with an estimate from official data of a minimum 840 animals taken from 1990-2008 (Diniz, 2012). All piracatinga products have been exported to Colombian markets. There is no evidence of local consumption. Since 2008, no information is available about the Piracatinga trade or dolphin catches in Venezuela. Trade with Colombia is now prohibited but there is no current information on suspected movements of piracatinga products through the black market to Colombia.

6.4.2 Summary

All range countries of botos and tucuxis have laws in place to protect dolphins and prohibit killing them intentionally or through bycatch. Fishing for piracatinga is banned in Brazil on the basis of its impact on botos and other wildlife. Colombia passed a resolution to permanently ban the trade of piracatinga in 2017. This went forward on the basis of public health concerns over the high levels of mercury in the fish. Piracatinga fishing with boto as bait does not occur in Colombia but Colombian demand was driving the practice making this an important measure to assist in the conservation of botos in the overall region. No other range country has taken specific legislative or regulatory action, beyond the general protection of river dolphins, in response to the emergence of the use of botos as bait in the piracatinga fishery.

The practice of using dolphins as bait has moved from country to country with the imposition of restrictions in Brazil and the arrival of traders who encourage fishers to use botos for bait to generate a supply of piracatinga, or in some cases with immigration of Brazilians familiar with the practice.

Fishing for export to Colombia using boto for bait was reported for Brazil, Peru, Bolivia, Ecuador and Venezuela. While the original market for piracatinga was in Colombia, piracatinga is now known to be consumed in the following additional countries – Brazil, Peru, Bolivia and Ecuador. As fishing for export has been introduced into other countries, domestic markets have emerged and the products are often sold under different names to avoid negative associations with piracatinga consumption.

6.5 Recommendations

While this Workshop focused on the impact of the piracatinga fishery it was understood at the outset that the intentional killing of dolphins for bait is only one of the threats the dolphins face in the river basins of South America. Incidental bycatch in fisheries is a threat of equal or greater importance and intentional killing of dolphins in the name of reducing fisheries competition has been reported from several countries. Destruction of the habitat that supports freshwater dolphins is a growing concern. Hydropower development leads to habitat fragmentation, changes in water flows and reductions in fish numbers and species. Pollution, including plastic and other debris, from a wide range of sources degrades habitat and water quality with presumed longer term health effects and, in some cases, multiple deaths from poisoning events.

Domestic and international discussions and priority setting are already taking place among the scientists and government authorities of the South American river basin countries, focused on river dolphin conservation, including on response to the threat of intentional killing of botos for the piracatinga fishery. Action plans have been finalised and adopted for the conservation of South American river dolphins at regional and national levels that contain detailed and prioritised recommendations. As a first priority the actions in these plans should be implemented and funded. Basic research on abundance and trends of cetaceans and fishery and trade studies on the piracatinga fishery are of particular importance.

In order to better elucidate the status of river dolphins in the Amazon and Orinoco basins and the past and current impact of the piracatinga fishery, the Workshop participants recommended that work proceed in the following general areas.

6.5.1 Research on the piracatinga fisheries and the location and severity of threats to dolphins (mapping and documentation)

Conduct studies focused on areas of known or recent fisheries using boto as bait and new areas where the practice is unknown. At the local scale this will involve continued efforts to document fishing in boto habitat based on the presence of traps typical of piracatinga fishing, landings of piracatinga and other evidence. Physical market evidence should be gathered, as part of enforcement or civil society efforts, in larger towns where fish processing facilities are located. Freezer surveys and sampling at markets, using available ID guides for identifying fish species and processed fillets, can be particularly valuable in identifying illegal sources and illegal trade. Such studies should extend to more distant domestic markets and in cooperation with foreign authorities to international markets.

6.6 Specific recommendations

- Identify and specify the products of piracatinga that are falsely labelled as other products (e.g. the label douradinha or surubim) and work to require clear labelling so consumers are aware of what they are buying. This may require work at the inter-ministerial level on product labelling to clarify. Investigate whether there are requirements or other means to put the species name on such products.
- Use government monitoring and enforcement and other databases to provide data and information on source areas for fish arriving in urban or international markets.
- Enhance understanding of the characteristics of piracatinga, the fishery and the products thereof (using genetics, stable isotopes and other tools) to identify differences between populations and localities and enhance the traceability of whole fish and parts.
- Conduct socio-economic research to identify the significance of the piracatinga fishery to local people.

6.6.1 Research on taxonomic status

It is very important to elucidate the taxonomic status of *Inia* to identify the genetic units for conservation management and generate the corresponding evaluations and categorisation of the threat status for the IUCN.

6.6.2 Research on abundance and trends of river dolphins

Continuation and expansion of research to document abundance and trends of dolphins in the South American river basins should be a high priority. There are severe methodological and resource challenges to conducting standardized and comparable surveys and monitoring over the vast areas of the region and in each country. Such research should be designed to provide basic data as well as the capability to evaluate population response to threats or measures to reduce them, in particular the use of dolphins for bait in the piracatinga fishery. Participants agreed that the five-year period of the Brazilian moratorium is not long enough to assess its impact on reducing mortality of dolphins.

6.7 Specific recommendations
- Continue the moratorium on the piracatinga fishery in Brazil to allow sufficient time to evaluate the effectiveness of protective measures and continue necessary protection of dolphins.
- Trend and abundance surveys should be continued or initiated in areas where the methodology has already been standardized and in areas of particular concern with respect to deliberate killing of dolphins for use as bait in the Piracatinga fishery (e.g. Purús, Japurá, etc.).
- Monitoring programs should be designed taking into consideration the statistical power to detect patterns and trends over the medium and long-term.
- Consolidate and evaluate historical data in order to compare historical and current conditions and consider whether repetition of earlier studies can provide insights in to current trends.
- Strengthen research capacities at the regional level and promote the standardisation of methodologies and the incorporation of new technologies (drones, satellite tracking) to understand key aspects of these species biology, at population, behavioral, habitat use, acoustic and other levels.

6.7.1 Legal measures
While legal measures are in place to some degree in all countries, means to strengthen these and build the effectiveness of enforcement should be pursued.

6.8 Specific recommendations
- Review the laws that include the use of wildlife and protection of cetaceans and enhance enforcement under the existing laws and action plans. Consider the need for more specific laws concerning the deliberate killing for use as bait in the piracatinga fishery.
- Take measures to increase the effectiveness of deterrence against illegal activities including by increasing criminal and civil penalties for engaging in activities that result in the killing of dolphins.
- Consider the specific circumstances of border regulations and the effectiveness of policies and border agreements governing the transboundary movement of fish.
- Encourage governments to be aware of these fisheries and the dangers they present to dolphin populations, and study the necessity of legislative action to ban such fisheries in these countries.

6.8.1 General enforcement
- Encourage governments at all levels to support and enhance enforcement effort. Focus trade enforcement efforts on the freezing plants and other areas or facilities identified as key bottlenecks of the trade.
- Engage in targeted enforcement on the river directed at fishing activities meeting the characteristics of this illegal fishery.
- Enhance fishery laws and controls.

6.9 Specific recommendations
- Develop and review the fishery management plans for regions and countries to encourage sustainable legal fisheries in the Amazon and avoid the emergence of such unsustainable practices and cetacean interactions in the future.
- Recognising the difficulties and shortfalls in characterising the fisheries species of the Amazon, encourage governments to work together to increase scientific understanding of fisheries and develop a single regional sustainable fisheries management plan for the Amazon.

6.9.1 Outreach and public awareness
While legal measures are in place in most of the range countries, the level of awareness of the basic existence of freshwater cetaceans, the understanding of the prohibitions in place and the impact of intentional take is low.

6.10 Specific recommendations
- Build public awareness, education, communication and outreach to communities both in the areas where fisheries take place and in the areas where piracatinga products may be processed or consumed. Target messages to specific sectors, such as fishermen and fishermen's associations, traders, consumer's etc.
- Provide information on the conservation implications for the dolphins of their use as bait.
- Provide information on the potential health risks of consuming mercury contaminated fish.

6.10.1 International cooperation
The current Workshop is an outcome of previous deliberations of the IWC Scientific Committee and its sub-committee on Small Cetaceans. Previous IWC/SC recommendations expressed concerns over the decline in dolphin populations as a result of the use of dolphins and bait in the piracatinga fishery and encouraged collaboration among the range states and regular reporting to the IWC/SC on this matter.

6.11 Specific recommendations
- The Workshop reiterates and expands on previous IWC/SC recommendations that range states engage in bilateral and multilateral discussions of legislative, enforcement, management and scientific efforts to ensure effective cooperation among them.
- The Workshop recommends that range state authorities work together to exchange information on the movement of products across international borders.

6.11.1 Additional recommendations related to the larger range-wide distribution and threats
- Assess the magnitude and impact of all existing threats on dolphins and their habitats. It must move from the descriptive to the quantitative in order to make appropriate conservation decisions and at an appropriate scale.
- Evaluate the threat status of *Sotalia* taking into account that it shares most of the same threats as *Inia*.
- Evaluate the dolphins that currently inhabit areas of hydropower dams, or whose populations are fragmented and exposed to habitat degradation and genetic change, as in the case of the Tocantins River.
- Analyze the population size and population trends of *Inia geoffrensis* and S*otalia guianensis* during the mega Project 'Arco Minero del Orinoco' in the Orinoco River basin.

- Strengthen networks of work between researchers and organisations and create a regional strategy for the conservation of river dolphins.

7. COOPERATION WITH OTHER ORGANISATIONS

The importance of collaboration with other international organisations is well recognised and encouraged on many issues that the IWC SC tackles. On the issue of poorly documented takes of small cetaceans for food and non food purposes, IWC and the Aquatic Mammal Working Group (AMWG) of the Convention on Migratory Species (CMS) have been coordinating efforts since 2014. In 2018 this collaboration led to a new cross-taxa approach to aquatic wild meat that provides a platform for a strengthened and coordinated approach between the CMS Scientific Council and the IWC SC. During CMS 12th Conference of the Parties (CoP) (October 2017) governments formally recognised aquatic wildmeat as a significant and immediate threat to at least 33 CMS-listed aquatic species– cetaceans, sirenians, turtles and crocodiles. At this meeting, a new cross-taxa Aquatic Wild Meat Working Group was established, within the structure of the CMS Scientific Council, which includes members of the IWC Scientific Committee as well as representatives from other conventions. The working group aims; to establish an online knowledge base on aquatic wild meat relating to CMS-listed cetaceans, sirenians, turtles and crocodiles; collaborate with the IWC and participate in IWC meetings with a focus on aquatic wildmeat; input aquatic wildmeat information to the Abidjan Convention Endangered, Threatened or Protected Coastal and Marine Species Action Plan; and serve as an expert resource for CMS Parties and the CMS Secretariat about aquatic wild meat issues.

The Working Group will also develop an aquatic wild meat action plan which will include information gathered during the IWC series of workshops on aquatic wild meat and small cetaceans. The Working Group will also work closely with regional CMS agreements for dugongs, marine turtles, water birds, and marine mammals. The Working Group will formally present its activities to each CMS Scientific Council meeting and at the IWC Scientific Committee, providing a consistent platform for a science/policy interface on this important issue.

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Annex A

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Annex B

Agenda

1. Introductory items
2. Opening remarks
   a. Appointment of Rapporteurs
3. Presentation of the Workshop goals and outcomes of previous workshop
4. Poorly documented takes of small cetaceans globally and in South America
   a. Introduction
   b. Country reports
   c. Argentina
   d. Bolivia
   e. Brazil
   f. Chile
   g. Colombia

   h. Costa Rica
   i. Ecuador
   j. Peru
   k. Uruguay
   l. Venezuela
   m. French Guiana, Guyana and Suriname
5. Data gaps
6. Tools for investigating and understanding wildmeat issues
   a. Analyse techniques to determine regional drivers, scale and impacts of exploitation
   b. Data collection tools and techniques
7. Recommendations
8. Overview: status of Amazon dolphins
9. Status of Amazon dolphins used as bait in the Piracatinga fisheries
   a. Bolivia
   b. Brazil
   c. Colombia
   d. Ecuador
   e. Peru
   f. Venezuela
10. Summary of proposed and existing management actions and their effectiveness
   a. Bolivia
   b. Brazil
   c. Colombia
   d. Ecuador
   e. Peru
   f. Venezuela
11. Recommendations
12. Governing legislation and management mechanisms

Annex C

List of Documents

SC/M18/SAW01. Elizabeth Campbell. Country Report for Peru.

SC/M18/SAW02. Fernando Felix. Country Report for Ecuador.

SC/M18/SAW03. Enrique Crespo and Pablo Bordino. Country Report for Argentina.

SC/M18/SAW04. Cecilia Passadore. Country Report for Uruguay.

SC/M18/SAW05. Fernando Trujillo and Isabel C. Avila. Country Report for Colombia.

SC/M18/SAW06. S. Siciliano and Renata Emin-Lima. How cetaceans are used along the Eastern Amazon coast: two contrasting situations.

SC/M18/SAW07. Enzo Aliaga Rossel. Country Report for Bolivia.

SC/M18/SAW08. Cristina Castro A., Diana Cardenas and Gregory Kaufman. First records of marine mammal takes in fisheries on the Ecuadorian Continental Coast.

SC/M18/SAW09. Javier Rodriguez. Country Report for Costa Rica.

SC/M18/SAW10. Vera M F da Silva, Angelica C G Nunes, Louzamira F B de Araujo, Jacqueline S. Batista, Haydee Cunha, Tony Martin. The use of Amazonian dolphins (*Inia* and *Sotalia*) as bait for the piracatinga fishery.

SC/M18/SAW11. Yurasi Briceno. Report of aquatic wildmeat: Venezuela.

SC/M18/SAW12. Vera M.F. da Silva, Carlos E.C. Freitas, Rodrigo de L. Dias and Anthony R. Martin. Both cetaceans in the Brazilian Amazon show sustained, profound population declines over two decades.

SC/M18/SAW13. Salvatore Siciliano, Ana Carolina Meirelles, Fabia Luna, Adriana Vieira de Miranda, Pedro Fruet and Vera Maria Ferreira da Silva. Country Report for Brazil: coastal section.

Annex D

Forensic Testing for Cetacean Meat

'Love charms' that allegedly contained boto flesh were purchased from local markets in Santos, Brazil, during the Workshop. Four were tested for the presence of cetacean DNA using the rapid test kit developed by Chan *et al* (2016).

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Chan, K.W., Lo, C., Chu, C.S., Chin, L.T., Wang, Y.T. and Yang, W.C., 2016. Development of a colloidal gold-based immunochromatographic test strip for detection of cetacean myoglobin. *J. Vis. Exp.* p113. [p.e53433].

Fig. 1. Testing flesh samples found in 'boto perfume': (a) remove sample; (b) prepare test kit; (c) thoroughly rinse alcohol from sample; (d) macerate sample in the buffer from kit; (e) insert test strip; (f) lines will appear and negative test is single line at 'C'; and (g) all three perfumes tested are negative for cetacean DNA.

Annex E

Study Objectives, Appropriate Data Collection Methods and Suggested Analyses

RECOMMENDED DATA REQUIREMENTS

1. Data on take of wild meat
    - 1.1. What are the genera/species/subspecies is taken?
    - 1.2. How many individuals are taken?
    - 1.3. What is the location of the take?
    - 1.4. When does the take occur?
    - 1.5. What body part is used?
        - 1.5.1. Meat
        - 1.5.2. Fins/tail
        - 1.5.3. Blubber
        - 1.5.4. Oil
        - 1.5.5. Genitalia

        - 1.5.6. Tooth
        - 1.5.7. Others
    - 1.6. For what use is it taken?
        - 1.6.1. Medicinal / zootherapeutics
        - 1.6.2. Aphrodisiac?
        - 1.6.3. Bait
        - 1.6.4. Food
        - 1.6.5. Religious / customary
            - 1.6.5.1. Taboos
        - 1.6.6. Boat maintenance
        - 1.6.7. Hand crafts (decoration, ornamental)
        - 1.6.8. Cosmetics (personal beauty)
        - 1.6.9. Gift
        - 1.6.10. Others
    - 1.7. Who takes the wild meat?
        - 1.7.1. Migrants
            - 1.7.1.1. Age
            - 1.7.1.2. National
            - 1.7.1.3. Regional
        - 1.7.2. Locals (?) / indigenous
        - 1.7.3. Industry workers
        - 1.7.4. Religious groups
        - 1.7.5. Tourists
        - 1.7.6. Non-conformist cultures
        - 1.7.7. Non-nationals
    - 1.8. Who is the end user?
        - 1.8.1. Personal use
        - 1.8.2. Family / neighbours
        - 1.8.3. Local settlement / market
        - 1.8.4. National market
        - 1.8.5. International market
    - 1.9. What is the value of the animals or their derivatives?
        - 1.9.1. Price per kg / carcass
            - 1.9.1.1. At each stage (hunter, intermediate, market sale)
        - 1.9.2. Cultural / social value (?)
    - 1.10. How was the animal obtained? (Robarts and Reeves 2011)
        - 1.10.1. Non-target salvage bycatch
        - 1.10.2. Non-target salvage stranding
        - 1.10.3. Non-target deliberate stranding
        - 1.10.4. Non-target deliberate bycatch
        - 1.10.5. Targeted opportunistic
        - 1.10.6. Targeted direct
    - 1.11. What method was used to obtain wild meat
        - 1.11.1. Harpoon
        - 1.11.2. Gill net
        - 1.11.3. Long-line
        - 1.11.4. Strandings
        - 1.11.5. Machete / baton
        - 1.11.6. Guns
        - 1.11.7. Poison
        - 1.11.8. Dynamite
    - 1.12. Individual information on animals taken
        - 1.12.1. Sex
        - 1.12.2. Age (class)
        - 1.12.3. Body length / measurements
        - 1.12.4. Body mass
        - 1.12.5. Tissue / blood samples
        - 1.12.6. Stomach contents
2. Data on the motivations or reasons for take / use?
    - 2.1. Socio-economic drivers
    - 2.2. Opportunity
    - 2.3. Environmental (change in it)
    - 2.4. Cultural / religious
    - 2.5. Others
3. What is the perception of fishermen to cetaceans?
4. Data on the species
    - 4.1. Distribution (endemism / cosmopolitan)
    - 4.2. Abundance (relative or metrics thereof) of the species
    - 4.3. Demographic parameters of the unit (e.g. survival, migration routes)
    - 4.4. Residency / transient
    - 4.5. Conservation status (IUCN, national and regional lists, CITES, CMS)
    - 4.6. Structure and composition of the threatened/impacted unit (connectivity, genetics)
    - 4.7. Behaviour (habituation etc.)

RECOMMENDED METHODS TO OBTAIN THE DATA

5. Methods used
    - 5.1. Interview
    - 5.2. Community survey
        - 5.2.1. Cultural items
    - 5.3 Market survey
    - 5.4. On-board observer
    - 5.5. Opportunistic records
    - 5.6. Literature review / meta-analyses
    - 5.7. Fisher records (log book)
    - 5.8. Authorities reports (landings)
    - 5.9. Seizures / law enforcement
    - 5.10. Museum collections
    - 5.11. Proxies
        - 5.11.1. Bait counting methods (e.g. Piracatinga boxes)
        - 5.11.2. Hunting signs
        - 5.11.3. Permanent fishing gear (fences, Fish Attract Device [FAD])
        - 5.11.4. Damage to net gear
        - 5.11.5. Carcass survey
        - 5.11.6. Bone survey
        - 5.11.7. Strandings (?)
        - 5.11.8. Behavioural changes
        - 5.11.9. Fishermen's perceptions (?)
    - 5.12. Source of information
        - 5.12.1. Interview 1st hand
        - 5.12.2. Anecdotal
            - 5.12.2.1. Personal observation – direct informant
        - 5.12.3. Published (peer reviewed)
        - 5.12.4. Grey literature
            - 5.12.4.1. Federal agencies
        - 5.12.5. Databanks
        - 5.12.6. Social media
    - 5.13. Quality of data
        - 5.13.1. Survey effort
            - 5.13.1.1. Area surveyed
            - 5.13.1.2. Length of survey
            - 5.13.1.3. Season
        - 5.13.2 Surveyor
            - 5.13.2.1. Citizen science
            - 5.13.2.2. Parabiologist / trainee / technician / community researcher
6. Analysis
    - 6.1. Is the data comparable?
    - 6.2. Which species are taken?
    - 6.3. Assess data needs (e.g. power analyses)
    - 6.4. What is the distribution of the take (spatial extend)?
    - 6.5. What is the change over time?

6.6. What is the magnitude of the take?
6.7. Evaluation of risk? (overlap of human activities and species occurrence)
6.8. Vulnerability of the species
6.9. Extrapolation to other communities (people per location)

DATA COLLECTION REQUIREMENTS FOR THE SYSTEMATIC REVIEW OF REGIONAL AND GLOBAL TRENDS IN AQUATIC WILDMEAT USE

Category	Data Type	Unit	Categories
Take	Taxonomic group		
	Number taken	Individuals, biomass, items	
	Location of take		
	Time of take		
	Body part used	Carcass, biomass, items	Meat Fins/tail Blubber Oil Genitalia Teeth Other
	Use of take		Medicinal Bait Food Religious / customary (inc. taboos) Handicrafts (decoration, ornamentation) Maintenance (e.g. boat) Cosmetics Gift Other
	Target category		Non-target salvage bycatch Non-target salvage stranding Non-target deliberate bycatch Non-target deliberate stranding Targeted opportunistic Targeted directed
	Acquisition method		Harpoon Gill-net Long-line Stranding Machete Guns Poison Dynamite Other
Individual animal information	Age category		Calf Juvenile Sub-adult Adult
	Sex		
	Body mass		
	Body length		
	Tissue/blood taken		Y/N
	Stomach contents taken		Y/N
Acquisitioner information (who)	Group		Non-local Local
	Age category		<20, 20-30,30-40…
	Occupation		Industry worker Handicraftsmen Fisher
	Tourist		Y, N
	Cultural /religious group		[Categories]
	Motivation		Economic Cultural Opportunistic Environmental Others
	Perception of cetaceans		Like Dislike
	Perceived pop trends		Increase Decrease Static
	Perceived changes in animal behaviour		

Category	Data Type	Unit	Categories
End user	Group		Acquisitioner (personal) Family/neighbours Local settlement (people or market) National market International market
	Age category		<20, 20-30,30-40…
	Occupation		[Categories]
	Tourist		Y, N
	Cultural /religious group		[Categories]
	Motivation		Economic Cultural Opportunistic Environmental Others
	Perception of cetaceans		Like Dislike
	Perceived population trends		Increase Decrease Static
	Perceived changes in animal behaviour		
Survey information	Time of study		
	Effort	Number of fishers Distance surveyed	
	Location		
	Surveyor		Scientist Local
	Source		Interview Anecdote Published (peer-reviewed) Theses Grey Literature Database Social media
Site level information	Seasonality of take		
	Site population		
	Historic use		Y/N
Value	Price	Currency per unit	
	Price stage		Local, intermediary, market
Importance to community	Cultural		High Medium Low
	Food		[Categories]
	Cash		[Categories]
	Economic		[Categories]

Annex F

Database of Collated Information and Expert Knowledge on the Use of Small Cetaceans for Wildmeat Purposes in South America

Scientific name code	Country code	Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user			Cause for concern	Comment	Submitters
		Ocean and river basin code	Region	Ongoing	Period of activity							Non-targeted				Targeted		Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International			
CCOM	AR	ATL	Tierra del Fuego		1970-1980		X										X					X	X			X			NO	Heavy impact in the past.	CRES
LAUS	AR	ATL	Tierra del Fuego		1970-1980		X										X					X	X			X			NO	Heavy impact in the past.	CRES
LOBS	AR	ATL	Tierra del Fuego		1970-1980		X										X					X	X			X			NO	Heavy impact in the past.	CRES
PBLA	AR	ATL	Buenos Aires Prov.	X	1970-2018	X			X			X					X		X			X	X			X			NO	Low frequency, status of population is of concern; the meat categorized as "cultural use" is used to feed dogs.	CRES
PSPI	AR	ATL	Tierra del Fuego		1970-1980		X										X					X	X			X			NO	Heavy impact in the past.	CRES
PSPI	AR	ATL	Buenos Aires Prov.	X	1970-2018	X			X			X					X		X			X	X			X			NO	Used to feed dogs.	CRES
IGBO	BO	MAD	Beni, Santa Cruz, Cochabamba; (Pando)	X	<1998-2018	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		YES	Very concerning, bycatch levels could be unsustainable; use as bait.	ROSS
GMAC	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X			X				X	X			X			NO		MERE
IGBO	BR	MAD	Rondônia, Amazon	X					X																					Marmontel: CHECK WITH DANIELLE LIMA AND WALESKA GRAVENA.	MARM, SILV

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
IGEO	BR	AMA	Amazonas, Roraima, Rondônia, Acre, Amapá, Pará, Goiás, Tocantins, Mato Grosso, Maranhão	X	1990s-2018		X	X	X		X	X	?	X	X	X	X	X	X	X	X	X	X			X	X		**YES**	Very concerning, level of mortality not known; very concerning bycatch levels likely much larger than realized.	MARM, MELO, SILV,
IGEO	BR	TOAR	Pará, Tocantins, Mato Grosso, Goiás	X	2012-2018	X		X	X			X	X				X	X	X	X	X	X	X			X	X		UNKN	Levels of mortality unknown, use of oil from blubber for medicinal uses, eyes, genitalia and teeth for love charms, direct interactions with sport fishing (social media).	MELO, TRUJ
KBRE	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X			X				X	X			X			NO		MERE
KSIM	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X	X		X				X	X			X			NO		MERE
LHOS	BR	ATL	Maranhão		2005 to 2010	X									X							X	X						**YES**	Stranded specimens consumed opportunistically, law enforcement needed.	SICI
MNOV	BR	ATL	Bahia	X	2010-2018		X				X				X							X	X			X			**YES**	Stranded carcasses used opportunistically for shark bait, law enforcement needed.	SICI
PMAC	BR	ATL	Bahia	X	2010-2018		X		X		X				X			X											**YES**	Stranded carcasses used opportunistically for shark bait, law enforcement needed.	SICI
PMAC	BR	ATL	Ceará	X	1990-2018				X				X					X				X	X			X			NO		MERE

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
SBRE	BR	ATL	Bahia	X	2010-2018		X				X						X					X	X				X		**YES**	Intentional and incidental catches reported, populations are probably resident and relatively small, law enforcement needed.	SICI
SBRE	BR	ATL	Ceará	X	1990-2018	X	X					X	X	X	X			X				X	X			X			UNKN		MERE
SFLU	BR	AMA	Amazonas, Roraima, Rondônia, Acre, Amapá, Pará	X	1990s-2018				?	?	?	X	X					X	X	X		X	X	?		X			**YES**	Concerning, bycatch levels unknown or increasing in some areas. Records of reduction of population.	MARM, MELO, SILV
SFRO	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X	X		X				X	X			X			NO		MERE
SGUI	BR	ATL	Amapá	X	1990-2018		X	X	X		X	X		X								X	X	X					**YES**	Very concerning, levels of bycatches could be unsustainable.	SICI
SGUI	BR	ATL	Bahia	X	2010-2018		X				X						X					X	X				X		**YES**	Intentional and incidental catches reported, populations are probably resident and relatively small, law enforcement needed.	SICI
SGUI	BR	ATL	Bahia	X	1997-2007	X	X					X	X									X	X			X			UNKN		MERE
SGUI	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X	X		X	X	X		X	X			X			**YES**		MERE

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
SGUI	BR	ATL	Maranhão	X	2004-2006	X	X	X	X		X	X	X		X							X	X						**YES**	Carcasses of bycatch specimens intensely used for multiple purposes, protected species, population size unknown, law enforcement needed.	SICI
SGUI	BR	ATL	Northeast Pará	X	1990-2018	X	X	X	X		X	X			X							X							**YES**	Carcasses of bycatch specimens intensely used for multiple purposes, protected species, population size unknown, law enforcement needed.	SICI
SGUI	BR	ATL	Pará		1970-1985		X	X	X		X	X					X					X	X						**YES**	Past harpooning practice could have depleted local populations.	SICI
SGUI	BR	ATL	Pará, Marajó Island	X	1990-2018		X	X	X		X	X	X		X							X	X	X					**YES**	Carcasses of bycatch specimens intensely used for multiple purposes, protected species, population size unknown, law enforcement needed.	SICI
SGUI	BR	ATL	Piauí	X	2000-2018	X	X	X	X			X	X	X	X				X	X		?	X			X			UNKN		MERE
SGUI	BR	ATL	Rio de Janeiro		1980-2005		X				X	X										X							NO	The use of dolphin for shark fishery has stopped around 2005.	SICI
SGUI	BR	ATL	Rio Grande do Norte	X	1990-2018	X	X	X	X			X	X	X	X				X	X		X	X			X			UNKN		MERE
SLON	BR	ATL	Ceará	X	1990-2018	X	X	X	X			X	X	X	X			X				X	X			X			NO		MERE

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
TTRU	BR	ATL	Bahia	X	2010-2018		X				X						X					X	X				X		**YES**	Intentional and incidental catches reported, populations are probably resident and relatively small, law enforcement needed.	SICI
TTRU	BR	ATL	Bahia	X	1990-2018	X	X					X	X					X	X			X	X			X			NO		MERE
TTRU	BR	ATL	Ceará	X	1990-2018	X	X					X	X	X	X			X	X			X	X			X			NO		MERE
TTRU	BR	ATL	Pernambuco	X	1990-2018	X	X					X	X					X	X			X	X			X			NO		MERE
ZCAV	BR	ATL	Bahia		2005				X						X			X											NO	Opportunistic use.	SICI
ZCAV	BR	ATL	Rio Grande do Norte		2000		X															X	X						NO	Opportunistic use.	SICI
CCOM	CH	PAC	Magellan region		1970-1990		X				X						X					X	X		X	X		X	NO		SEPU
CEUT	CH	CEN	Maule - Los Lagos	X		X						X							X	X			X			X			UNKN		SEPU
CEUT	CH	PAC	Magellan region		?-1990	X	X										X					X	X			X			NO		SEPU

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
LAUS	CH	PAC	Lagos/Aysen	X		X						X					X			X		X	X			X			UNKN		SEPU
LAUS	CH	PAC	Magellan region		1970-1990		X										X					X	X			X			NO		SEPU
LOBS	CH	PAC	Arica-Antofagasta		1960-1970	X					X					X			X			X	X			X			UNKN		SEPU
LOBS	CH	PAC	Magellan region		1970-1990	X	X									X						X	X			X			NO		SEPU
LPER	CH	PAC	Magellan region		1970-1990		X									X						X	X			X			NO		SEPU
PSPI	CH	PAC	Arica-Coquimbo		1970's	X										X			X			X	X			X			UNKN		SEPU
PSPI	CH	PAC	Magellan region		1970-1990		X									X						X	X			X			NO		SEPU
TTRU	CH	PAC	Antofagasta		1980's	X					X						X					X	X			X			NO		SEPU
IGEO	CO	AMA	Amazonas	NO	1954-1970					X												X							NO	This activity was to capture alive dolphins for zoos in Europe and United States.	TRUJ

Scientific name code	Country code	Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user			Cause for concern	Comment	Submitters
												Non-targeted				Targeted															
		Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International			
IGEO	CO	AMA	Amazonas, Putumayo, Meta	UNKN	<2000-2017		X		X			X		X				X				X	X	X			X		NO	This activity is very scarce nowadays.	AVIL, TRUJ
IGEO	CO	ORI	Amazonas, Putumayo, Meta	UNKN	<2000-2017		X		X			X		X				X				X	X	X			X		NO	This activity is very scarce nowadays.	AVIL, TRUJ
IGEO	CO	ORI	Casanare	X	2017-2018						X	X					X	X					X				X		**YES**	Fishermen killing them to sell their oil; activity seems to have increased recently.	AVIL, MOSQ
SATT	CO	PAC	Choco, Nariño	UNKN	1992-2006		X					X					X	X					X	X			X		**YES**	Used as bait. No information available on population size or if it is still ongoing.	AVIL
SFLU	CO	AMA	Amazonas, Putumayo	X	<2008-2018		X					X				O		X					X	X			X		NO	Activity is very scarce nowadays.	AVIL, MOSQ,
SFLU	CO	AMA	Amazonas	UNKN	<2008		X										X	X					X	X		X			NO	Activity is very scarce nowadays.	AVIL
SGUI	CO	ATL	Magdalena, Córdoba	UNKN	1986-<2005						X	X						X					X	X			X		**YES**	Yes, but we don´t know the impact over population.	AVIL
TTRU	CO	ATL	Bolivar, Magdalena, Golfo de Morrosquillo	NO	<1988-1997					X	X	X					X	X					X	X			X		NO	No, because this activity is very scarce nowadays.	AVIL
TTRU	CO	PAC	Choco, Nariño	UNKN	1993-2009		X					X					x	X					X	X			X		**YES**	An estimation of 3 individuals/ month used as bait. No information available on population size or if it is still ongoing.	AVIL

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
SATT	CR	PAC	Province of Puntarenas	X	2000-2018		X					X		X		X	X		X				X			X	X		**YES**	Situation continues and possibly growing, and started with the beginning of shark finning in the region.	RODR
SFRO	CR	PAC	Province of Limón	X	2008-2018		X					X		X		X	X		X				X			X			**YES**	Situation continues and possibly growing, and started with the beginning of shark finning in the region.	RODR
TTRU	CR	PAC	Provinces of Guanacaste and Puntarenas	X	2000-2018		X					X		X		X	X		X	X			X			X			**YES**	Situation continues and possibly growing, and started with the beginning of shark finning in the region.	RODR
DDEL	EC	PAC	Puerto López, south Manabí	X	2016		X					X		X				X			X	X	X						**YES**	Information from SM/M18/SAW08 using cetaceans as bait in Fish Aggregation Devices (FAD).	CAST
GMAC	EC	PAC	Cojimies, north of Manabi	X	2016		X					X		X				X			X	X	X						**YES**	Information from SM/M18/SAW08 using cetaceans as bait in Fish Aggregation Devices (FAD).	CAST
GMAC	EC	PAC	Puerto López, south Manabí	X	2016		X					X		X				X			X	X	X						**YES**	Information from SM/M18/SAW08 using cetaceans as bait in Fish Aggregation Devices (FAD).	CAST
IGEO	EC	AMA	Cuyabeno, Napo, Yasuni, Aguarico	X	1995-2016						X	X						X				X	X						**YES**	Occasional bycatch, not quantified, but may be important in a region with low river dolphins density values.	TRUJ, UTRE
SATT	EC	PAC	Puerto López, south Manabí	X	2012		X					X		X				X			X	X	X						**YES**	Information from SM/M18/SAW08 using cetaceans as bait in Fish Aggregation Devices (FAD).	CAST

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
SFLU	EC	AMA	Cuyabeno, Napo, Yasuni, Aguarico	X	1995-2016						X	X						X				X	X						**YES**	Occasional bycatch, not quantified, but may be important in a region with low river dolphins density values.	TRUJ, UTRE
UNSM	EC	PAC	Santa Rosa, Santa Elena	X	2014		X					X		X				X				X	X						**YES**	Fernando Felix data and report in IWC SM/M18/SAW02.	CAST
SGUI	FG	ATL		UNKN		X	X		X			X					X					X	X			X			UNKN		
DSP	PE	PAC	Entire coast	X	1980-2018	X	X				X	X		X		X			X	X		X	X	X			X				CAMP
GGRI	PE	PAC	Southern Peru		2010	X	X				X		X		X							X	X				X				CAMP
IGEO	PE	AMA	Loreto	X	2010-2018		X		X		X	X	X	X	X	X		X	X	X	X		X	X	X	X	X		**YES**	Yes, as is a growing trend. Also locals in case of the cultural use in the Belen market.	CAMP, GILL
IGEO	PE	AMA	Ucayali	X	2010-2018		X		X		X	X	X	X	X	UNK		X	X	X	X		X				X		**YES**	Yes, as is a growing trend.	CAMP
IGEO	PE	AMA	Caballo Cocha, Bagazán, Requena	X	1990 to 2018		X				X	X	X			X		X	X	X	X	X	X	X					YES	There are often reports of bycatch in these **three strategic** areas, but also poisoning of dolphins accounting at least 45 dead dolphins during the last five years.	GILL, TRUJ

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
IGEO	PE	AMA	River Javari (border with Brazil)	X	2010-2016		X				X	X		X				X	X			X	X	X					YES	There are report of killing of dolphins for piracatinga bait specially from Peruvian fishermen.	MOSQ, TRUJ
LOBS	PE	PAC	Entire coast	X	1970-2018	X	X				X	X		X		X	X		X	X		X	X	X			X		YES	Reduction in proportion of landings. Distinct population of dolphins.	CAMP
PSPI	PE	PAC	Entire coast	X	1970-2018	X	X				X	X		X		X	X	X	X	X		X	X	X			X		YES	Almost no information available, distinct population.	CAMP
SFLU	PE	AMA	Amazon river, Caballo Cocha	X	1990 to 2018		X				X	X	X					X	X	X	X	X	X	X					YES	Ongoing bycatch.	TRUJ
SFLU	PE	AMA	Loreto and Ucayali	X	2010-2018		X		X		X	X	X		X				X	X	X		X				X				CAMP
TTRU	PE	PAC	Entire coast	X	1980-2018	X	X				X	X		X		X			X	X		X	X	X			X				CAMP
UNSM	PE	PAC	Central	X	2010		X				X					X						X	X				X				CAMP
SGUI	SU	ATL																													POOL
PBLA	UY	ATL	Maldonado, Rocha	UNKN	1970-2016?	X		X				X						X	X	X			X			X			NO	Information based on an online (SC_M18_SAW04).	PASS

Scientific name code	Country code	Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user			Cause for concern	Comment	Submitters
												Non-targeted				Targeted															
		Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International			
PBLA	UY	PLA	Montevideo, Canelones, Maldonado	UNKN	1970-2016?	X		X				X						X	X	X			X			X			NO	Information based on an online (SC_M18_SAW04).	PASS
PCRA	UY	ATL	Rocha		2010?				X				X						X				X			X			NO	A single case of use for decoration of false killer whale found stranded was recorded (SC_M18_SAW04).	PASS
PSPI	UY	PLA	Maldonado	UNKN	2010?	X						X						X					X			X			NO	A single case of consumption of Burmeister's porpoise derived from bycatch was recorded (SC_M18_SAW04).	PASS
DSP	VE	ATL	Margarita Island, northeast	X			X					X										X	X			X			NO		BRIC
IGEO	VE	ORI	Orinoco river basin	X		X	X	X				X	X	X		X	X		X	X		X	X			X		X	**YES**	Used as bait and for cultural use since 1990 until 2008; 840 individuals counted but almost 6 year without information on fish harvest, used as proxy used to estimate the captures of Boto..	BRIC
SATT	VE	ATL	Margarita Island,northeast	X			X					X										X	X			X			NO		BRIC
SCLY	VE	ATL	Margarita Island, northeast	X			X					X										X	X			X			NO		BRIC
SFRO	VE	ATL	Margarita Island, northeast	X			X					X										X	X			X			NO		BRIC

		Location		Time		Use						Source animals						Information source					Who takes the wildmeat			Consumer, end user					
												Non-targeted				Targeted															
Scientific name code	Country code	Ocean and river basin code	Region	Ongoing	Period of activity													Direct observation	Direct comm.	Anecdotal	Social media	Scientific	Locals	Migrants	Transient	Local	National	International	Cause for concern	Comment	Submitters
SGUI	VE	ATL	Maracaibo lake	X		X	X				X	X	X	X		X	X	X	X	X	X	X	X			X			**YES**	Hunting of *Sotalia g.* for meat and bait, direct capture of 4-5 individuals per week; 5 individuals monthly bycatch. Numbers increasing in the last four years.	BRIC
SGUI	VE	ORI	low and middle Orinoco river basin	X			X					X	X	X		X	X		X	X		X	X					X	**YES**	Direct capture of *Sotalia g.* in Orinoco river to use as a bait, also has been reported its use for cultural purposes to replace *Inia g.*	BRIC
SLON	VE	ATL	Margarita Island, northeast	X			X					X										X	X			X			NO		BRIC
TTRU	VE	ATL	Margarita Island, northeast	X			X					X							X	X		X	X			X			NO		BRIC

Country	Country abbreviation
Argentina	AR
Brazil	BR
Bolivia	BO
Chile	CL
Colombia	CO
Costa Rica	CR
Ecuador	EC
French Guiana	FG
Peru	PE
Suriname	SU
Uruguay	UY
Venezuela	VE

Submitter	Submitter short
Ana Carolina Mereilles	MERE
Cecilia Passadore	PASS
Cédric Gilleman	GILL
Cristina Castro	CAST
Elizabeth Campbell	CAMP
Enrique Alberto Crespo	CRES
Enzo Aliaga Rossel	ROSS
Fernando Trujillo	TRUJ
Frederico Mosquera	MOSQ
Gabriel Melo-Santos	MELO
Isabel Cristina Avila	AVIL
Javier Rodríguez-Fonseca	RODR
Maritza Sepulveda	SEPU
Miriam Marmontel	MARM
Monique Pool	POOL
Salvatore Siciliano	SICI
Vera de Silva	SILV
Victor Utreras	UTRE
Yurasi Briceño	BRIC

Ocean and river basin	Ocean and river basin code
Amazon River basin	AMA
Atlantic Ocean	ATL
Central	CEN
Madeira River basin	MAD
Orinoco	ORI
Pacific Ocean	PAC
Rio de la Plata	PLA
Tocantins-Araguaia River basin	TOAR

Species scientific name	Scientific name short
Cephalorhynchus commersonii	CCOM
Cephalorhynchus eutropia	CUET
Delphinus delphis	DDEL
Delphinus spp.	DSP
Globicephala macrorhynchus	GMAC
Grampus griseus	GGRI
Inia geoffrensis	IGEO
Inia geoffrensis boliviensis	IGBO
Kogia breviceps	KBRE
Kogia sima	KSIM
Lagenodelphis hosei	LHOS
Lagenorhynchus australis	LAUS
Lagenorhynchus obscurus	LOBS
Lissodelphis peronii	LPER
Megaptera novaeangliae	MNOV
Phocoena spinipinnis	PSPI
Physeter macrocephalus	PMAC
Pontoporia blainvillei	PBLA
Pseudorca crassidens	PCRA
Sotalia fluviatilis	SFLU
Sotalia guianensis	SGUI
Stenella attenuata	SATT
Stenella clymene	SCLY
Stenella frontalis	SFRO
Stenella longirostris	SLON
Steno bredanensis	SBRE
Tursiops truncatus	TTRU
Unidentified small cetacean	UNSM
Ziphius cavirostris	ZCAV

Report of the Workshop on Identifying Key Research Questions for the Modelling and Assessment of Whale Watching Impacts (MAWI)

Report of the Workshop on Identifying Key Research Questions for the Modelling and Assessment of Whale Watching Impacts (MAWI)[1]

The Workshop was held at the Confindustria building in La Spezia, Italy, on 5-6 April 2018, immediately before the 32nd Conference of the European Cetacean Society. The agenda is given as Appendix A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

New welcomed the participants (listed in Appendix B). She explained that the goals of the International Whaling Commission (IWC) Scientific Committee's Modelling and Assessment of Whale Watching Impacts (MAWI) intersessional working group are to define those research questions and hypotheses that will best benefit our understanding of whale watching impacts, identify key locations that are both suitable and amenable to addressing these research questions, and assess the available modelling tools. These goals are consistent with Action Items 1.3, 2.1 and 2.2 of the IWC's Five Year Strategic Plan for Whale Watching.

As a starting point, the Workshop participants **recommended** that their discussions ultimately be placed within a Strategic Framework, supported by a Decision Tree. The latter was defined as a series of linked decisions that would enable users to prioritise research. The former would aid managers in their policy choices. The Framework's goal would be to ensure that the recommendations and concerns raised in the Workshop were applicable to the wider community interested in the potential impacts of whale watching. While the detailed Framework and Decision Tree were not constructed over the course of the Workshop, it was **agreed** that the report would be used to build them in the near future. The Framework and Decision Tree should be consistent with, and complement, the Five Year Strategic Plan.

In their discussions, participants used established IWC whale watching definitions and terminology (see Parsons *et al.*, 2006) and considered the following types of whale watching (which in practise may occur simultaneously): (1) commercial vessels; (2) recreational vessels; (3) 'swim-with' encounters (in-water interactions); (4) land-based; (4) air-based, both fixed-wing aircraft and helicopters; (5) recreational drones; and (6) food provisioning.

1.2 Objectives of this Workshop

The objectives of the Workshop were to identify the impacts of whale watching that are of greatest concern, define the research questions that will enable assessment of these impacts, determine which data should be collected to address these questions, foster collaboration amongst stakeholders and identify where there is the current capacity to implement this research, as well as how to foster capacity building in other locations of operational concern.

1.3 Election of Chair and appointment of Rapporteur

New was elected Chair and Rose was appointed rapporteur.

2. BACKGROUND – SUMMARY OF 2014 WORKSHOP

New gave a presentation on the progress of the MAWI initiative to date. In 2014, a workshop was held at the International Marine Conservation Congress in Glasgow to begin to address MAWI's goals (New, 2015; New *et al.*, 2015). The workshop identified the need for a unified platform that provided an integrated, coordinated approach to assessing the impacts of whale watching. Two main components of this platform were the need to identify key research questions and increase communication amongst stakeholders, which led to the organisation of this workshop.

[1] Presented to the meeting as SC/67b/Rep03.

3. IMPACTS OF WHALE WATCHING

3.1 General

In discussion, it was noted that, while the Scientific and Conservation Committees are generally concerned with population level impacts, welfare indicators (a measure of impact on individuals) not only may provide a proxy for population health, but may also inform ethical and social license implications, and should not be neglected (e.g. Papastavrou *et al.*, 2017). It was generally noted that new methodologies and technologies (e.g. drones) have made it increasingly possible to measure and collect data on welfare indicators, such as stress hormone levels and other health indices, including body condition and skin lesions. This is a promising avenue for future study of whale watching impacts. However, it was also noted that in many situations, isolating whale watching pressure as a cause of these and other impacts might be difficult. Other stressors, such as pollution or other sources of noise present in the environment, may also affect cetacean welfare and health.

There is a preponderance of data on whale watching impacts already available on small cetaceans, but comparatively fewer on large whales. MAWI was originally conceived with a focus on large whales for this reason. However, the participants **agreed** that it was vital to take all data currently available, which is primarily on short-term behavioural reactions (see below and Item 5.1), and assess them with current and new modelling techniques, in order to move beyond short-term impacts and estimate or predict mid- and long-term (population level) impacts on cetaceans. Ideally, managers can use such modelling to establish Limits of Acceptable Change (see Item 6.1) (e.g. the magnitude of a decline in foraging time due to whale watching pressure that will be tolerated before managers respond) in targeted populations. It was urged that every effort be made to leverage the existing datasets available on small cetaceans to collect similar and other data on large whales.

Participants spent some time generating a list of potential impacts from whale watching, on both cetaceans (cetacean-related) and people (sociocultural-related), including operators, local communities and tourists. The intent was to guide both natural and social science research by providing a foundation for developing research questions that appear most urgent from a conservation and management perspective. While each location at which whale watching is occurring will have unique challenges, the goal was to establish either a universal list of impacts of concern or a universal set of criteria for identifying impacts that could be evaluated relevant to a specific location. The participants **agreed** that both natural and social science research needs to proceed in tandem. Many management regimes are based on the best available science; this needs to include both social and natural science as they are equally vital to successful management of whale watching.

Participants also concurred that it was important, for each location and species, to prioritise impacts of concern. It was not considered possible to develop a universal 'trigger' for management decisions for all impacts everywhere, but developing universal criteria for prioritising impacts was considered possible. The lists below are of the impacts of greatest concern generally, but the prioritisation will differ between locations and species. Universal criteria for prioritisation, which could be used to generate lists of impacts of concern for each location and species, currently do not exist. The participants **recommended** that universal impact prioritisation criteria be developed as a future task of the MAWI initiative, to be incorporated into the Decision Tree (see Item 1.1). Once particular impacts are identified as priorities for a location or species, researchers will know which data to collect and which modelling approaches may be most appropriate.

3.2 Impacts

3.2.1 Cetacean-related

Participants **agreed** that changes to vital rates and life history (e.g. survival, reproductive success, calving intervals) and their population-level effects (e.g. changes in abundance) were of the greatest concern, but were difficult to measure, difficult to attribute to a particular pressure and often detected long after significant impacts to a population had already occurred. Therefore, participants focused on other impacts as proxies that could be used to inform potential effects on life history parameters, recognising the role that modelling could play in predicting the long-term implications of some short-term indicators. In addition, it was noted that abundance estimates, while important, can be time-consuming and expensive to produce, requiring extensive data collection over significant time periods to detect trends; therefore, again proxies could be used (such as changes in age structure), particularly in developing regions where resources are scarce.

Numerous behavioural (short-term) impacts of whale watching have been relatively well-studied, particularly in small cetaceans, including changes in deviation index (path of travel), dive durations, resting patterns, group cohesion and behavioural budgets. Other potential impacts have received less study, particularly in large whales, and participants focused on these concerns. They **agreed** that the following potential cetacean-related whale watching impacts were of greatest concern. These concerns were due to proven impacts (in well-studied small cetaceans), or because of potential effects of whale watching that are not well understood:

(1) Acoustic impacts (from human-produced noise), e.g.
 (a) Loss of foraging opportunities
 (b) Masking
 (c) Changes in types, sound level, or rates of vocalisations

(Acoustic impacts were considered the most likely to be universal, e.g. not location or species specific).

(2) Changes in spatial use, e.g.
 (a) Distribution
 (b) Feeding/breeding areas
(3) Temporal shifts, e.g.
 (a) Mating season
 (b) Migration
(4) Changes in population/age/social structure
(5) Changes in energy expenditure
(6) Effects on health indices, e.g.
 (b) Cortisol and other stress hormone levels
 (b) Body condition, including skin lesions
 (b) Increased incidence of disease (due to immunosuppression)
 (b) Microflora
 (b) Toxicology
(7) Disturbance of known individuals (via photo-identification)

Impacts to vulnerable sectors of the population, such as calves, who may have learning or nursing opportunities interrupted by whale watching, were also considered important. It was emphasised that all of these impacts are species-specific and may differ according to the type of whale watching vessels (e.g. motorised vs. non-motorised) or the type of whale watching activity (e.g. provisioning operations may require additional data to be collected, such as the prevalence of begging behaviour). Estimating the physiological impact (e.g. increased stress levels) from parameters measured in the field (e.g. respiration rate) has been or can be ground-truthed with captive studies for small cetaceans, but for large whales, only field studies are possible. Therefore, developing field methodologies and appropriate modelling approaches to link the field parameter with the physiological impact should be given priority attention for large whales.

Participants mentioned a variety of other impacts, such as harassment (including the rising popularity of close encounters to take 'selfies' with the animals), boat strikes, and for provisioning situations, vandalism, changes in foraging patterns and serving as an attractant to predators. However, these were considered less urgent because they were not as severe, were infrequent or were less universal in prevalence. Some concerns, such as increases in marine debris (from vessels), pollution (both in-water and in air), introduction of invasive species and increases in disease prevalence, were also considered important, but were set aside from current consideration due to the difficulty in isolating whale watching as a cause. In addition, it was noted that new technologies used for research might also contribute to impacts, either inherently (e.g. drones) or by allowing animals to be located more easily by recreational vessels. Habituation was also flagged as a concern, as overt reactions may 'fade' over time, while impacts (e.g. elevated stress levels) remain. Finally, it was noted that cumulative and synergistic impacts must be considered as much as possible, especially when modelling mid- and long-term impacts.

3.2.2 Sociocultural-related

Participants also generated a list of sociocultural-related impacts of whale watching. These were further divided into positive and negative impacts. It was clarified that not all listed impacts were proven to occur; for example, several studies have indicated that changes in attitudes amongst whale watchers toward the environment have been short-lived and have not led to significant conservation action on their part. The participants **agreed** that the sociocultural-related impacts of whale watching of greatest concern were:

(1) Positive
 (a) Opportunity to raise issues of wider conservation concern, e.g. climate change
 (b) Changes in attitudes toward environment
 (c) Changes in conservation-related behaviour

(d) Changes in economic indices
i. Direct effects
ii. Indirect effects
iii. Induced effects
(e) Creation of human ambassadors
(f) Opportunity to share cultural knowledge
(2) Negative
(a) Loss of cultural traditions
(b) Conflicts with other user groups (e.g. fishermen, ferries)
(c) Exceeding capacity of an area through an influx of people to a whale watching area (e.g. researchers, workers, tourists)
(d) Creating unrealistic expectations of wildlife interactions

While impacts on human safety, including human injuries/fatalities due to provisioning or in-water interactions, were considered a concern, such impacts are generally a priority only for managers where provisioning or in-water interactions occur and therefore were not included in the list.

Participants **agreed** that natural science researchers should collaborate with social science experts (see also Items 6.3 and 7), to ensure that these impacts are addressed satisfactorily. It was suggested that a range of experts should be consulted and included in research projects to ensure a holistic approach and improve capacity for making informed management decisions. For example, a natural science researcher might partner with an economist, conducting two research projects in tandem, to ensure the most comprehensive and useful data relevant to management were collected.

4. DEFINE KEY RESEARCH QUESTIONS

4.1 General

Participants **agreed** that any location chosen as a study site needs to be assessed for baseline information before research on the impacts of whale watching can commence. This baseline information includes, but is not limited to: (1) the species being watched; (2) their conservation status and recovery potential including, e.g. their abundance and distribution; (3) the reason they are using the area, e.g. foraging, breeding, migrating; (4) the predictability of their presence; and (5) the identification of any data gaps. This information will need to be considered carefully depending on the length of time whale watching has been occurring in the area. 'Baseline' information may not be baseline, but instead more of a benchmark, if whale watching has been underway for some time, whereas it is truly baseline if whale watching has yet to be established (but is anticipated) or has only just started.

Given the importance of social science research to understanding the impacts of whale watching (see item 3.1), the participants identified the need for baseline data on the socio-political aspects of whale watching as well. This baseline information includes, but is not limited to: (1) economic importance of whale watching; (2) cultural values that may be affected; and (3) knowledge of the governance of the region.

It was acknowledged that it may be difficult to secure investment (e.g. of researchers and funding) in 'naïve' locations, where whale watching is likely but not certain to begin. One solution suggested was to focus research attention on locations that already have baseline data from past research projects initiated for reasons other than whale watching concerns, such as Iceland. Another was to focus baseline research on locations that cetacean populations may occupy as they recover or expand (and where whale watching may commence once they do), as appears to be occurring in Argentina with the southern right whale (*Eubalaena australis*), which is now being resighted in areas from which it disappeared during the whaling era. However, it was noted that most models, including PCoD (see Item 5.1), do not require pre-whale watching data to generate impact projections into the future, so this is more a management than a modelling concern.

Several participants also emphasised that research questions should be prioritised according to management needs. Researchers should confer with managers in order to identify those data that are most critical to the local management regime, as well as the targeted cetacean population. Academic research, and even research addressing clear impacts but which managers cannot mitigate with current management tools, may be interesting and eventually useful to conservation. However, priority should be given to questions addressing specific needs as identified by managers, especially when designing experimental approaches that seek deliberately to introduce stressors to the targeted population. One way forward to achieve this is to develop collaborative projects amongst managers, scientists and other stakeholders, which will facilitate the inclusion of results in management decisions. Finally, experimental designs that include Limits of Acceptable Change or dose/response curves are of particular importance as they provide a useful benchmark to managers as part of their effort to ensure sustainable practises.

4.2 Research questions

4.2.1 Cetacean-related

Participants generated a list of potential, cetacean-related research questions for each of three behavioural response timescales (see Item 5.1) – short-, mid-, and long-term. It was emphasised that new technologies have made experimental designs increasingly feasible for whale watching impacts research and such approaches are encouraged. The following list of research questions was not intended to be exhaustive, but was meant as an initial effort to identify the most urgent or important issues to be addressed or variables to be assessed:

(1) Short-term
(a) What are the acoustic impacts of whale watching on cetaceans?
(b) What features of whale watching vessel noise (e.g. intensity [sound level], quality [e.g. abrupt and frequent changes in speed; short or long intervals between watching bouts]) are most relevant to the animals?
(c) What are the ramifications of using engine quieting technology, e.g. acoustic impacts may be reduced, but other impacts, such as boat strikes, might increase due to a decline in cetaceans' ability to detect vessel presence.
(d) What are the relative impacts on cetaceans from recreational, as opposed to commercial, vessels?
(e) Do commercial vessels influence the behaviour of recreational vessels?
(f) What are the combinations of vessel size, numbers and time spent with cetaceans that have the greatest impact?
(g) What are the short-term responses (including welfare indicators) to whale watching that could serve as 'triggers' to managers or researchers that there is concern regarding potential population level effects?

(h) Do different types of whale watching, especially those that lead to very close approaches (including in the pursuit of 'selfies') or include swimming with or provisioning the animals, have different impacts or different severity of impacts?
(i) Do short-term impacts vary for different age classes (i.e. calves vs. juveniles or adults)?

(2) Mid-term
(a) What are the energetic costs for cetaceans targeted by whale watching?
(b) Are cetaceans changing their spatial distribution in response to whale watching?
(c) Are cetaceans changing how or when they use an area in response to whale watching?
(d) Do social structure and social networks of the targeted population change in response to whale watching activities?
(e) Is there a change in the age structure of a population due to whale watching?

(3) Long-term
(a) Has there been a change in the species' vital rates (e.g. survival, reproduction) that is leading to a decline in the population?
(b) Could the short- and mid-term effects (e.g. changes in energetic costs) of whale watching lead to a population-level effect?
(c) Given that welfare indicators in individuals can precede population-level impacts, what are the relevant indicators (including health indices) for a specific population?
(d) Given the long timeframe required to identify population trends from monitoring data, how can potential trends be predicted on a timescale that is useful for management?

In addition, the participants **agreed** that a key question, regardless of the timeframe, is whether the impact of whale watching can be isolated from the other stressors the animals may face, such as pollution or environmental fluctuations (see Item 3.1). An extreme example of the problems that arise from confounding factors was the possibility of conducting a whale watching study in an El Niño year. Significant impacts might be observed in such a year that would be absent in another, but could be erroneously attributed to whale watching pressure rather than El Niño. This emphasises why long-term research and monitoring commitments to whale watching locations are essential (see Item 6.1), to account for large-system fluctuations of this nature.

Some participants felt that focusing research on impacts such as health indices should not be a priority because of the risk of erroneously attributing observed changes to whale watching, rather than to other causal stressors. Others felt that identifying whale watching locations where the environment is relatively pristine, with less environmental degradation, could be a strategic way of addressing this issue. Nonetheless, all participants concurred that monitoring population health was important (and see also Item 7 for additional discussion of the inability of attributing impacts to whale watching when there are other stressors present).

It was generally noted that most studies have been on the impact of commercial operations. The participants **agreed** that recreational vessels in many instances may be of greater concern, as they are often more numerous, less aware of codes of conduct or regulations and more difficult to influence, due to their often transient nature in an area. For these and other reasons, it may also be more difficult to study the impact of recreational vessels, but it was **agreed** that an effort to do so nevertheless should be made, at least in situations where recreational vessels may be having a disproportionate impact on vulnerable populations. In addition, simply acknowledging the potential for recreational vessels to have equal or greater impact could help the relationship-building process between researchers and operators (see Item 6.1). Finally, it was noted that while it is more difficult to manage recreational whale watching vessels individually, in some locations time-area closures and zoning (entry-prohibited areas), where targeted animals are most vulnerable and recreational vessels are excluded, can be effective mitigation.

On this last point, it was noted that there are on-going efforts internationally to establish protected areas, such as the IUCN's Important Marine Mammal Areas (IMMAs) initiative. The participants **recommended** that any effort to establish protected areas in the whale watching context should collaborate with such initiatives, rather than begin anew. While IMMAs have no regulatory authority, they do provide locations with international recognition and can be used as leverage for research funding, local regulatory attention or simply public relations prestige. The IMMAs initiative may also be less threatening to user groups (including whale watching operators), who may be resistant to the concept of 'protected areas'.

It was noted that at a minimum, the number of recreational vessels present on average in a whale watching area can be monitored. One suggestion was to treat areas with regulated (stable) numbers of commercial vessels, but increasing numbers of recreational vessels, as a 'natural' experiment. Any increases in impacts seen in such an area that researchers attribute to whale watching could plausibly be attributed specifically to recreational vessels.

4.2.2 Sociocultural-related

Research questions in this category identified as important included:

(1) What are the retention rates of information and attitude changes reported by whale watching tourists?
(2) What proportion of income from whale watching operations remains in the local community, particularly in locations where operators do not live locally?
(3) How much of a knock-on effect does a local whale watching industry have on the related tourism economy (e.g. hotels, taxi companies)?
(4) What specific information, including about communities and tourists, will help improve management?
(5) What socio-political, socioeconomic or cultural factors contribute to management failures?
(6) What is the impact on operator income of various management requirements?
(7) When the stated intent of a whale watching operation is to 'create human ambassadors for the environment', how effective is this effort?
(8) Do children make effective human ambassadors?
(9) How does one study tourists who are transient, only present in an area for an order of days or at most weeks?
(10) Due to the sheer density of recreational vessels, how can they be approached for surveys and other data collection?

Some research has been conducted on these questions, particularly information retention, including by participants attending this Workshop, but more work needs to done. It was noted that, as with managers, social science researchers and whale watching operators should communicate more directly with passengers, to find out what they want to learn. Framing information so that it is not perceived negatively (even if it is objectively negative, such as the impacts of climate change) is key and can be critical in improving retention rates.

Much more work also remains to be done on the socioeconomics of whale watching. Economy and business experts should be recruited to address this question specifically in whale watching communities, working in partnership with natural science researchers.

5. DATA COLLECTION

5.1 Existing data collection techniques and corresponding analytical approaches

Pirotta gave a presentation on existing data collection techniques and corresponding analytical approaches. The effects of disturbance from whale watching vessels have been mostly assessed at the individual level, measuring short-term changes in behaviour and activity state via Markov chains. A meta-analysis of visual studies on cetacean responses to whale watching has been used successfully to identify common responses across species and contexts. Acoustic data can also be used to monitor animal occurrence and activity, but appropriate modelling tools (e.g. hierarchical modelling) must be used to account for potential interference of vessel noise with the detection of cetacean vocalisations. Other important applications of acoustic methods include the estimation of communication rates, acoustic masking and ranges of various impacts.

Pirotta noted that existing behavioural studies suggest that responses to whale watching are highly context-dependent. As a result, a lack of detectable responses does not imply the lack of an effect, especially as there may be physiological responses to disturbance. New data collection methods, such as dedicated tags and the collection of blow or faeces, could make it possible to measure stress hormones and thus estimate a physiological response. However, regulatory and management bodies are generally interested in population-level effects, which has motivated the development of quantitative frameworks, such as the population consequences of disturbance (PCoD), to link short-term changes in behaviour or physiology to changes in population dynamics. Different options for estimating the population-level effect of whale watching exist; individual-based models have been successfully applied to simulate individuals over time and explore long-term effects. These models can be extended to include a socioeconomic component in order to test the effectiveness of different management scenarios. Future studies should prioritise informing such predictive approaches, using emerging technologies (e.g. drones) to non-invasively measure potential biological responses, such as the variation in individual body condition.

The participants thanked Pirotta for an excellent presentation. In discussion, it was concluded that, in order to adequately address any research questions, there were three levels of organisation to be considered: (1) identification of the nature of whale watching stressors (e.g. number of boats, acoustic footprint); (2) the cetaceans' exposure to these stressors (e.g. duration of daily/seasonal period animals are subjected to presence of whale watching vessels; multiple boats for short daily periods of watching vs. one or two boats for long daily periods of watching); and (3) the biological responses to these stressors. Biological responses could occur at three timescales: (1) short-term (e.g. changes in behaviour); (2) mid-term (e.g. changes in spatial use); and (3) long-term (changes in vital rates and population dynamics). Data collection and modelling techniques should therefore be approached with the appropriate level of organisation in mind. While the majority of whale watching studies have focused on the short-term effects on the animals' behaviour, as noted above, in order to understand the mid- or long-term effects of whale watching it is necessary to have information on exposure. Also, data need to be collected at a sufficient level of detail to model effects.

It was noted that identifying locations for experimental approaches should be done strategically, considering where research can generate the best and most useful results for the most cost-effective investment of time, resources and funding. However, researchers should not pursue work merely because it is easy logistically, funding is readily available, or to simply replicate already common studies. An example would be the short-term effect of whale watching on bottlenose dolphins, *Tursiops* spp. It is generally accepted that vessel presence affects this species' behavioural budget. Future bottlenose research, even at new locations, should focus more on the mid- and long-term effects of whale watching. This may require the development of new research tools and approaches to analysing the data. For those species where the short-term effect of whale watching is unknown (e.g. the majority of large whales), short-term data are still necessary before research can move into understanding the potential mid- and long-term effects of whale watching.

5.2 Use of platforms of opportunity to help understand the potential effects of whale watching

Currie gave a presentation on platforms of opportunity (e.g. whale watching vessels, fishing vessels, cruise ships, ferries, seismic survey vessels, oil-rig platforms). Platforms of opportunity have been used to study a wide variety of cetacean species (e.g. humpback whales *Megaptera novaeangliae*, sperm whales *Physeter macrocephalus*, Bryde's whales *Balaenoptera brydei*, fin whales *B. physalus*, killer whales *Orcinus orca*, common and Antarctic minke whales *B. acutorostrata* and *B. bonaerensis*). These platforms are low-cost alternatives to dedicated research surveys, which can facilitate long-term monitoring of populations. Inherent biases must be addressed, but if they are, then platforms of opportunity can be used to monitor changes in distribution, relative abundance and habitat use, and can potentially relate these changes to whale watching pressure. Further, platforms of opportunity can be used to assess potential impacts of whale watching on behaviour, foraging, nursing and mating, as well as to monitor compliance with codes of conduct and regulations.

The participants thanked Currie for an excellent summary of the issues surrounding platforms of opportunity. It was noted that this, or a similar summary, could be a useful addition to the IWC's guidance for researchers and managers on the benefits and limitations of platforms of opportunity for data collection.

In discussion, it was noted that citizen science is increasingly used to collect data. There are several available mobile phone apps that allow members of the public to input basic data (e.g. species sighted, estimated number of animals, location, weather), although where these data are archived or how they are utilised varies. It has been noted that without positive feedback on their data collection effort, some potential citizen scientist recruits can become disenchanted and cease to participate in these projects. Participants

recommended that any project collecting citizen science data should clearly and consistently communicate with the public how their data are used in research.

Standardisation of data was also discussed. There are now multiple apps available that allow the public to collect data while watching whales and the designers have rarely if ever coordinated to ensure the most relevant information is collected. The IWC Five Year Strategic Plan on Whale Watching prioritises data standardisation under Action 2.1. The Scientific Committee has previously offered guidance on standardising the types of data collected, but to date, this guidance has had limited influence on app design. Wider promotion of this guidance is needed; the IWC could also provide guidance on the apps themselves, at least at the level of informing the public of the various apps that are available and their specifications.

It was noted that one substantive drawback of apps is that they encourage recreational vessels using them to approach closer than regulations allow or codes of conduct recommend. Educating the public on why the use of apps should not be used as an excuse for close approaches by recreational boaters should be a priority for managers, researchers and NGOs, in areas where this has been observed.

The value of monitoring compliance when researchers are on board a whale watching vessel was discussed. The presence of a researcher might influence an operator to comply with regulations or a code of conduct, biasing any monitoring results. Compliance might fall when researchers are not on board, although it was also noted that some studies indicate that compliance is independent of the presence of researchers on board. In addition, it was noted that many compliance studies on small cetaceans indicate a low level of compliance irrespective of the presence of a researcher on board. This led to the suggestion that passengers could be recruited to monitor compliance. Should a distance finder capability for mobile phones be developed, this could greatly enhance the ability of passengers to monitor compliance.

It was noted that one issue commonly considered a weakness of platforms of opportunity – the fact that multiple whale watching vessels approach groups of cetaceans, making it difficult to establish the start of a first approach for surveying purposes – was not a weakness if the research question related to cumulative approach impacts. Research questions, identifying data to be collected and study design should always carefully take available data collection methods, including from platforms of opportunity, into account.

Given the concerns expressed about the potentially greater impact of recreational vessels, the participants **recommended** that managers give serious consideration to recruiting commercial whale watching vessel operators and passengers as monitors of recreational vessel activity and behaviour. In some jurisdictions, this is already happening or is being considered. In addition, consideration should be given, in jurisdictions where recreational vessels are a significant management issue and regulations governing recreational vessels exist but are difficult to enforce, to placing a dedicated observer on board commercial whale watching vessels, whose sole responsibility would be monitor compliance of recreational vessels.

5.3 Identify whether the types of data currently being collected are sufficient for addressing key research questions

In discussion, it was noted that it would be a useful exercise to attempt to identify archives of whale watching-related data (including on paper data sheets), at universities, government agencies and elsewhere, that may be lying neglected. At least some of these data may be suitable, with review and preparation, to inform modelling approaches that did not exist when the data were collected. In addition, rather than continue to replicate behavioural response studies in different locations, it should be a priority to take available short-term behavioural data and model it to assess mid- and long-term impacts (see Items 3.1 and 5.1). In fact, new research should avoid replicating short-term behavioural impact study designs. The exception is when studies are focused on species (including several large whales) where there is reason to conclude that there exist sufficient differences in ecology and behaviour from well-studied species to justify adding these results to the literature. Finally, there is a considerable body of research on impacts from other stressors, such as noise, and this work should be reviewed to help determine best experimental and modelling approaches for whale watching impacts.

One participant noted that some government agencies are collecting track data from registered commercial whale watching vessels using GPS technology, as well as sightings data. These are routine data collections, not tied to any particular research question or project, but allow the agencies to monitor commercial effort and cetacean distribution data. The participants encouraged the sharing of such data with researchers wherever possible.

It was suggested that a proxy for direct impacts, such as boat strikes by recreational vessels, might be certain types of injuries and scars. Recreational vessel strikes would be rarely observed and almost never reported, while passengers are highly likely to report strikes from commercial whale watching vessels. Injuries inflicted by various sizes of commercial vessels could be categorised and then attributed to recreational vessels when similar injuries are observed.

It was noted that in many locations, passive acoustic recorders could be deployed and are a cost-efficient, minimal-effort method for collecting important data on ambient soundscapes, sound levels of engine noise and cetacean occurrence and vocal behaviour. Such data collection was considered especially relevant for large whales, where masking of important communication signals may be a significant impact of whale watching.

There was discussion of the feasibility of using drones to collect relevant whale watching impact data. Drones may prove particularly valuable for collecting body condition data and age structure information (e.g. the number of calves present in a group). They may also capture finer details of behaviour, particularly for large whales where the aerial perspective enlarges the observational field of researchers beyond the water level, but also for small cetaceans, as high-resolution stills can now be captured from drone video footage of these smaller, faster moving species. Some limitations of drones were noted, including the need for high visibility in air and water and the possibility of the drone itself causing disturbance (see Item 3.2).

It was noted that a key gap in many areas is adequate metrics for determining whether management measures are actually proving effective at mitigating whale watching impacts. This lack was identified as an urgent need for managers and it was suggested that adequately monitoring and measuring management effectiveness should be built into the Strategic Framework (see Action 5.4 of the Five Year Strategic Plan).

There was discussion of the need to aid developing locations and those with limited resources to monitor impacts. This will require identification of those aspects of short-term effects that may serve as management 'triggers' (see Item 4.2), as well as specific strategies to help such areas build the capacity to collect the data required (see next item).

6. CAPACITY BUILDING

6.1 Impacts of whale watching on social and biological components of an area

Coscarella gave a presentation on a holistic approach to studying whale watching as part of a 'sociobiological' system (i.e. the interaction between the human socio-political system and the biological system facing whale watching pressure). He offered a case study for how researchers' direct involvement in management increased the influence of whale watching studies on the subsequent behaviour of managers and operators (see also Chalcobsky *et al.*, 2016). Whale watching targeting southern right whales began in Península Valdés, Argentina, in 1973. Building a long-term collaboration with stakeholders, including managers, has allowed the sustainable development of whale watching in this location. This holistic approach focused on setting Limits of Acceptable Change by assessing indicators in four dimensions: Social, Political, Economic and Biological. Social indicators include the percentage of acceptance of whale watching by local inhabitants; attitude changes in people on conservation issues affecting whales; and the importance of the whales in daily life. Political indicators include regulations and governance. Economic indicators include inclusion in the provincial budget of whale watching 'credits' and incentives to whale watching operators. Biological indicators include whale respiration rates (observed from land via theodolite) in the presence and absence of whale watching vessels and an evaluation of the proportion of whales being affected by the activity. Respiration rate data indicate that the presence of whale watching vessels is the only variable influencing changes; collecting these data is a first step toward building bioenergetic models to assess the mid- to long-term impacts of whale watching. All of these indicators will be incorporated into a Bayesian Decision Framework.

The participants thanked Coscarella for an excellent presentation. In discussion, it was noted that only in the past 15 years has the research started having a positive and measurable influence on management and operator decisions to protect southern right whales from whale watching pressures. Operators can feel threatened by researchers and the prospect of management, so it is essential to address these concerns. It was noted that it can take some time before sufficient trust is built to allow productive and effective communication amongst stakeholders, including researchers. Participants **recommended** that whale watching research be planned for the long-term (in the order of 5-10 years or more) and research sites chosen strategically to ensure that long-term investment is possible and indeed likely.

It was noted that research can produce detailed, comprehensive and compelling science, yet lead to ineffective or even no management action. In response to this, participants emphasised that, in the case of whale watching and managing its impacts on cetaceans, natural science researchers must take on a greater role in the management process. It was suggested that researchers can, and should, actively engage with managers, both in discussing research questions prior to undertaking research (see Item 4.1) and in providing support for the decisions made by managers, which they already do in several locations. Without effective communication, constructive relationships and direct involvement by the researchers in the local socio-political and socioeconomic systems, science will be insufficient in effecting necessary management change. Yet without good science, necessary management decisions will also be impossible to effect. Both are essential to cetacean conservation and effective whale watching management. It was suggested that a potential way to increase communication was the identification of knowledge brokers who could facilitate researchers' connections within management agencies, or the use of knowledge transfer partnerships to directly link researchers with managers to co-produce information.

It was emphasised that in order for research to effectively influence policy, management and operator decisions, researchers must become members of the community, to build trust. Researchers cannot behave as outsiders who come into a whale watching community, collect data, offer information and then leave (also known as 'parachute science'). For successful conservation and management, they must build relationships and learn to communicate effectively with all stakeholders, including local, regional and/or national managers and policy-makers, whale watching operators, local residents and tourists. The participants **strongly recommended** that researchers studying whale watching impacts learn effective communication skills in order to facilitate this process.

It was noted that the principle difference between whale watching operators and many other user groups is that, as an industry, they are often more willing to adapt their behaviour to protect the 'resource'. This is, in part, because whale watching customers often perceive the operators as a 'green' industry and the operators may perceive themselves in the same context. Therefore, interacting positively with operators to influence their behaviour through bottom-up management, such as voluntary codes of conduct, may be more effective in certain situations than top-down management through regulations. Researchers working within a bottom-up management regime may go so far as to, at times, consider refraining from publishing research results that would be perceived negatively, such as on poor compliance, until they have discussed these results with operators, in order to build trust.

It was noted that relationship-building can be an on-going process, as government officials, at all levels, turn over with time, changing the receptiveness to recommendations. Researchers would also benefit from understanding local socio-political and socioeconomic issues, as these may explain the resistance at times of managers and operators to recommendations based on the best available science. Managers' and tour operators' receptiveness to advice from researchers can vary widely due to political, social or economic issues that can hinder communication and re-order management priorities. It was noted that, when research results fail to influence management, the research could still have value from a political standpoint. That is, sometimes it is important for researchers to be present and continue their work, despite a lack of current management response, to maintain and build relationships into the future, when the socio-political climate may change and eventually allow action.

It was noted that in some areas, the whale watching public may be resistant to certain research; for example, passengers on whale watching vessels may not be receptive to biopsy sampling. The suggested solution was an extension of researcher-manager relationship-building. Researchers must also build relationships with the public; whale watching is a business and researchers must market their work to ensure its acceptance by whale watching customers. Researchers should consult and collaborate with business experts who are proficient in conservation marketing.

A final point was made about the political climate in a whale watching location. Issues such as government corruption or tourist/researcher safety should be considered when determining appropriate research locations. This should be part of the Strategic Framework – areas where corruption or safety are concerns should be assessed and approached carefully before decisions to initiate research projects are made.

Despite the various difficulties or complexities inherent in building capacity where it does not currently exist, participants **agreed** it was important to make the effort to expand capacity, as otherwise there can be no expansion of, or diversification in, the research community, locations or questions.

6.2 Current capacity to address the defined research questions

In discussion, the participants noted that social science is just as important, and often more so, as natural science when addressing whale watching impacts (see Item 3.1). This is because it enables understanding of the motivations, attitudes and challenges of all stakeholders who play a role in whale watching and without whose cooperation management and compliance are hindered. Indeed, whale watching management is about managing people rather than cetaceans. Unfortunately, the importance of social science is often ignored and even challenged by policy-makers, managers and natural science researchers. Capacity for such research is therefore often limited. Many locations of operational concern could benefit from investment in well-designed social science research.

Participants recognised that in many locations of operational concern, particularly in developing countries, small whale watching operators may have neither the capacity nor the willingness to cooperate with researchers. Building that capacity, but particularly improving the willingness to work with researchers, should therefore be a priority. Long-term researcher presence and relationship-building are essential to accomplish those goals. Wherever such capacity and willingness are already present, data sharing amongst operators and with researchers should be encouraged. Sharing can be facilitated with the establishment of centralised websites or other mechanisms to ensure data are suitably archived and accessible to all stakeholders.

It was also suggested that wherever capacity and willingness amongst operators to have dedicated naturalists or researchers on board are present, this should be actively encouraged. While in some cases, operators themselves can collect data, in many cases the focus and priority for the captain of a vessel are the passengers and safe operation of the vessel. However, having a dedicated, trained data collector on board, who could also serve as the naturalist, addresses this concern.

It was noted that, in developing countries in particular, new and emerging technologies for research may not be utilisable. In some, it is a simple case of lacking capacity; in others, it might be a governance issue. However these problems are addressed, a strategic approach should be made to ensure any investment in overcoming the obstacles will have maximum benefits and minimum costs.

As an example of the former problem, researchers might collect blow or faecal samples to assess for stress hormones, but must export the samples, as no laboratories in-country can handle the analysis. However, one participant cautioned against assuming establishing such a laboratory (or adding to the capacity of existing labs) will solve this problem. Some assurance should be secured in advance that the added capacity will be useful into the future. It cannot be assumed that a new lab, for example, will always be used frequently enough to justify its existence and it could eventually become dormant and even derelict from lack of use.

As an example of the latter, drones might not be legal for researchers to fly in some countries. Before investing in such new technologies or designing a study that requires them, it is important to assess the governance structure of a country or region to ensure that all planned methods are both legal and properly permitted.

An issue of growing concern within the research community at large was identified as potential gaps in modelling capacity. It is imperative to ensure a new generation of experts in modelling is available to meet the needs of various natural science research projects seeking to determine long-term impacts of various environmental threats and human activities. It was noted that, rather than trying to train biologists in advanced statistics or modelling, natural scientists building partnerships and research collaborations with expert mathematicians who are interested in marine conservation could be a more fruitful way forward. It was also suggested that making certain resources easily available online, including statistical software or packages for open-source languages such as R, would be useful.

A major gap identified in capacity world-wide is sources of funding for whale watching research and associated management initiatives. While some locations, such as the Arabian Sea where a critically endangered population of humpback whales is targeted by an emerging whale watching industry, are receiving much-needed attention, others constantly struggle to attract needed investment of funds and other resources, particularly in long-term whale watching research and management. It was noted that this may be because potential funding sources look at whale watching as a business with its own revenue, without recognising that this money is not necessarily available to researchers. One participant suggested that affluent whale watching companies with a strong commitment to conservation could potentially subsidise research in other locations where whale watching is conducted by indigenous or local operators with limited income. Tourists from affluent or developed regions might also be willing to participate in a scheme where a small ticket surcharge goes to subsidising research in less affluent or developing regions of operational concern. Appropriate, context-specific marketing would be a critical element in making such a surcharge scheme acceptable and/or successful.

Participants **agreed** that identifying and securing – and even creating – reliable sources of funding for whale watching research should be a major focus of any initiative such as MAWI and the IWC's Five Year Strategic Plan. It was suggested that international bodies such as the IWC could create a whale watching research fund, to which Contracting Parties contribute (similar to the existing Small Cetacean Research Fund) and to which researchers competitively apply for grants. In addition, a future task for the IWC might be to identify locations where funding is a critical need, allowing foundations and granting agencies to more strategically evaluate research proposals. It was noted that a reliable source of funding in developing areas would strongly support capacity building.

6.3 Global areas of particular operational concern and approaches to building capacity

In discussion, it was determined that it would not be possible at this Workshop to develop a comprehensive list of locations where impacts research as envisioned by the MAWI initiative can be undertaken in the near future. This is, however, the ultimate goal – to identify specific locations of operational concern where research addressing key questions, relevant to local management, can be undertaken with sufficient investment to leverage existing capacity and build additional capacity where needed. Action 1.2 of the Five Year Strategic Plan is related to this goal. Participants did make a preliminary, very general list of possible locations, where whale watching impacts are clearly occurring but long-term investment in research is currently lacking, including Panama (Bocas del Toro), Sri Lanka, southeast Asia, the southwest Pacific Islands (e.g. Samoa, French Polynesia), Africa and the Philippines. It was noted that there may be locations of operational concern where such research is not yet possible due to logistical, socio-political, economic or other reasons. Such areas should either be prioritised for capacity building or set aside at present to focus on locations where investment will be most effective.

Participants **agreed** that the goal of any research project undertaken under the MAWI initiative should be to produce data useful to management, conducive to modelling, acknowledged and accepted by operators and of course beneficial to the animals. ‘Parachute science’ should be actively discouraged, as it not only hinders trust-building but can actually breed distrust of researchers in the local community. Long-term investment of resources, effort and funding should be built into any research project. This should include capacity to train researchers to communicate effectively with managers and other stakeholders (see Item 6.1), to partner with social science and business experts and to effectively market research projects to the public. It was emphasised that, rather than limiting recommendations to students interested in marine mammals or marine conservation to pursue a career in biology, it would be equally and even more effective to encourage such students to study, *inter alia*, social sciences, policy, communication, economics or statistics, as these disciplines are essential to managing the impacts of environmental threats and human activities on cetaceans.

One suggested approach to building capacity was for outside and local researchers, NGOs and managers to partner and collaborate with local and regional universities. Identifying and recruiting local and regional graduate students in an effort to create and support a research community in the whale watching area can help ensure the continuation of a research project, which may need to persist for years in order to collect sufficient data, particularly for modelling purposes. Even temporary programmes such as ‘junior year abroad’ or exchange programmes can help identify students who might return to an area and continue research into the future. It was suggested that graduate research programmes sending international students to a whale watching region might include a requirement to train local students to continue collecting data. It was also suggested that formal exchange programmes be developed in which graduate students from each university would spend time in both institutions, thus further building capacity in students who would be likely to return to, or remain in, an area of operational concern. It was noted that such partnerships with universities already exist in several locations, while in others this approach has been infrequent or non-existent. Participants **recommended** that international bodies addressing whale watching impacts, such as the IWC, emphasise the value of academic collaborations, as international recognition and promotion of academic partnerships with whale watching research projects could be useful in encouraging local universities to see the value in such efforts.

Another approach discussed was conducting local and regional workshops, with local operators, managers and other stakeholders, under the aegis of international bodies such as the IWC. Workshop organisers should seek to bring operators from developed regions with successful management approaches to offer input to fellow operators in developing regions of operational concern. This approach has been used in various locations, sometimes successfully, sometimes not. In the latter case, while attendance at some workshops has been high, ultimately the information on codes of conduct, research results and the like has been ignored or under-utilised, for various social or political reasons. It could also be because the input offered by the workshop organisers was not prepared or packaged in a way that appealed or made cultural sense to the attendees, or because local operators did not react well to outsiders ‘telling them what to do’. When workshops do not improve a situation of significant operational concern, it should be a priority to determine why and to identify and implement other approaches that may be more effective, which may include simply reframing information so it can be assimilated and appreciated within the local culture.

In general, it was noted that research should be considered and planned under the assumption that conditions in the identified location will be ideal, but then modified as necessary to accommodate local capacity and circumstances. For example, alternative data and data collection techniques should be considered and/or incorporated into research programmes when capacity for ideal techniques is lacking. Building capacity under those circumstances should be factored into the research programme and funding requests as necessary and possible.

7. CONCLUSIONS AND RECOMMENDATIONS

The Workshop achieved a majority of its goals and objectives but was unable to go into depth on some important points, such as the type of data that need to be collected to address the research questions generated. The participants **recommended** the organisation of a third workshop whose principle focus would be to identify and develop specific research locations, research questions, data to be collected and study designs.

Participants **strongly recommended** that potential study sites be identified by this future workshop where a holistic approach using social and natural sciences, taking into account socio-political and socioeconomic factors, is both possible and welcomed. It is essential for researchers to build a network of international and local experts, managers, NGOs and others with needed expertise, to ensure appropriate input and assistance is readily available as research projects progress.

It was emphasised that each whale watching location needs to be assessed individually, but global tools can and should be developed and made available, to assist in assessing and addressing a local industry. Chief amongst these was the **recommendation** to develop a Strategic Framework supported by a Decision Tree, to assist users to prioritise research and assess policy choices (see Item 1.1). It was noted that the Framework must include the viewpoints of all of its potential users – tour operators, local business owners, managers, the public (customers) and researchers – and identify the communication links amongst them. Using the Decision Tree, researchers should assess the research and management tools available in each location, including research technologies, modelling methods and monitoring and enforcement capacity, so their research is relevant (e.g. to managers addressing established or emerging industries, whose management needs will differ); there is no immediate use for answers to questions managers are not asking.

Participants **strongly recommended** the development of toolkits and resources so global stakeholders can ideally be directed to a single location (a 'repository') where these resources can be accessed. The IWC is developing several resources, such as its Whale Watching Handbook, and these can be expanded to include, *inter alia*, modelling toolkits and statistical packages that can be downloaded. Such software is dynamic and constantly being upgraded – any repository would need to keep pace with these updates. Ideally, managers would also find resources of value in this repository; for example, the IWC's compendium of whale watching regulations and codes of conduct. A tagging toolkit, available at *http://www.animaltags.org/doku.php*, was offered as an example of the freely available type of resource whale watching researchers need to develop.

The participants **strongly recommended** that data collection be standardised to the extent possible, on a global scale (see Item 5.2). They urged collaboration and coordination with other bodies, such as the Secretariat of the Convention on Migratory Species, which are also undertaking work streams to expand understanding of the impacts of whale watching on cetacean populations, to avoid unnecessary duplication of effort and to optimise standardisation of data collection, methodologies and general approaches to various areas of operational concern. This will also aid in the comparability of studies, greatly furthering the understanding of the potential impacts of whale watching.

It was noted that, from a management perspective, the difficulty in isolating whale watching as a cause of observed impacts when multiple stressors are known to be present in the environment can be addressed by focusing attention on populations whose conservation status is sub-optimal (see also Item 4.2.1). In such situations, while it may not be possible to assign responsibility to whale watching operations for a decline in population or poor health status, it can reasonably be assumed that whale watching pressure is having a cumulative/synergistic impact, thereby justifying a precautionary approach to whale watching management. For example, a migrating whale may pass through areas facing a series of stressors, then arrive on a feeding or breeding ground where whale watching occurs. If whales' foraging or breeding behaviours are affected by this whale watching, then there is the potential that the role of whale watching as part of the cumulative effects of stressors could have an impact at the population level. Prohibiting or restricting whale watching under such circumstances might need to be considered by managers, as it is a stressor they have the ability to mitigate.

It was also noted that regulations can be rigid and unresponsive to changing circumstances; building in adaptive management principles to regulations and codes of conduct is important from the outset. However, in practice, adaptive management has rarely been effectively implemented, in part because of the extended time horizon and lack of continuity in managers and other stakeholders over that period. Improving implementation of adaptive management principles should be a focus of whale watching management.

As a final point, participants wished to highlight for the IWC that whale watching development and management can be extremely complex, from a socio-political and socioeconomic viewpoint. The impact of whale watching on indigenous cultures, small community structures (which can be strained and changed by the influx of whale watching infrastructure and tourism) and so on, can be considerable, but engagement with local communities by managers and natural science researchers is often insufficient or initiated well after social impacts are already occurring. Additional complexities, such as whale watching developing in countries that conduct whaling, also need to be considered. Participants **strongly recommended** that the IWC approach its increasing focus on whale watching holistically, integrating the work of the Scientific Committee's Sub-Committee on Whale Watching and the Conservation Committee's Standing Working Group on Whale Watching as much as possible.

8. ADOPTION OF THE REPORT

The report was adopted by email correspondence on 22 April 2018 at 17:30. The Workshop participants thanked New for her constructive and helpful guidance during the discussions and Rose for her efficient rapporteuring.

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Appendix A

Agenda

1. Introductory items
   1.1 Convenor's opening remarks
   1.2 Objectives of this Workshop
   1.3 Election of Chair and appointment of Rapporteur
2. Background
3. Impacts of whale watching
   3.1 General
   3.2 Impacts
      3.2.1 Cetacean-related
      3.2.2 Sociocultural-related
4. Define key research questions
   4.1 General
   4.2 Research questions
      4.2.1 Cetacean-related
      4.2.2 Sociocultural-related
5. Data collection
   5.1 Existing data collection techniques and corresponding analytical approaches
   5.2 Use of platforms of opportunity to help understand the potential effects of whale watching
   5.3 Identify whether the types of data currently being collected are sufficient for addressing key research questions
6. Current capacity
   6.1 Impacts of whale watching on social and biological components of an area
   6.2 Current capacity to address the defined research questions
   6.3 Global areas of particular operational concern and approaches to building capacity
7. Conclusions and recommendations
8. Adoption of the report

Appendix B

List of Participants

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Report of the Workshop on Assessing the Cumulative Effects of Multiple Stressors on Cetaceans at the Individual and Population Level

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The Workshop was held in Bled, Slovenia, on 23-24 April 2018, immediately before the SC/67b meeting. The list of participants is given as Annex A.

1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

The Workshop was chaired by Hall. Ylitalo and Cippriano were appointed as rapporteurs and Hall thanked them for the invaluable contribution to the workshop.

Hall welcomed the workshop participants, thanked them for attending the meeting and looked forward to a lively and wide-ranging discussion on how the impact of cumulative effects of multiple stressors on cetacean populations could be investigated and potentially progressed with the support of the Scientific Committee's sub-committee on Environmental Concerns. It was agreed at IWC/SC/67a that a workshop on this topic would provide an important contribution to the initiatives currently being undertaken in other fora, and would be a particularly timely activity following the recent publication of the US National Academies of Sciences, Engineering and Medicine report on 'Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals' (National Academies of Sciences, Engineering, and Medicine, 2017). This topic is important to IWC through its concern about the effect of environmental change on cetaceans, particularly noted in IWC Resolutions 1998-5 and 2007-7. It also follows on from an IWC workshop on Habitat Degradation that was hosted by the University of Siena in 2004 (IWC, 2006).

2. BACKGROUND AND OBJECTIVES

Hall opened the Workshop by briefly summarising the report of the IWC Habitat Degradation workshop (IWC, 2006). Although the emphasis of the 2004 workshop was on the impact of deterioration in cetacean habitat rather than explicitly on cumulative effects, there was much overlap between the focus and objectives of that workshop which were to: (1) develop frameworks and approaches that could be taken to understand the impact of habitat degradation on cetaceans, both at the individual and population levels; (2) consider case studies in relation to the species and populations to which the frameworks could be applied; (3) help assess current understanding of cetacean critical habitat and evaluate issues such as habitat quality indices; and (4) review methodological considerations including modelling approaches.

The objectives of the current workshop were similarly broad and were to:

(1) Summarise the methods available for assessing cumulative effects of multiple stressors on cetaceans (both individual and population).
(2) Discuss and review those methods and frameworks.
(3) Identify case studies on specific species and populations (identifying their pros and cons) to which the frameworks, or components of the frameworks, could be applied.
(4) Develop criteria required for robust case studies.
(5) Recommend the means and ways of progressing this work and communicating the importance of recognising the potential impact of multiple stressors on cetaceans to a wider audience.

3. METHODS AVAILABLE FOR ASSESSING CUMULATIVE EFFECTS OF MULTIPLE STRESSORS ON CETACEANS

L. Thomas gave a summary of the findings of the 'Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals' reported by National Academies of Sciences, Engineering, and Medicine (2017), of which he and Schwacke, also present at the Workshop, were National Academies of Sciences (NAS) committee members responsible for undertaking this work. The remit of that work was to: (a) review scientific understanding of cumulative effects; (b) to assess theoretical and field methods used to estimate the effects of anthropogenic stressors and (c) to identify new approaches to improve these assessments. The NAS committee distinguished between cumulative risk (combined risk from exposure to multiple stressors) and aggregate risk (combined risk from exposure to one single stressor from multiple sources or pathways). Both are of relevance to cumulative effects assessments. A major concern behind such assessments is the possibility of synergistic interaction – i.e. cases where the effect of multiple stressors is greater than the sum of the effects of the stressors applied independently. However, as is well recognised in toxicological studies, such cases can arise simply because the dose-response function is non-linear. Although no experimental studies on interactions between multiple stressors have been undertaken for marine mammals, the NAS committee reviewed meta-analyses of laboratory and small-scale studies on other animals and plants. They found no strong patterns that would enable generalities to be made about when to expect interactions between stressors, except one: if stressors act along the same causal pathway then interaction may be more likely.

Given the considerable scientific uncertainties, the NAS committee created a flowchart to enable managers to determine when possible interactions may be of concern when considering permitting a new anthropogenic stressor or change in existing stressor (Fig. 1). They also created a conceptual framework for considering cumulative effects, the so-called PCoMS model (Population Consequences of Multiple Stressors, Fig. 2). This builds upon the earlier PCoD (Population Consequence of Disturbance) model (King *et al.*, 2015). The framework assumes that stressors cause physiological and behavioural responses in exposed animals; these responses may have direct, acute effects on demographic parameters (survival and reproduction) or may have chronic effects by affecting animal health. Individual effects on demographic parameters may lead to population consequences depending on the number and level of animals affected, and on population processes such as density dependent responses. A key concept is that animal health acts as a buffer, integrating the short-term responses to stressors and affecting the longer term demographic parameters. Health may be quantified in several ways (see Fig. 2).

[1] Presented to the meeting as SC/67b/Rep10.

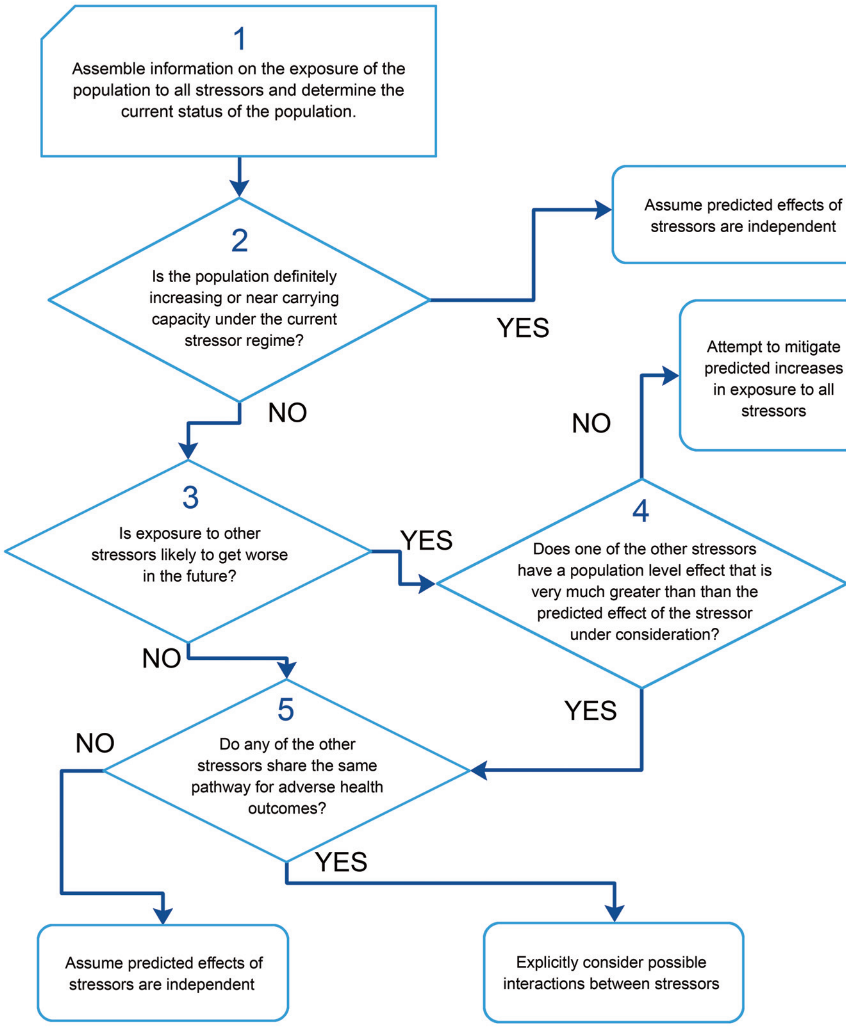

Fig. 1. A decision tree for identifying situations where studies of the possible interactions between stressors should be given a high priority when considering the effect of a focal stressor on a population (Reproduced with permission from National Academies of Sciences, Engineering, and Medicine 2017).

Lastly, given the considerable scientific uncertainty around cumulative effects assessment, the NAS committee recommended a dual approach to dealing with the possibility of ecological surprises: relatively inexpensive population surveillance to detect major unexpected declines combined with monitoring of early-warning indicators of population-level responses, if such indicators can be found.

In discussion, the Workshop participants noted the importance of understanding the definitions for the various terms used in the cumulative effect models presented and summarised above. For example, ecological drivers such as climate change would not be considered a stressor whereas a reduction in food and increases in temperature resulting from climate change, would be considered as stressors. The terminology used is therefore defined in a glossary which is given in Annex B and this is consistent with the terms used in the US National Academies of Sciences report.

The Workshop noted that multiple levels of responses could be included in the models including physiological and behavioural responses and that responses to stressors could differ across species. Transgenerational effects were not explicitly considered in the NAS models but the Workshop noted the need to include these effects in specific cases. There was also some discussion regarding the use of qualitative assessments, which are often proposed approaches for assessing cumulative effects of multiple stressors, *in lieu* of other options. However, it was suggested that these qualitative approaches are no substitute for real data collection for a quantitative approach. Although response scales were also considered by the NAS committee, it was most concerned with measurable behavioural and physiological responses. The Workshop also recognised the difficulties in collecting response measurements and noted that the collection of baseline information is critical, particularly prior to the introduction of a novel activity that would introduce an additional stressor into cetacean habitat.

This led to a discussion on dose-reduction experiments in which effects might be observed following the decline in a single stressor. One example discussed was a study that reported reduced ship traffic and vessel noise in the Bay of Fundy, Canada after 11 September 2001 and decreased levels of stress-related faecal hormones in North Atlantic right whales during the same time frame (Rolland *et al*., 2012). However, it was recognised that there are limitations to these studies and opportunities for them to be applied to situations where multiple stressors are impacting cetacean populations are likely to be limited.

3.1 Modelling the population consequences of exposure to multiple stressors

L. Thomas gave a second talk covering in more detail modelling approaches to assessing cumulative effects. The presentation focused on the PCoD and PCoMS frameworks, and the cases in which the former has been implemented to

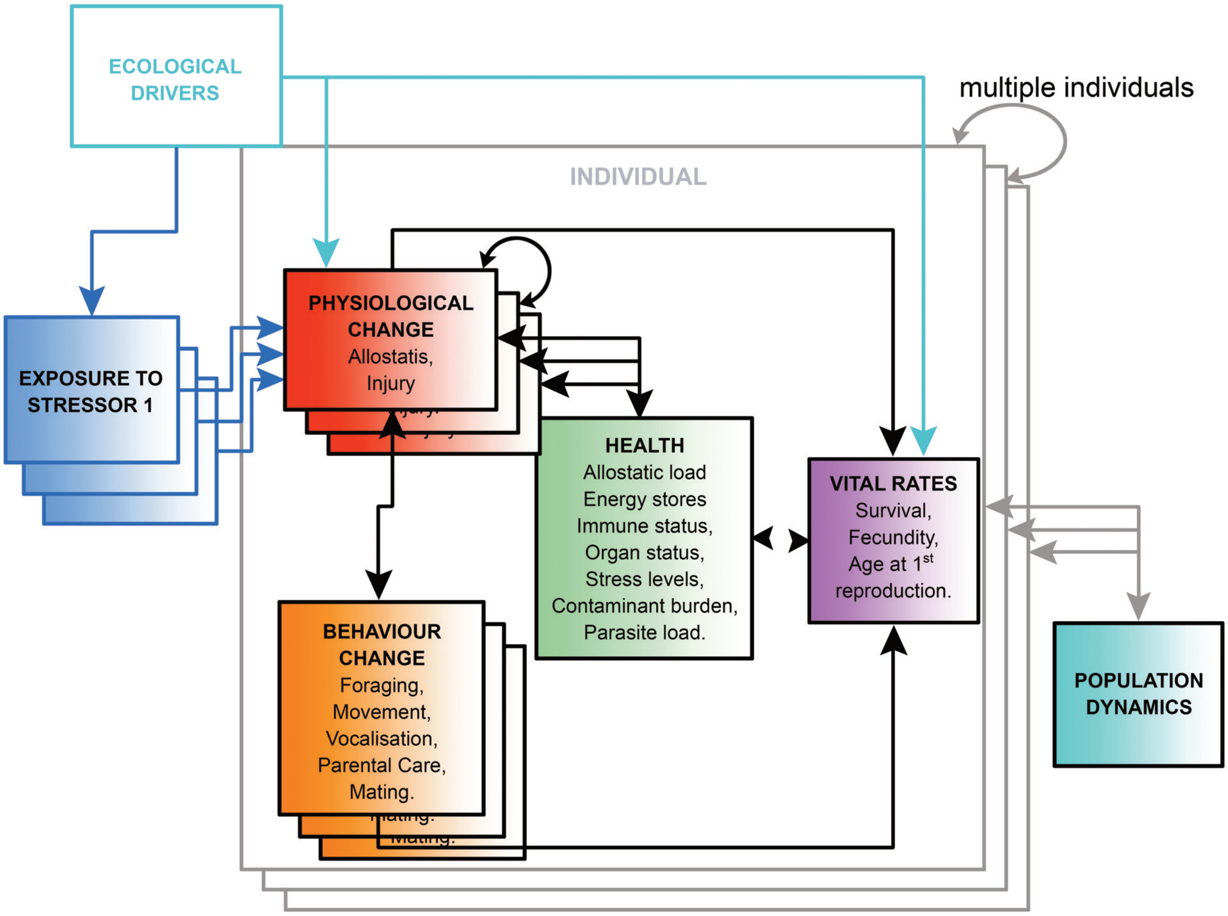

Fig. 2. The Population Consequences of Multiple Stressors (PCoMS) framework. Each compartment (bold box) in the framework represents one or more quantities (variables) that evolve over time. Compartments are connected by arrows that represent causal flows (also called 'transfer functions'). Stressors affect multiple individuals (indicated by the stack of light boxes), causing population-level consequences (Reproduced with permission from National Academies of Sciences, Engineering, and Medicine 2017).

date. These cases have largely focused on body condition and energetics as the basis to quantify individual health. In cases where data are available, these are used to construct detailed data-based models, often focused on modelling individual energy budgets in either a stochastic or deterministic framework. In more data-poor situations, formal expert elicitation has been used to parameterize the overall PCoD model, or in some cases to bypass the health component by proceeding to directly elicit putative relationships between stressor dose and ecological response. Although considerable progress has been made in formulating PCoD models, PCoMS represents a much more challenging problem that will require considerable effort to approach.

The Workshop discussed this approach in more detail and agreed that collecting population monitoring data and health measures for cetaceans are likely to be the components of the model in which advances towards understanding cumulative effects could be made. An example was the 1999-2000 gray whale unusual mortality event that occurred along the west coast of North America, in which observations of strandings indicated that something was happening to individuals in the population, prior to the population level effects being detected. Although both population dynamics and health assessments are equally subject to imprecision, development of new methodologies for population assessments (e.g. environmental or eDNA, unmanned aerial vehicles (UAV) and passive acoustic monitoring approaches) and health measures (e.g. hormone measurements in faeces or blow and body condition determined through aerial photogrammetry) will improve data precision. The Workshop suggested that efforts should be directed towards the further development of both of these assessments (health and population) to reduce uncertainty in the risk models. However, the Workshop recognised that population abundance assessments, particularly for cetaceans, are typically relatively imprecise and are primarily used to detected large scale changes in abundance over time. Without associated health assessments, it is difficult to determine the mechanism(s) behind any detected declines, which are often only observed sometime after the onset of the cause or causes. Therefore, monitoring health parameters was emphasised rather than focusing on population abundance and trend monitoring.

Furthermore, the Workshop noted that for understanding exposure impacts and determining the most appropriate metrics, animal movements (e.g. 'residents' in exposure zone are exposed for a long period of time compared to animals that move through the zone and have a much shorter period of exposure) must be included.

3.2 Health assessments and multiple stressors: challenges and opportunities

The need to more comprehensively assess the health of cetaceans is now widely recognised as a key component in making headway towards understanding cumulative effects of multiple stressors. Hall described a conceptual model for understanding the multiple risk factors involved in the

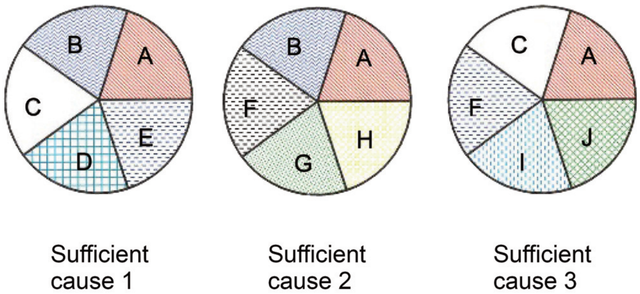

Fig. 3. Rothman's causal pie model. Three sufficient causes are illustrated, all resulting in the same disease or outcome. The sufficient causes are made up of different component causes.

occurrence of a given disease that was developed by Rothman in the 1970s (Rothman, 1976) in the field of human and veterinary epidemiology, the 'causal pie' model. Rothman defines risk factors (i.e. different disease-causing stressors) as individual or 'component' causes. Outcomes (that can be a specified disease or it can simply be all-cause mortality) result from the occurrence of a number of 'sufficient' causes, pathways through which the disease comprising multiple component causes may occur. Thus each sufficient cause is a causal pie comprising a number component causes (i.e. risk factors or stressors, Fig. 3). Several different causal pies may exist for the same outcome. If, and only if, all component causes of a sufficient cause are present, i.e. the completion of a causal pie, does the disease or outcome occur. The effect of each individual component cause hence depends on the presence of the other component causes that constitute a given causal pie. There is therefore no limit to the number of component causes.

The model can also assist in understanding interactions between component causes. For example, in Fig. 3, if G was a substance that did not exist then no disease would occur through sufficient cause 2 as the causal pie would not be complete. In this case component causes B and F would be biologically independent because they act through different pathways (sufficient causes 1 and 3). However, if G was then created, the disease could then also occur through sufficient cause 2 and since component causes B and F are also present in sufficient cause 2 they would interact. Component causes can be exposures of any kind, biotic or abiotic, intrinsic or extrinsic. Wensink *et al.* (2014) investigated the applicability of this model to ecological and evolutionary biology and illustrated the concept in relation to how component causes may accumulate through an animal's life course. Vital rates might be improving during an animal's life but causal pies of morbidity (disease) and death are being filled in during maturation and ageing making the distance to death shorter. The time at which component causes, i.e. the addition of stressors occur, will influence the likelihood that a given sufficient cause will be complete. So the causal pie model can assist in determining when and why exposures, risk factors, or stressors (component causes) have an effect. Component causes can also influence when other component causes have an effect.

One study design that is widely used in human and veterinary epidemiology to investigate the causes of a disease is the case control study. Hall then outlined how case control studies can be used to estimate an effect measure in causational epidemiological studies. The most robust method for understanding the relative risk of a disease is achieved by following individuals in a population that have been 'exposed' or 'unexposed' to the stressors of interest over time, to determine the occurrence of disease in each group (known as a prospective cohort study). The incidence rates for each group are calculated as the number of incident cases divided by the population at risk (or animal-time at risk). The relative risk (or incidence rate ratio) is then calculated as the ratio of the incidence rate in the exposed divided by the rate in the unexposed. It is important to specify the time period at risk because if you are looking at all-cause death then the longer the time at risk is, the more similar the incidence (of death) will be among the exposed and unexposed (if the time is long enough, the risk of death will be 100% in both groups resulting in a relative risk=1). However, this is generally only a viable option in a very limited number of cases for cetaceans where individuals can be consistently followed over time to determine exactly when disease or death occurred. Another option is to use a case-control approach. In this study design, individuals who have developed the disease (cases) and individuals without the disease (controls), are identified. The previous exposure to the stressors for each case and control is then identified. The case group is composed only of individuals known to have the disease or outcome and the control group is ideally drawn from the population that gave rise to the cases. The odds of exposure between cases and controls is then calculated and the ratio of the odds is calculated as the odds in the exposed divided by the unexposed. Odds ratios > 1 indicate the likelihood of disease is higher in the exposed, but the associated 95% confidence intervals must be considered when interpreting the results.

There is extensive literature in the medical field on this approach and it has drawbacks (DiPietro *et al.*, 2010; Szeker *et al.,* 2017). The odds ratio is a good approximation of the relative risk when the outcome is infrequent and becomes less reliable as the outcome becomes more common. In addition, the exposure of interest must precede the disease, something which may not be reliably determined for all stressors of interest. However, it has the potential to be applied to the problem of understanding the effect of multiple stressors on cetaceans, particularly as dead stranded animals can be used if the exposures or stressors of interest can be identified. An example of where this approach has been applied in cetaceans is a study in which the risk of infectious disease mortality following exposure to contaminants in harbour porpoise was investigated (Hall *et al*., 2006).

In addition, Hall presented a summary of the individual based model (IBM) approach (Effects of Pollutants on Cetacean Populations) (Hall *et al.,* 2018; Carlsen *et al*., 2004; Stow and Carpenter, 1994) that has been developed under the IWC Pollution 2020 initiative and how it might have some application for investigating the population consequences of exposure to multiple stressors, particularly those affecting immune function. This model quantifies the effects of PCBs on potential population growth rate, using maternal contaminant concentrations to modify calf survival and disease resistance. The states (live/dead, age, parturition and contaminant concentration) of individuals are simulated through time. Because IBM models incorporate stochasticity, multiple simulations produce a range of potential growth rates from which confidence intervals may be calculated. We refer to the growth rates as 'potential' because there is no attempt to incorporate density dependence into the model. The model simulates the fate of individual female dolphins, using published fecundity and survivorship data for case study populations. The model also simulates the accumulation of PCBs through transplacental transfer, suckling, and prey and loss of PCBs through female lactation (depuration). Maternal PCB concentrations then affect calf survival and disease resistance in a dose-dependent manner. Published information from laboratory animal models with associated uncertainty, was used to provide an estimated concentration-response function, due to the absence of data for cetaceans. The model can then be run under various scenarios of exposure to infectious diseases, the estimated impact on the population of a viral epidemic and the time to recovery explored. It is conceivable that if data on the cumulative effect of stressors (synergistic or antagonistic effects) which act on immune function (such as contaminants and biotoxins) were available, this could also be incorporated into the model. This data could also be from surrogate model species or from *in vitro* studies, in the absence of cetacean-specific concentration-response functions.

The Workshop thanked Hall for providing this summary.

4. REVIEW OF CUMULATIVE EFFECT MODELLING APPROACHES AND FRAMEWORKS

4.1 Health measures

The Workshop discussed the advantages and disadvantages of the modelling approaches and frameworks, and how they can be applied to studies of cetaceans. Health measures, including our ability to assess the magnitude of the stress response that could be used in cumulative effects models were discussed by the Workshop. Participants acknowledged that the term 'stress-levels' is often used in relation to the response of animals and humans to various risk factors or situations but that it is widely used without a full understanding of its meaning. Animals increase circulating 'stress hormones' such as the glucocorticoids, particularly cortisol as well as catecholamines following a stimulus. These responses are entirely normal and whilst they may indicate the presence of a stressor or a stressful situation, the animal is responding as it should in order to cope with the perceived danger. However, the health of the animal is in jeopardy when this endocrine response is inappropriately enhanced or reduced. The Workshop noted that stress response has several different arms – neurological (e.g. behavioural avoidance), cellular responses (e.g. indicators of oxidative stress) as well as the endocrine response, recognising that evaluating baseline data is essential before these additional stress response measures can be interpreted. However, instant response measures such as cortisol concentrations may be impossible to interpret without substantial context information. It was suggested that a review of stress responses from the cellular, neurological and endocrine perspectives and how they relate to marine mammals was needed and this was discussed.

Other health measures, such as body condition, may be more directly valuable but we need to understand the relationship between body condition indicators and population response measures, particularly changes in vital rates. And whilst it may seem that body condition is relatively easy to assess, in practice it is very difficult to accurately measure energy stores in cetaceans.

4.2 Vital rates

The Workshop noted that care is needed when defining reproduction, as pregnancy is not the same measure as the number of live births. For the suggested modelling approaches, 'successful reproduction' is generally defined as the number of offspring living to age one, as was seen to be the most useful measure. Adult survival estimates are often also needed but changes in overall survival rates can be very difficult to measure. Individual growth rates and energy balance or budgets are probably also linked to reproductive success rates, but the models at this stage only include observable rather than unobservable state changes.

4.3 Study designs

Reference populations for cumulative effect studies that differ in only a few exposures of interest (e.g. similar habitats with fewer vessels) might allow for valuable comparative studies.

The Workshop also discussed and considered the 'expert elicitation' approach, in which the synthesis of opinions of subject experts is utilised where there is insufficient data or when such data is unobtainable at the time an assessment is required. Expert elicitation is essentially a scientific consensus method that quantifies uncertainty and is an interim approach. Clearly background documentation is necessary for the experts involved in this approach, as is information on who was invited to participate, who participated and who declined. Although the Workshop noted that expert elicitation approach is not ideal, it does have value for filling in knowledge gaps in situations where decisions are needed quickly, as well as providing guidance on the potential use of data to address a particular problem. The Workshop noted that taking a precautionary management approach is another alternative to the expert elicitation, noting that this still essentially relies on opinion regarding where the level of precaution should be set.

5. ECOSYSTEM MODELLING

The Workshop received summaries of two relevant work streams being carried out by members of the Scientific Committee's sub-committee on Ecosystem Modelling.

5.1 Long-term environmental variability on whale populations

Cooke summarised the framework (developed by Cooke, 2007) for incorporating environmental variation into models of the net recruitment rate of baleen whales. Drawing from last year's report of the Ecological Modelling sub-committee Cooke described how they were investigating the effect of environmental variability on recovering populations of baleen whales (also drawing on earlier studies under MSYR working group). These modelling efforts projected population recovery trends using deterministic and stochastic-influenced models, for a range of assumptions, including no, medium, or long-term variability, and low, medium, and high-quality habitats. In early years, there were no differences between the stochastic and deterministic models. However, more fluctuations were observed in the future as baleen whale populations continue to recover. These models were also able to explore the effects of disturbance where they either reduce the amount of time spent feeding and where they reduce the effective reproductive rate. The Workshop thanked Cooke for his valuable input and noted that a dramatic decline in a population may be due to historic environmental changes which could occur at any time.

5.2 Individual-based energetic models

De la Mare described a modelling class library that links environmental characteristics relating to prey availability to population characteristics through the modelling of individual animals on daily or longer time steps. The model was originally developed to link rates of increase observed in depleted populations of baleen whales to characteristics in yield curves. In particular the model allows for density dependence to occur not only in births, but also in age-specific mortality and for the covariance in the demographic parameters to arise, all as emergent properties of the model. The model uses individual animal models with a detailed energy budget to determine reproductive success, growth and mortality in an environment where food has a patchy spatial distribution. The details of this model can be found in SC67b/EM07. All the major processes of the animal's seasonal activities are modelled including migration, breeding, and feeding. Their location and movement are specified by latitude, longitude, and velocity. Animals must search for food and look for new food patches when local food abundance falls due to the effects of local intra-specific competition. Animals accumulate long-term memories about locations where they can forage at specific times over multiple seasons, but with a forgetting coefficient to discount older memories. Complete forgetting occurs when the discounted memory falls below a threshold. The same structure could also be used to accumulate aversive memories relating to stressors. The model uses an environment with spatial grid structure that allows flexible modelling of spatial characteristics of prey through recursion, i.e. a cell on any level of a spatial grid can itself contain a finer scale grid. Each cell can have an arbitrary number of data values and parameters and could include information on local stressors. A cell address is fully resolved by any latitude and longitude that it contains and the smallest cell containing a given location is automatically selected. The model includes options to model individual feeding dives (De la Mare *et al.*, 2018) and searching behaviour (SC/67b/EM04) to locate individual prey schools.

De la Mare noted that the model is coded in standard C++ and is available on request to interested researchers. The Workshop participants thanked De la Mare for his input and appreciated that this approach would be potentially very constructive for assessing cumulative effects of multiple stressors.

The Workshop discussed the complexities involved in measuring energetics in cetaceans due to variability in space (e.g. depth, migration range) and time (e.g. seasonality changes). Blubber mass and thickness has been widely used as a measure of body condition for cetaceans, but more recently other techniques have been explored such as deploying telemetry tags to measure animal density and buoyancy (Miller *et al*., 2004), determine protein biomarkers and adipocyte size in blubber biopsy samples (Kershaw *et al*., 2018; Castrillon *et al*., 2017) and photogrammetry (Durban *et al*., 2015).

In addition, the prey field is well defined in the De la Mare energetic model whose dynamics is highly adjustable, and the scale of which can be refined in the energetics models. De la Mare noted that the type of feeder (e.g. specialist, generalist), as well as the effect of competition for animals that share the same environment, can be included in the model.

Transgenerational, epigenetic effects could also be incorporated into the De la Mare energetic model and this led to a discussion among the participants on the importance and potential impact of these effects. It was concluded that in some instances these transgenerational effects (e.g. on lower growth rates in subsequent generations where nutritional limitations were imposed in the previous generation) could be significant and consideration should be given to their impacts.

6. CASE STUDIES

A presentation of an assessment of the global threats to cetaceans, as well as four potential case studies for understanding the impact of cumulative effects were presented to the Workshop.

Avila presented a summary of her recent paper entitled 'Current global risks to marine mammals: taking stock of the threats' (Avila *et al.,* 2018). Based on a literature review of more than 3,000 papers over four years, the authors geo-referenced and encoded available information from more than 1,780 papers on marine mammal threats into a database, which is also available to the scientific community. Threats to 121 marine mammal species that occurred globally between 1991 and 2016 were included. From the database a series of risk maps were developed, linking information about species-specific vulnerabilities to large-scale species distributions, thus providing an assessment of how threat levels for marine mammals vary in space. Risk areas were produced based on binary (presence/absence) range maps using the core habitat. Risk severity was quantified with respect to: (1) number of species affected per cell; (2) proportion of affected species per cell of the total marine species present per cell and (3) number of threats documented per cell. The results show that almost all studied marine mammal species, 98% (119 species), were documented to be affected by at least one threat. Bottlenose dolphin (*Tursiops truncatus*) was the species with the largest range of diversity of threats. Incidental catch affected the most species (112 species), followed by pollution (99 species), direct harvesting (89 species) and traffic-related impacts (86 species). Risk areas were identified for 51% of marine mammal core habitat. The majority of local marine mammal communities are at high-risk in 47% of world coastal-waters. Higher risk areas were located mainly in temperate and polar coastal waters and in enclosed seas. However, risk areas differed by threat types and taxa. The risk maps presented in this study are based on documented threats and species requirements and are a more nuanced approach which could be a starting point for systematic and comprehensive global research and conservation efforts.

In addition, Avila presented unpublished results of the documented effect or outcome of the threats. Death and diseases/health problems were the major effect of the documented threats on the marine mammals between 1991 and 2016.

The Workshop thanked Avila for presenting information on a global mapping tool to visualize hot spots for cumulative effects for cetaceans.

6.1 Bottlenose dolphins in the US and UK

The common bottlenose dolphin (*Tursiops truncatus*) was proposed as a model species that could be highly amenable for studying the nature of cumulative effect interactions. A significant amount of information is currently available on baseline demographics and vital rates for *Tursiops*, and much has been documented regarding stressor effects and the health status of inshore stocks, particularly along the southeast U.S. and Scottish east coasts.

There are over 40 Bay, Sound, and Estuary (BSE) *Tursiops* stocks, managed as separate units by NOAA/NMFS, along the US Gulf of Mexico and Atlantic coast. Many of these stocks have been the focus of health, stressor exposure and effects assessments and photographic monitoring studies over the several decades. The health assessment studies have included temporary capture for hands-on sampling, comprehensive veterinary examination, blood and tissue analysis and satellite and/or VHF tag attachment. Aside from having extensive baseline health information, including established reference ranges for a suite of health parameters (e.g. normal ranges of blood values and body mass index), the BSE stocks have well characterised reproductive and age-specific survival rates (e.g. Kellar *et al.,* 2017, Schwacke *et al.,* 2017, Lane *et al.,* 2015, Wells *et al.,* 2014, Wells and Scott, 1990). In addition, BSE *Tursiops* remain in the inshore waters year-round, which can simplify stressor exposure assessments and facilitate photographic follow-up monitoring for longitudinal studies of effects. The multiple, independent stocks within the BSE habitats make *Tursiops* conducive for epidemiological study, allowing for populations with varying degrees of exposure to stressors to be compared.

Three specific BSE stocks are considered particularly good candidates for assessing cumulative effects. The first of these is the Southern Georgia Estuary System (SGES) stock, which has been followed since 2004 to assess the exposure and associated health effects of chemical contaminants. The SGES habitat has been highly polluted with persistent contaminants and these dolphins have been found to have some of the highest tissue concentrations of polychlorinated biphenyls (PCBs) ever reported for marine species (Balmer *et al*., 2011, Kucklick *et al.,* 2011). The PCB exposure is associated with disruption of thyroid hormones and suppressed immune function in the SGES stock (Schwacke *et al.,* 2012), and PCBs are well-established to cause immune suppression in other marine mammal species (Ross *et al.*, 1995,1996). Another risk for this stock is its potential exposure to morbillivirus. Health assessments of SGES dolphins conducted in 2015 determined that at least some members of the stock were previously exposed to the deadly virus (Rowles *et al.,* unpublished). Morbillivirus was determined to be the cause of a massive Unusual Mortality Event (UME) in 2013-2015, in which over 1800 dolphins stranded along the US Atlantic coast (*http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins 2013.html*). Morbillivirus infection, when not fatal, has been associated with long-term immune perturbations and chronic disease. The co-exposure to morbillivirus and high levels of PCBs, both of which are known to affect a common immune effects pathway, suggests a higher likelihood for effect interaction potentially leading to a synergistic and thus more severe impact on the population.

The remaining two *Tursiops* stocks of interest are within the Gulf of Mexico. One, the Barataria Bay stock, was heavily impacted by the Deepwater Horizon oil spill, which has led to chronic disease conditions (e.g. immune perturbations, altered adrenal/stress response, and lung injury) and reproductive impairment (Kellar *et al*., 2017, Smith *et al.,* 2017). Additional ongoing stressors in Barataria Bay include fishery entanglement and fluctuations in salinity, and more extreme and prolonged decreases in salinity are anticipated in future years with planned ecosystem restoration efforts. This low-salinity stress on top of the ongoing chronic oil-related disease conditions will certainly hinder the recovery of the population and potentially lead to synergistic effects on population health through interactions in the hypothalamus-pituitary-adrenal (HPA) pathway.

In contrast, injuries following the Deepwater Horizon oil spill were not documented for the St. Andrew Bay stock (along the Florida Panhandle), but this stock is being impacted by other environmental stressors which also have the potential for HPA pathway interactions. High concentrations of DDT, a persistent pesticide, have been found in the St. Andrew Bay dolphins; metabolites of DDT are known to be toxic to the adrenal gland and can lead to impaired adrenal hormone response and thus inappropriate or inadequate response to stress events. In addition, a high prevalence of human interaction (i.e. provisioning) has been documented in this stock, raising the question of how these multiple stressors may interact through the HPA pathway.

Other populations of bottlenose dolphins which could be of interest for furthering our understanding of cumulative effects include those in the East coast of Scotland. Hall summarised the information available for this population which includes long-term abundance estimates (over the last ~20yrs) as well as estimates of vital rates. Potential stressors in this region include noise and vessel interactions, pollution, pathogen exposure from sewage outfalls and exposure to biotoxins including domoic acid and saxitoxins.

6.2 Southern resident killer whales

Noren presented information on southern resident killer whales (SRKW), a group of resident type (fish eating) killer whales that inhabit the Northeast Pacific Ocean. The SRKW distinct population segment (DPS) is comprised of three matrilineal pods (J, K, L). This population occurs in waters off the USA and Canada, ranging from the central California coast (Monterey Bay) to southeast Alaska. The core critical habitat of SRKWs (Apr.-Oct.) includes coastal waters off Washington (USA) and the inland straights of Washington (USA) and British Columbia (Canada). Beginning in the late 1960s, a live-capture fishery removed killer whales for display at marine parks, resulting in an immediate steep population decline. Live captures of SRKWs ended in the early 1970s and since that time the population experienced several periods of growth and decline. From 1996 to 2001, the population was reduced to 80 whales. Because of this decline and other factors, the Southern Resident killer whale DPS was listed as Endangered under both the US Endangered Species Act (ESA) and the Canadian Species at Risk Act (SARA).

Individuals are highly tractable to study because there is an annual photo ID survey, which was initiated in the early 1970s. As such, all births, deaths, and maternal relationships since that time are known. The total number of individuals (76 individual SRKWs as of Sept. 2017), survival rates (by age and sex class), and female fecundity (by age) are lower (Ward *et al*., 2013, 2016) in SRKWs compared to other resident populations in the Northeast Pacific Ocean (e.g. Northern resident killer whales and Southeast Alaska resident killer whales). There is some evidence (fecal hormones, aerial photogrammetric images) that SRKWs have a high rate of pregnancy loss, including the loss of calves during late term gestation/early post-partum. The primary stressors facing SRKWs are lack of sufficient prey (quantity and/or quality), disturbance from vessels and sound, and exposure to chemical contaminants (e.g. persistent organic pollutants, POPs).

Southern resident killer whales primarily consume salmon, particularly Chinook. Several salmon stocks in the region are depleted and listed under the US ESA. The size of individuals in some stocks have also decreased over recent decades (Ohlberger *et al.,* 2018). Vital rates (survival and fecundity) of both Northern and Southern resident killer whales are related to indices of Chinook abundance (Ward *et al.,* 2009). SRKWs compete with fisheries and other predators, particularly increasing populations of pinnipeds (Chasco *et al.,* 2017a, 2017b). Finally, POP concentrations (measured in SRKW feces) may be higher when prey abundance is low (Lundin *et al.,* 2016).

SRKWs are exposed to high levels of vessel noise and disturbance from shipping traffic, ferries, private boaters and a large commercial fleet of whale watch boats from Canada and the US. During the summer months SRKWs can be followed by private and commercial whale watchers for nearly 12hrs per day. Changes in respiration rate, swim speed, and path directedness have been observed when boats are within 400m (Williams *et al*., 2009). Rates of surface active behaviours (SABs) increase in response to close approaches and the number of vessels present within 400m (Noren *et al.,* 2009, Williams *et al.,* 2009). Call amplitude (loudness) increases with increasing background noise, which increases with the number of vessels present within 1,000m (Holt *et al.,* 2009). The metabolic cost of most of these short-term behavioural responses, measured through modelling and experiments on trained bottlenose dolphins, are relatively low, but do increase with intensity and/or repetition (Holt *et al*., 2015; Noren *et al.,* 2012, 2013, 2017a, 2017b). The reduction of foraging behaviour and increase in travel when boats are within 400m (Lusseau *et al.,* 2009) is likely to be a greater impact to SRKW, particularly because the number of hours spent foraging can significantly decrease when SRKWs are exposed to vessels for 12hrs (Noren *et al*., 2017b). Vessel presence may increase stress hormones during periods of low prey availability (Ayres *et al*., 2012).

Relative concentrations of persistent organic pollutants vary by pod and individual (Krahn *et al.,* 2007, 2009). Differences between pods reflect differences in habitat use patterns. As yet, no empirical studies to assess effects of POPs on reproduction and health have been conducted, but that is an area of concern given the lower survival and reproductive rates for SRKWs. Preliminary results from a study on trained killer whales to assess POP transfer from females to their calves suggest that the highest contaminant concentrations are transferred in milk during the first few months post-partum, which is a concern, given that neonate mammals are still developing after birth.

Given the multiple risks facing Southern resident killer whales, this population is an excellent case study for cumulative effects. Several killer whale populations (resident and transient killer whales) residing in the Northeast Pacific Ocean could be used as comparative populations to tease apart the relative impacts of risk factors facing Southern Resident killer whales. Trained bottlenose dolphins and killer whales could also be used to collect relevant physiological data to better understand physiological impacts of stressors.

6.3 Gulf of Mexico sperm whales

Garrison presented information on the northern Gulf of Mexico (GoMex) sperm whale population that has been the focus of environmental impact assessments and related studies since the late 1990s. The sperm whale is only cetacean species in the GoMex listed under the US Endangered Species Act, and therefore the primary focus of this research has been supporting environmental assessments related to the potential impacts of energy exploration and extraction activities. In particular, the Bureau of Offshore Energy Management (BOEM, formerly Minerals Management Service) has supported several studies directed at understanding the response of sperm whales to exposure to seismic airgun activity (e.g. SWSS, Jochens, 2008). Additional studies have focused on sperm whale prey resources and the habitats and spatial distribution of sperm whale in the southeastern Gulf of Mexico (SEFSC, unpublished data). Most recently, a Population Consequences of Disturbance (PCoD) model has been developed for GoMex sperm whales that quantifies the behavioural and energetic effects of exposure to sound from seismic airguns. The PCoD study included the development of a detailed bioenergetics model. Given the management requirements for understanding the influence of anthropogenic stressors on sperm whale population dynamics and the work done to date on behavioural and bioenergetic responses to exposure to sound, the GoMex sperm whale population may be a tractable study species to explore applications of the PCoMS approach.

Information on GoMex sperm whale abundance and spatial distribution has been collected since the late 1980s. Abundance estimates have primarily been developed from vessel-based visual line transect surveys. To date, the estimates used in MMPA stock assessment reports have not been corrected for the probability of detection on the trackline and thus are known to be negatively biased. The most reliable abundance estimates based upon survey data from 1996-2001, 2003-2004, and 2009 range between 763 animals (CV=0.38) and 1,665 animals (CV=0.20). The estimate for 2009 was substantially lower than that from 2003-2004, though the difference was not statistically significant. A recent abundance estimate derived from a spatial density model, averaged over all available survey data, and including corrections for detection probability was 2,138 (Roberts *et al.,* 2016). Additional vessel data collected during the summers of 2018 and 2019 will provide updated abundance estimates and will be followed by a more robust analysis of temporal trends in abundance. There is a lack of information on the degree to which sperm whales in the northern GoMex utilise habitats of the southern Gulf outside of US waters.

Sperm whale habitat use and spatial distribution are key considerations in evaluating the exposure of GoMex sperm whales to anthropogenic stressors. Spatial density modelling conducted by the SEFSC evaluated seasonal and spatial patterns in sperm whale density from recent survey data. There was a bimodal relationship with bathymetric slope whereby there were high densities of sperm whales in areas with high values for slope (i.e. along the shelf break), a gap in distribution, and then high densities in areas with lower slope (i.e. in deeper waters of the central Gulf). In addition, sperm whales demonstrated a strong association with mesoscale circulation features and regions with water flows tending to transport primary production from the continental shelf into deep waters and along the outer edges of eddies. These are regions where upwelling may be expected to occur driving high concentrations of mesopelagic secondary production. In general, the spatial density models predict high densities of sperm whales both along the shelf break from the Mississippi River delta into the western Gulf and in deep waters of the central Gulf. These spatial patterns are consistent with movement patterns of sperm whales tagged with telemetry tags during both the SWSS project (Jochens *et al.,* 2008) and Natural Resource Damage Assessment studies conducted during 2010-2013 (Bruce Mate, Oregon State University, unpublished data) indicating distinctions between sperm whales that prefer ‘shallow’ versus ‘deep’ habitats. In addition, there is an area of high sperm whale density in the southeastern Gulf North of the Dry Tortugas. Telemetry tag studies and some genetic and photo-identification analyses suggest that sperm whales in this region may be distinct from those of the northern GoMex, and their range may include Mexican waters of the Campache Bank and the

Florida East (Atlantic) coast. This apparent complexity in population structure and/or habitat use may result in sub-groups of sperm whales with differential exposure to various stressors.

The GoMex is one of the most highly industrialised bodies of water in the world and, as a result, sperm whales occupying the region are exposed to a broad suite of anthropogenic and natural stressors. The primary industrial activity is oil and gas extraction that is focused on the continental shelf and inner continental slope of the western GoMex. This includes oil platforms, pipelines, and high levels of vessel activity associated with servicing of this infrastructure. To a large extent, these activities overlap with regions of high sperm whale density along the shelf break and inner continental slope. The eastern Gulf and deeper waters of the central Gulf are largely free from oil extraction activities.

Another key stressor for this population was exposure to oil from the Deepwater Horizon oil spill in 2010. Sperm whales were observed during the spill close to the wellhead and in the areas with the highest concentration of surface oiling. The footprint of the most intense oil exposure included deep waters of the north-central Gulf. Based upon this footprint, it was estimated that approximately 16% of the sperm whale population was exposed to surface oil and was expected to experience injury including reductions in both survival and reproductive success. In addition, recent studies have suggested the possibility of large-scale depletion of potential prey resources as a long-term secondary effect of the Deepwater Horizon oil spill. It remains to be seen if this is an additional, as yet unquantified, stressor for sperm whales.

A broad suite of additional stressors may influence sperm whale population dynamics, in particular the possibility of disease events, a large region of hypoxia in the central Gulf, and the potential transport of pollutants into the oceanic waters of the GoMex through inputs from the Mississippi River. The high level of industrial activity also results in very high levels of pervasive low frequency noise due primarily to vessel traffic and seismic exploration. While it is unlikely that sperm whales have the same sensitivity to low frequency sound that baleen whales may have, it is unknown whether or not chronic increases in noise levels interfere with sperm whale feeding and communication.

The available information on sperm whale behavioural responses, bioenergetics and population dynamics has been recently integrated into a PCoD model focused on the influence of exposure to sound from airguns (Farmer *et al.,* in review). The primary mechanism for impacts to the sperm whale population is through a behavioural response whereby animals suspend foraging activity in the presence of airgun noise. The model explicitly included the degree of overlap between sperm whales and the degree of airgun activity in different regions of the Gulf. The cessation of feeding may lead to depletion of metabolic reserves, reduction in the energy available for calving and lactation, and perhaps a starvation response and elevated mortality. These responses at the level of individuals were integrated into a population model that also accounted for the reductions in survival and reproduction for the portion of the population exposed to Deepwater Horizon oil. The key uncertainty in this model is the degree of behavioural response to sound exposure. There is a dearth of available data to characterise this response and a broad range of values are reported in the literature. In addition, the underlying bioenergetics model relies upon data from other regions and it is possible that GoMex sperm whales have chronically low levels of energetic reserves due to the long term and increasing exposure to industrial activities over the last 50-70yrs. Identifying and addressing these key uncertainties through additional data collection will be essential for improving the current PCoD approach.

The GoMex sperm whale is a viable candidate in which to explore the development of a PCoMS approach that includes the effects of interactions between multiple stressors on population dynamics. Relative to other deep-diving cetaceans (e.g. beaked whales), there is a relatively rich collection of data on abundance, spatial distribution, behavioural responses, bioenergetics and physiology. In addition, analogies may be drawn between bottlenose dolphins exposed to Deepwater Horizon oil and sperm whales experiencing similar exposure. For example, quantification of the intensity and duration of lung diseases or adrenal effects in bottlenose dolphins may be used to characterize potential impacts on sperm whales that could intensify the energetic costs associated with cessation of feeding or food limitation. The primary challenge for implementing the PCoMS approach will be developing and applying tools to assess the health and metabolic status of free-swimming sperm whales. Tools such as photogrammetric analysis of body condition, sampling and analysis of biopsy tissue samples, and sampling and analysis of fecal or breath samples hold some promise for improving health assessment. Ideally, the current models could be evaluated for sensitivity to key parameters and field studies could be implemented to collect data that would reduce bias and uncertainty in those parameters. In addition, the differential exposure of different sperm whale groups to different suites of stressors may provide an opportunity to test hypotheses regarding interaction effects within the PCoMS framework. There are significant management and conservation drivers that may lend both urgency and resources to addressing these key data gaps over the next 3-5yrs.

6.4 Cook Inlet belugas

Rowles provided an overview on the Cook Inlet beluga population that was proposed as one of the case studies that would be useful to examine interactions of cumulative effects. The recent North Atlantic Marine Mammal Commission (NAMMCO) Global Assessment of beluga populations and the recent PCoD modelling workshop for the Cook Inlet beluga population provide information on both status, potential comparison populations and an approach to evaluate noise which would inform the study of cumulative effects interactions. Cook Inlet belugas are one of five recognised beluga populations in the US and reside within Cook Inlet, Alaska. Historically, the population was subject to unregulated commercial, sport and subsistence hunting. A steep decline in the population during the mid-1990s coincided with a period of large-scale, unregulated subsistence hunting. In 1999, a moratorium promulgated through regulation was implemented on Cook Inlet beluga whale harvests limiting subsistence hunts to those conducted under cooperative agreements between NMFS and affected Alaska Native organisations. There has been a zero quota since 2006. The corrected annual abundance estimates for 1994-2016 are shown in Fig. 4. From 1999 to 2016, the rate of decline was 0.4% (SE=6%) per year, with a 73% probability that the growth rate is negative, while the 10-year trend (2006-2016) is -0.5% per year (with a 76% probability the population is declining) (Shelden *et al.,* 2017). In

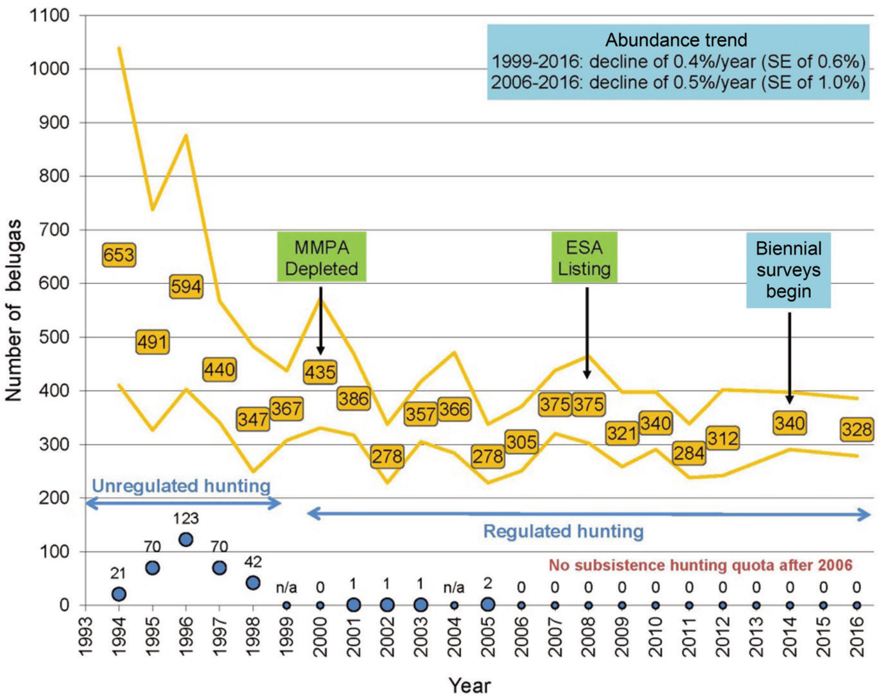

Fig. 4. The corrected annual abundance estimates of Cook Inlet beluga for 1994-2016.

addition to the decline in abundance, there has been a contraction of habitat use to the upper portion of Cook Inlet. The area of habitat used has decreased by 75% from 7,226km^2 in 1978-79 to 1,787km^2 in 2009–14 (Shelden *et al*., 2015). The 2009-16 range was estimated to be only 29% of the range observed in 1978-79, a slight increase from 25% for the period 2009-14 (Shelden *et al*., 2017). Through examinations of carcass, growth curves have been developed using evaluation of GLGs of teeth with total carcass length and timing of reproduction from identification of fetuses, calves and neonates. Based on these studies, breeding is most likely occurring in May and calving is primarily occurring from June through August. There remain data gaps relative to the assessment of the population, however new studies are underway to fill some of those gaps.

The decline of the Cook Inlet beluga stock has been well documented (Hobbs *et al*., 2015). While the early cause of the decline is most likely the unrestricted hunting, the factor(s) preventing recovery of this stock since that time are unclear. There has been a zero quota since 2006 and the role of commercial fisheries is likely to be very low. The threats that may be affecting this population were discussed and ranked in the Recovery Plan for the Cook Inlet Beluga Whale (NMFS 2016). Threats that were ranked as high include cumulative effects of multiple stressors, catastrophic events, noise and disease (i.e. pathogens, harmful algal blooms); medium includes habitat loss or degradation, prey reduction and unauthorised take; and low includes pollution, predation and subsistence harvest. Of continued concern is the reduction in habitat use and the high concentration of the population in the same area at the same time, which increases the risk of large catastrophic events (e.g. oil spill, harmful algal blooms, infectious disease outbreak) affecting a large portion of the population. Recent passive acoustic monitoring studies provide further evidence that noise is a high priority threat for this population (Castellote *et al*., 2016, Small *et al*., 2017). These studies demonstrated that a variety of noises have exposures of greater than an hour and for several sound sources, the proportion of time with sound exposures exceeding 120dB, the current threshold for behavioural harassment for cetaceans, was high (Castellote *et al*., 2016). This population, therefore, provides an excellent case study or model population for future research into the impacts and interactions of multiple stressors. The St. Lawrence beluga population provides a comparison population for evaluation and collaboration between US and Canadian researchers is already underway.

7. CONCLUDING REMARKS

The participants thanked all the presenters of the case studies for their excellent overviews and noted the importance of information on cumulative effects for each of these populations. The Workshop recognised the value of highlighting these cases that could be used in future cumulative effects assessments and collectively identified all of the potentially beneficial case study species and populations where research on multiple stressors and the nature of their interactions, could be conducted. This was conducted at two levels. The first was to list *only* those examples where it was recognised the multiple stressors and cumulative effects (i.e. where antagonistic or synergist effects were likely, rather than impacts being additive) were potentially important (Table 1, Group 1). The second was to identify additional cetacean species and populations where data were available for a more limited set of stressors and where cumulative effects *may* be acting (Table 1, Group 2).

8. RECOMMENDATIONS

Recognising IWC's ongoing interest in environmental changes on cetacean populations and identifying the need to better understand the impact of cumulative effects on cetaceans, it was noted that there is considerable uncertainty in this field and a continuing need to provide assessments and management advice with current state of knowledge.

The Workshop **recommended** that:

(1) Case studies be further developed, particularly focusing on how stressors interact to affect cetacean health and how that relates to vital rates.

Table 1

Case study populations and species that could be used to investigate the cumulative effect of various stressors.

Where are cumulative effects potentially important?	Relevant data available?	Pathogens	Biotoxins	Chemical pollution	Noise	Prey quantity/ quality	Human Interactions (e.g. dolphin or whale watching)	Ship /vessel strike	Entanglement	Bycatch (lethal and non-lethal)
Possible potential case study species and/or populations										
GROUP 1										
North Atlantic right whales	High	X	X		X	X		X	X	X
Beluga Cook Inlet	High	X	X	X	X	X				
Beluga St Lawrence Estuary	High	X	X	X		X	X	X	X	X
Southern resident killer whales	High			X	X	X	X	X		
Bottlenose dolphins (GoM)	High	X	X	X	X	X	X		X	X
Harbour porpoise (N Sea)	High	X	X	X	X					X
Bottlenose dolphins (Georgia)	High	X		X		X	X		X	X
Franciscana	High	X		X	X	X			X	X
GROUP 2										
Western gray whales	High	X			X	X				
Bottlenose dolphins (Black Sea?)	Low		X	X						X
Sperm whales (GoM)	Low/Medium			X	X	X		X		
Bryde's whales (GoM)	Low/Medium			X	X	X		X		
Bottlenose dolphins (North Sea)	Low/Medium		X	X	X					
Bottlenose dolphins (Southern Brazil)	High	X		X	X			X	X	X
Bottlenose dolphins (Northern Gulf of California)	Low			X	X					X
Guiana dolphins (South and Southeast Brazil)	Medium	X	X	X	X			X	X	X
Harbour porpoise (West Scotland)	Medium		X	X	X					
Bottlenose dolphins (Carribean Panama)	High	X	X	X	X		X	X	X	
Bottlenose dolphins (Madeira)	High			X	X	X	X	X		X
Short finned pilot whales (Madeira)	High			X	X	X	X	X		
Bottlenose dolphins (Fjordland NZ)	Low?						X			

(2) Methods to assess health be developed across species and populations for which similar and sufficient data sources are available (see Table 1). The primary focus should be on populations for which it is believed there is most chance of success i.e. those for which good information is available on both cetaceans and potential stressors over a reasonable time period, recognising that overall there are few cetacean populations studied with sufficiently broad sampling programmes covering sufficiently long-time frames.
(3) Biomarkers of health be developed for use in the field, particularly using 'omics approaches and new technologies, recognising that new techniques need to be applicable to free-swimming cetaceans. In addition, methods for investigating interactions between stressors should be developed, (or example utilising the potential of *in vitro* exposure-response studies).
(4) The key data gaps in assessing the nature of the interactions between stressors be addressed, focusing primarily on those that may act through the same physiological pathways.
(5) Nevertheless, consideration needs to be given to developing a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern. For those where there is immediate concern, where possible, action should be taken to mitigate any recognisable adverse effects.
(6) Develop ways of communicating current knowledge about multiple stressors and their potential for cumulative effects to a wider audience particularly conservation managers, policy makers and other stakeholders.
(7) Monitor the progress of cumulative effects studies in the Environmental Concerns sub-committee.
(8) Ways of progressing cumulative effects studies in conjunction with other similar initiatives should be explored, recognising that implementing these studies requires considerable resources due to their long-term and complex nature.

The Workshop thanked Hall for chairing the Workshop and looked forward to the advancement of assessing the impacts of cumulative effects to cetaceans.

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Annex A

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Annex B

Glossary of Terms

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Acute Effect – The severe, often lethal, effect of a stressor on an individual that occurs rapidly and is of short duration (see also Chronic Effect).
Acute Exposure – Exposure to a stressor that occurs for a single, discrete period of time (see also Chronic Exposure and Intermittent Exposure).
Adaptive Management – A systematic approach for improving resource management by learning from management outcomes.
Additive Stressor Effect – The combined effect of two or more stressors is considered additive when the shape of the dose–response function of either stressor does not change in the presence of the other stressor (see also Antagonistic Stressor Interaction, Interactions Among Stressors, Stressor, and Synergistic Stressor Interactions).
Adverse Outcome Pathways – A structured representation of biological events leading to adverse effects that is often considered in risk assessments.
Aggregate Exposure – The combined exposure to one stressor from multiple sources or pathways integrated over a defined relevant period: a day, season, year, or lifetime.
Allostatic Load – An organism's cumulative physiological degradation resulting from exposure to stressors, as well as from heightened activity of physiological systems or changes in metabolism.
Antagonistic Stressor Interaction – The interaction of two or more stressors is considered antagonistic if the resulting effects are less than the sum of the effects of the individual stressors (see also Additive Stressor Effect, Stressor, and Synergistic Stressor Interactions).
Bias – The difference between a true population parameter and the expected value of the estimate of that parameter (see also Precision).
Chronic Effect – A stressor effect that does not immediately result in death or reproductive failure, but persists or is irreversible, and may influence long-term survival or reproductive success.
Chronic Exposure – Ongoing or continuously occurring exposure to a stressor (see also Acute Exposure and Intermittent Exposure).
Cumulative Risk – The combined risk from exposures to multiple stressors integrated over a defined relevant period: a day, season, year, or lifetime.
Direct Effects – When considering the influences and interactions among species, and between species and their abiotic environment, direct effects are the proximate impacts that one species or factor has on another species or factor without the effect occurring via an intervening species or factor.
Dose – The magnitude or amount of a stressor that is directly experienced or ingested, inhaled, or absorbed by an animal, ideally measured by a dosimeter on the animal.
Dose–Response Relationship – The relationship between the amount of exposure (dose) to a stressor and the resulting changes in behaviour, physiology, or health (response).
Driver – A biotic or abiotic feature of the environment that affects populations directly and/or indirectly by changing exposure to a single (or multiple) extrinsic stressor.
Ecological Driver – A biotic or abiotic feature of the environment that affects multiple components of an ecosystem directly and/or indirectly by changing exposure to a suite of extrinsic stressors. Ecological drivers may operate on multiple species at varying trophic levels and may affect multiple ecosystems.
Exposure – Contact with or experience of a stressor, ideally measured in the environment near the animal.
Extrinsic Stressor – A factor in an animal's external environment that creates stress in the animal (see also Intrinsic Stressor and Stressor).
Health – The ability of an organism to adapt and self-manage.
Homeostasis – The tendency of the physiological systems of an organism to maintain internal stability in response to stimulus that might disturb its normal condition or function.
Indirect Effects – Interactions between species or between species and the abiotic environment that occur through one or more intervening species or abiotic factor.
Interactions Among Stressors – Interactions occur when the presence of one stressor changes the shape of the dose–response function of the other stressor (see also Additive Stressor Effect).
Intermittent Exposure – Exposure to a stressor that occurs intermittently, repeatedly, or in cycles (see also Acute Exposure and Chronic Exposure).
Intrinsic Stressor – An internal factor or stimulus that results in a significant change to an animal's homeostatic set point. Short-term internal stresses that evoke physiological responses occurring daily to maintain an organism near its homeostatic set points *are not* considered stressors, but

natural aspects of an individual's life cycle (e.g., lactation, migration and fasting) that result in significant changes to homeostasis are considered stressors (see also Extrinsic Stressor and Stressor).

Oxidative Stress – Stress to an organism caused by a disturbance in the balance of prooxidants and antioxidants.

Recovery – Restoration of normal function after withdrawal of a stressor.

Stressor – Any causal factor or stimulus, occurring in either the animal's internal or external environment, that challenges homeostasis of the animal.

Synergistic Stressor Interactions – The interaction of two or more stressors is considered synergistic if the resulting effects are more than that of the sum of the effects of the individual stressors (see also Additive Stressor Effect, Antagonistic Stressor Interaction, and Stressor).